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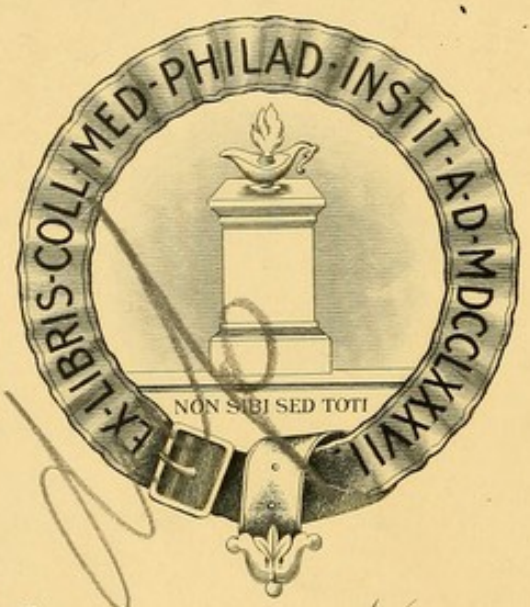

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Barton Cooke Hirst, M.D.

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MANUAL

OF

ANTENATAL PATHOLOGY

AND HYGIENE

THE FŒTUS

BY

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NEW YORK

WILLIAM WOOD & COMPANY

MDCCCCII

NATIS ET

NASCITURIS

Qui in utero est, pro jam nato habetur

LEGAL MAXIM

PREFACE

I HAD hoped within the compass of one volume to have presented the whole subject of Antenatal Pathology and Hygiene. It was my purpose to have included not only the physiology and the diseases of the fœtus, but also the monstrosities of the embryo and the morbid states of the germ. I have been compelled, however, to devote this volume to Fœtal Physiology and Pathology alone, leaving Teratology and Morbid Heredity to be treated in a separate but a companion book, which may be regarded as Section II. of this Manual. To have done otherwise, would have been to swell the work to an unwieldy size and to delay its appearance unduly.

There have been many workers in this field of research, and their work has been most fruitful; but each investigator has seldom had an opportunity of studying more than a few specimens of fœtal disease and deformity, and has, in consequence, been led to concentrate his attention upon the special pathological conditions which came in his way. I, on the other hand, have had the extraordinary fortune to be able personally to examine nearly three hundred specimens, embracing almost all the leading types of antenatal morbid states, and I have thus been enabled to take a somewhat wide view of the whole subject. Further, many other workers have been generously ready to put their own material at my disposal for inspection; and I have also read very widely the literature of the subject and of allied departments of medicine and biology.

I began this work in a spirit of something very like active curiosity, I have prosecuted it with an ever-deepening interest, and I have brought it thus far with the growing sense that I have been dealing with a subject of tremendous importance for the future of the race and the individual, with, in fact, *preventive medicine* in its simplest and most hopeful because in its earliest aspects. If we but knew the laws which govern antenatal health and the causes which produce antenatal disease and death, what might we not expect the possibilities of Hygiene to grow to!

In writing the book, I have honestly tried to avoid the four grounds

of human ignorance set forth so long ago by Roger Bacon: trust in inadequate authority, the force of custom, the opinion of the inexperienced crowd, and the hiding of one's own ignorance with the parading of a superficial wisdom. I dare not hope that I have always succeeded; many times I ought perhaps to have said, "I do not know," where I have set forth high-sounding theories; but I have done what seemed at the time possible.

Only one or two further prefatory sentences need be added. I have avoided, as far as possible, burdening the text with bibliographical references, and have endeavoured rather to cite articles which themselves contain full lists of literature; I have, for instance, often referred to contributions of my own, which have appeared elsewhere, which fulfil this requirement. In the Appendix will be found a list of my writings on Antenatal Pathology and cognate subjects, and the numbers within brackets which appear in the text refer to this list. The historical aspects of the subject have scarcely been touched; they are described in detail in the first volume of my work, *The Diseases of the Fœtus.* The illustrations are nearly all from specimens in my own collection; but for Figs. 9, 24, 28, 32–44, and 50 I am indebted to other workers. The investigation of most of the specimens was carried out in the Laboratory of the Royal College of Physicians, Edinburgh.

I cannot adequately express my indebtedness to my friend, Dr. John Thomson, who has not only read every proof with painstaking solicitude, but has also given me advice of great value and that unstintedly.

To my Publisher my best thanks go freely, and they are well deserved, for he has constantly endeavoured to meet my wishes with regard to every detail.

J. W. BALLANTYNE.

24 Melville Street, Edinburgh,
January 4, 1902.

CONTENTS

BOOK I

ANTENATAL IN RELATION TO POSTNATAL AND NEONATAL PATHOLOGY

CHAPTER I

PAGE

The Novelty of Antenatal Pathology: its Definition, Emergence, and Literature; Age-incidence of Morbid Processes; Divisions of Antenatal Life; Scheme of Antenatal Life; Subdivisions of Antenatal Pathology; Signs and Causes of Increased Interest in Antenatal Pathology 1

CHAPTER II

The Relation of Antenatal Pathology to the other Branches of Study: Scheme of Relationships; Relation to General Pathology; Relation to the Biological Sciences—Anatomy, Embryology, Physiology, Botany, and Zoology; Relation to the Medical Sciences—Obstetrics, Public Health, Pediatrics, Medicine, Psychology, Dermatology, Surgery, Orthopedics, and Medical Jurisprudence; Relation to Gynecology and Neonatal Pathology 16

CHAPTER III

The Postponed Effect of Antenatal Pathology; the Antenatal Factor in Gynecology; Traumatism, Infection, Antenatal Conditions; the Antenatal Factor in the Morbid Anatomy, Symptomatology, Etiology, Diagnosis, Prognosis, Therapeutics, and Jurisprudence of Gynecology . 22

CHAPTER IV

The Immediate Effect of Antenatal Pathology; the Antenatal Factor in Neonatal Pathology; the Neonatal Period of Life; Physiology of Neonatal Life; Physiological Traumatism of Birth, including the Pressure Effects and the Separation Effects; Physiological Readjustment at Birth, and its Influence upon the Characters of the Maladies of the New-born Infant; Anatomical Readjustment; the Antenatal Factor and its Influence upon Neonatal Pathological Processes . . 33

PAGE

CHAPTER V

Types of Neonatal Disease, illustrating the Intrusion of the Antenatal Factor: (1) Intracranial Traumatisms, Cephalhæmatoma Neonatorum, Facial Paralysis, Fractures of the Long Bones, Dislocations; (2) Intranatal Infections, Ophthalmia Neonatorum, Hæmatoma of the Sterno-Mastoid, Mastitis Neonatorum 44

CHAPTER VI

Types of Neonatal Disease, illustrating the Intrusion of the Antenatal Factor (*cont.*); (3) Neonatal Infections, Tetanus Neonatorum, Erysipelas Neonatorum, Sepsis Neonatorum, Hæmoglobinuria Neonatorum, Omphalorrhagia Neonatorum; (4) Disturbed Neonatal Readjustments, Icterus Neonatorum, Melæna Neonatorum, Keratolysis Neonatorum, Pemphigus Neonatorum, Sclerema Neonatorum, Asphyxia Neonatorum, Neonatal Heart Disease; Summary 57

BOOK II

THE PATHOLOGY AND HYGIENE OF THE FŒTUS

CHAPTER VII

Diseases of the Fœtus; General Characters of Fœtal Life; Contrast between Embryonic and Fœtal Life; The Neofœtal Period; Anatomy and Physiology of the Neofœtal Period; External, Internal, and Environmental Changes in the Neofœtal Epoch; Fœtal Growth and Development at the Successive Months of Intrauterine Life; Summary . 77

CHAPTER VIII

Anatomy of the Mature Fœtus. Anatomy of the Region of the Head, Spine, Neck, Thorax, Abdomen, Pelvis, and Limbs. Anatomy of the Umbilical Cord, Placenta, and Membranes 99

CHAPTER IX

Physiology of the Fœtus: General Statements; Sources of Information; Fœtal Circulation, Extra-corporeal or Placental, Intra-corporeal with Main Current and Secondary Circulations; Cardiac Activity, Peculiarities; Pulse; Blood in the Fœtus, Characters; Respiration in the Fœtus 126

CHAPTER X

Physiology of the Fœtus (*cont.*): Temperature of the Fœtus; Chemical Composition of Fœtus, Placenta, and Liquor Amnii; Nutrition of the Fœtus, by Liquor Amnii, Umbilical Vesicle, and Placenta; Secretions of the Fœtus, Hepatic, Buccal, Gastric, Pancreatic, etc.; Excretions of the Fœtus, Intestinal, Renal, Placental; Passage of Substances from Fœtus to Mother; Internal Glandular Secretions in Fœtus, of Thymus, Thyroid, Suprarenal Capsule, and Pituitary Body; Growth of the Fœtus, Determining Factors; Movements of the Fœtus; Sensation in the Fœtus 145

PAGE

CHAPTER XI

Fœtal Pathology: General Principles. Scope of Fœtal Pathology; Causes of Limited Knowledge; Fœtal Morbid States; Classification; Causes of Peculiarities of Fœtal Diseases — (1) Influence of Intrauterine Environment; (2) The Placental Factor; (3) The Embryonic Factor . 172

CHAPTER XII

Types of Transmitted Fœtal Diseases: Fœtal Variola; Pathogenetic Possibilities; Clinical Peculiarities; Diagnosis, Prognosis, and Treatment. Fœtal Vaccinia; Antenatal Immunity. Fœtal Measles, Scarlet Fever, Erysipelas, Parotitis, Influenza, Pertussis, Relapsing Fever, Yellow Fever, and Cholera. Fœtal Typhoid; Pathogenetic Possibilities; Widal Test in the Fœtus. Fœtal Malaria; Observations; Pathogenetic Possibilities 188

CHAPTER XIII

Types of Transmitted Fœtal Diseases: Fœtal Tubercle; Evidence of its Existence; Causes of its Rarity; Characters; Baumgarten's Theory of Latency; Non-tubercular Manifestations of Antenatal Tubercle; Prophylaxis; Fœtal Sepsis; Fœtal Epidemic Cerebro-spinal Meningitis; Fœtal Purpura; Fœtal Pneumonia; Fœtal Anthrax; Fœtal Rheumatic Fever 206

CHAPTER XIV

Types of Transmitted Fœtal Diseases: Fœtal Syphilis; Limitation of the Subject; Definitions of Infantile, Neonatal, and Fœtal Syphilis; Morbid Anatomy, General and Special; Dystrophies of Antenatal Syphilis; Pathogenesis; Nature of the Morbid Agent; Modes of Transmission of the Syphilitic Virus; Effects of Fœtal Syphilis; Modifying Influences; Treatment 225

CHAPTER XV

Types of Transmitted Toxicological Conditions: Sources of Information; Problems; Lead Poisoning; Mercurial Poisoning; Phosphorus Poisoning; Arsenical Poisoning; Poisoning with Copper and Sulphuric Acid; Carbonic Oxide and Coal Gas Poisoning; Effects of Chloroform and Ether; Morphin Poisoning; Tobacco Poisoning; Alcoholism . . 258

CHAPTER XVI

Ill-defined Morbid States of the Fœtus: in Maternal Eclampsia; Cancer; Diabetes: Leukæmia; Heart-Disease, etc.; Conclusions . . 278

CHAPTER XVII

Idiopathic Diseases of the Fœtus—Types: General Fœtal Dropsy—Definition, Clinical History, Symptomatology, Morbid Anatomy, Etiology, Pathogenesis, Diagnosis, Treatment; General Cystic Elephantiasis of the Fœtus—Definition, Clinical History, Morbid Anatomy, Pathogenesis; Congenital Elephantiasis — Definition, Clinical History, Symptomatology, Physical Signs, Pathogenesis, Treatment; Congenital Myxœdema; Atrophic States of the Subcutaneous Tissue . . 288

PAGE

CHAPTER XVIII

Idiopathic Diseases of the Fœtus (*cont.*): Types of Skin Diseases: Fœtal Ichthyosis (Grave Form)—Definition, Synonyms, Clinical History, Symptomatology, Appearances (Macroscopic and Microscopic); Fœtal Ichthyosis (Mild Form); Tylosis Palmæ et Plantæ; Fœtal Keratolysis; Hypertrichosis congenita—Definition, Synonyms, Recorded Cases, Clinical History, Pathogenesis; Localised Form of Hypertrichosis; Congenital Alopecia—Clinical Characters, Pathogenesis; Antenatal Pemphigus or Epidermolysis bullosa hereditaria; Congenital Absence of Skin; Acanthoma or Amnioma of the Skin 306

CHAPTER XIX

Types of Idiopathic Diseases of the Fœtus (*cont.*): Diseases of the Bones; Nomenclature; Classification; Type A, Characters; Type B, Characters; Type C, Characters; Type D, External Appearances—Clinical History, Pathology, Pathogenesis; Type E, Characters; Bibliography 334

CHAPTER XX

Types of Idiopathic Diseases of the Fœtus (*cont.*): Diseases of the Alimentary System: Fœtal Ascites, Definition, Clinical Features and History, External Appearances, Morbid Anatomy, Etiology, Pathology, Treatment; Fœtal Peritonitis; Congenital Obliteration of the Bile-Ducts, Definition, Clinical History, Symptomatology, Morbid Anatomy, Pathology, Diagnosis, Treatment; Congenital Hypertrophic Stenosis of the Pylorus, Definition, Symptomatology, Morbid Anatomy, Pathogenesis, Treatment 355

CHAPTER XXI

Types of Idiopathic Diseases of the Fœtus (*cont.*): Diseases of the Circulatory Apparatus: Fœtal Endocarditis—Relation to Congenital Cardiac Anomalies, Frequency, Etiology, Characters, Diagnosis, Associated Malformations, Treatment; Antenatal Atheroma: Congenital Goitre; Definition, Illustrative Cases, Morbid Anatomy, Clinical Results, Treatment, Pathology, and Etiology; Diseases of the Respiratory System 369

CHAPTER XXII

Types of Idiopathic Diseases of the Fœtus (*cont.*): Diseases of the Urinary Apparatus: Fœtal Nephritis, Distension of the Bladder, Hypertrophic Dilatation of the Bladder, Hydronephrosis, Cystic Degeneration of the Kidneys: Diseases of the Genital Organs: Congenital Prolapse of the Uterus; Diseases of the Nervous System: Hydrocephalus; Little's Disease; Congenital Chorea; Friedreich's Ataxia; Thomsen's Disease; Congenital Clouding of the Cornea 378

CHAPTER XXIII

Traumatic Morbid States of the Fœtus: Fœtal Fractures, Wounds, and Dislocations; Congenital Amputations. Diseases of the Fœtal Annexa; Placental Hæmorrhages; Fibro-Fatty Degeneration of the Placenta; Morbid States of the Umbilical Cord; Hydramnios—Definition, Clinical History, Symptomatology, Physical Signs, Diagnosis, Prognosis, Pathology, Pathogenesis, Treatment; Oligohydramnion 393

PAGE

CHAPTER XXIV

Intrauterine Death of the Fœtus; Mechanism, Fœtal Asphyxia and Uræmia, Rigor Mortis, Clinical History, Symptomatology, Physical Examination, Diagnosis, Pathology of Maceration, etc., Abortion, Causes of Fœtal Death, Treatment 409

CHAPTER XXV

Diagnosis of Fœtal Morbid States: Difficulties and Scope; Antenatal Diagnosis, Maternal, Medical, and Reproductive History, Paternal and Family History, Maternal Symptomatology and Physical Examination, Physical Examination of the Fœtus; Intranatal and Postnatal Diagnosis 430

CHAPTER XXVI

Therapeutics of Fœtal Diseases: Erroneous Opinions; Value of Fœtal Life, Estimation, Appreciation; Therapeutic Fœticide; Possibilities of Antenatal Therapeutics; Postnatal Treatment of Antenatal Morbid States; Intranatal Hygiene and Treatment 451

CHAPTER XXVII

Hygiene and Therapeutics of Fœtal Life: the Hospitalisation of the Pregnant; "Plea for a Pre-Maternity Hospital"; "Sanatoria de grossesse"; Hygiene of Pregnancy; Diet, Occupation, Exercise, Dress, etc.; Medication of the Fœtus, in Syphilis, Placental Disease, Nervous Maladies, Hæmophilia; Transmission of Immunity; Germinal Therapeutics; Conclusion 465

Appendix. List of Author's Contributions 489

Index of Authors 499

Index of Subjects 507

LIST OF ILLUSTRATIONS

COLOURED PLATES

		PAGE
I.	Transverse section through neck of Full-time Fœtus at level of 4th Cervical Vertebra	108
II.	Transverse section at level of 1st Dorsal Vertebra in same Fœtus	108
III.	Transverse section at level of 6th Dorsal Vertebra in same Fœtus	110
IV.	Transverse section at level of 9th Dorsal Vertebra in same Fœtus	110
V.	Transverse section at level of 12th Dorsal Vertebra in same Fœtus	112
VI.	Transverse section at level of cartilage between 2nd and 3rd Lumbar Vertebræ	112
VII.	Transverse section at level of 1st Sacral Vertebra in same Fœtus	114
VIII.	Transverse section at level of 4th Sacral Vertebra in same Fœtus	114
IX.	Transverse section at level of 3rd Coccygeal Vertebra in same Fœtus	116
X.	Liver from case of Fœtal Syphilis	233
XI.	Vertical Mesial section of Fœtus with Fœtal Bone Disease (Type B)	339
XII.	Vertical Lateral section of trunk of Fœtus with Ascites and Distension of Bladder	355
XIII.	Vertical Mesial section of Pelvis of Infant with Prolapsus Uteri	355
XIV.	Vertical Mesial section of Macerated Fœtus	422

FIGURES IN THE TEXT

1.	Divisions of Antenatal Life	8
2.	Scheme of Antenatal Life	11
3.	Relations of Antenatal Pathology	18
4.	Scheme of Morbid Factors	24
5.	Cephalhæmatoma and Facial Paralysis in New-born Infant (left side)	47
6, 7.	Microscopic appearances of Desquamation of Cuticle in New-born Infant, High and Low Powers	73
8.	Microscopic appearancees of Skin in Sclerema Neonatorum	75

PAGE

9. Embryo of 38 days—"Transition Organism"—After His . . 80
10. Fœtus of 56 days (*circa*) 80
11. Scheme of Fœtal Growth in Length 94
12. Scheme of Fœtal Growth in Weight 95
13. Scheme of Placental Growth in Weight 96
14. Scheme of Relative Development of various parts of Fœtus . . 97
15. Outline of Unmoulded Fœtal Head 100
16. Outline of Head of New-born Infant 101
17. Sagittal Mesial section of Full-time Fœtus 102
18. Lateral Vertical section of Full-time Fœtus 103
19. Coronal section of Head of Full-time Fœtus, through orbits . . 104
20. Coronal section of Head of Full-time Fœtus, through ears . . 105
21. Vertical Sagittal section of Pelvis of Male Full-time Fœtus . . 117
22. Vertical Sagittal section of Pelvis of Female Full-time Fœtus . 118
23. Pelvic Viscera of Six Months' Female Fœtus 119
24. Scheme of Fœtal Circulation. After W. Preyer . . . 128
25. Sphygmographic Tracing from Infant, 5 minutes after Birth . 138
26. Sphygmographic Tracing from Infant, 6 days old . . . 138
27. Placenta with Persistent Umbilical Vesicle and Vitelline Vessels . 155
28. Fœtal Variola. After Laurens 191
29. Section of Tricuspid Valve of Heart from case of Fœtal Endocarditis 197
30. Vertical Mesial section of Fœtus with General Dropsy . . 291
31. Appearances of Head and Face of Fœtus with General Dropsy . 293
32, 33. Cystic Elephantiasis in the Fœtus. After A. Meckel . . 299
34. Infant with Congenital Elephantiasis of right lower limb. After Moncorvo 302
35. Fœtal Ichthyosis. After Straube 309
36. Fœtal Ichthyosis. After Kyber 310
37. Skin of Palm of Hand in Fœtal Ichthyosis. After Kyber . . 311
38. Sections of Skin in Fœtal Ichthyosis, Chest and Head. After Kyber 312
39. Skin of Normal Infant. After Caspary 316
40. Skin of Infant with Ichthyosis of Minor Degree. After Caspary . 317
41–44. The Hairy Family, von Ambras 322
45. Infant with Acanthoma or Amnioma of the Hairy Scalp . . 331
46. Microscopical Appearances of Acanthoma or Amnioma . . 332
47. External Appearances of Fœtus with Bone Disease (Type B) . 338
48. External Appearances of Fœtus with Bone Disease (Type C) . 341
49. Appearances of Lower Limbs and Pelvic Region of the same . . 341
50. External Appearances of Fœtus with Bone Disease (Type D). After Villa 347
51. External Appearances of Fœtus with Bone Disease (Type E) . 351
52. External Appearances of Fœtus with Ascites 359
53. Microscopic Appearances of section of Abdominal Wall from same . 360
54. Appearances of External Genitals of same 361
55. External Appearances of Fœtus with Congenital Goitre . . 374

MANUAL OF ANTENATAL PATHOLOGY AND HYGIENE

BOOK I

ANTENATAL IN RELATION TO POSTNATAL AND NEONATAL PATHOLOGY

CHAPTER I

The Novelty of Antenatal Pathology; Its Definition, Emergence, and Literature; Age-incidence of Morbid Processes; Divisions of Antenatal Life; Scheme of Antenatal Life; Subdivisions of Antenatal Pathology; Signs and Causes of Increased Interest in Antenatal Pathology.

ANTENATAL PATHOLOGY is to some extent a new department of medicine. With it, however, as with many other new things, the novelty consists more in the point of view from which the subject is regarded, and in the mode of considering it which is adopted, than in the nature of the subject itself. From the earliest times congenital diseases and monstrosities and morbid predispositions have been known, and to some extent studied; but it is only within recent years that the information gathered together regarding them has been systematised, and that monstrosities as well as diseases have been shown to be capable of scientific investigation, and to be possessed of practical interest.

Antenatal Pathology, therefore, is new, but only in a limited sense. Nevertheless, Antenatal Pathology, more perhaps than any other branch of medical study, requires an introduction which shall be also an explanation. To some extent it may be thought to need a vindication—to be in want of a reason for its existence. Lately unborn among the sciences, it has but recently seen the light, and, like all new-born things, has a hold on life which is uncertain. Full, no one can doubt, of great possibilities, if it be able to reach maturity; but apparently so weak as to suggest to the careless observer little chance of that. Yet not so long ago was bacteriology—even as Antenatal Pathology now is—provoking the criticism, that the study

of organisms so minute as to need the microscope for their detection was hardly likely, most unlikely indeed, to prove of benefit to the human race, yet pregnant all the while with surgical antisepsis and asepsis, and with the marvels of serum therapeutics. Antenatal Pathology, too, deals with small organisms—to wit, the little fœtus, the tiny embryo, the altogether microscopic ovum and spermatozoon. It thus merits the same condemnation; it may receive a like justification.

Definition of Antenatal Pathology.

Antenatal Pathology is concerned with all the morbid processes which act upon the organism before birth, and with the effects which they produce by their action. In a narrow sense only can its limits be defined. It deals with the pathology of the individual during his fœtal and embryonic existence, and in this respect may be regarded as the pathology of intrauterine life, and have the period of its action limited to ten lunar months; but manifestly any such limitation is unsupported by the known facts. It cannot be doubted that pathological agencies are at work even before the occurrence of impregnation, and that they produce their effects upon the specialised reproductive cells before these have united together, sperm with germ, to form the first rudiments of the individual. Further, the great doctrine of the continuity of the germ plasm pushes back the *terminus a quo* of the action of morbid agents beyond the immediate progenitors of the individual, and compels the student of Antenatal Pathology to take into account the medical history of earlier ancestors. Just as birth marks not a beginning but a stage in the life of the individual, so impregnation marks not a beginning but a stage in the life of the family. Again, and with regard now to the *terminus ad quem*, Antenatal Pathology cannot be said to end with the close of intrauterine life, for it is impossible to prevent the morbid processes which occur before birth from projecting their effects, often with disastrous results, far into the life that is after birth. It is this projection of the antenatal into the postnatal which hinders the formation of an exact definition of Antenatal Pathology. It is necessary to think, not only of the effects of the action of morbid agents upon the organism still in utero, but also of the results which they produce upon the individual in extrauterine life. Incidentally it may be remarked that this fact constitutes one of the most cogent arguments in proof of the practical importance of the study of Antenatal Pathology. Since it has come to be recognised that all infants have not the same starting-point in their life race, so it has been borne in upon the practical physician and surgeon that it may be profitable to investigate the conditions which hinder them. Truly it matters little that the projection of the antenatal into the postnatal has interfered with the exactness of a definition, so long as it has compelled the attention of a medical public, until now perhaps but slightly inclined thereto. Where the profession has hung timidly back, the modern novelist has plunged boldly in, and has not hesitated to deal with any or all the problems of Antenatal

Pathology, from the transmission of syphilis and the causation of malformations, to the predisposition to tuberculosis and the inherited tendency to insanity. It need hardly be said that the effect upon the public mind has not always been for good. Disaster stares the mariner in the face who sets out without rudder or compass. The medical profession must in this matter provide the general public with a rudder, perchance it may yet be able to supply also the compass.

Emergence of Antenatal Pathology.

It is clear, then, that Antenatal Pathology has a novelty, which consists not so much in the facts with which it has to deal, as in the way in which they are approached, and in the standpoint from which they are surveyed. It sets forth a new manner of looking at old facts. The new manner is the scientific; and it has been rendered possible by the marked advances that have taken place in the other departments of medicine and biology. As has been aptly said by Professor A. R. Simpson: "Antenatal Pathology is one of the last provinces of medicine to have emerged from a kind of mediæval wonderland into the realm of science." This is particularly true of a large and very characteristic subdivision of the subject, which has been named Teratology, dealing, as it does, with monstrosities (*terata*) and their mode of origin. It may be doubted whether Teratology has yet emerged from its "mediæval wonderland." The general public, it must at once be admitted, looks upon monstrosities to-day very much in the same way as did the general public and the profession as well in the Middle Ages; but it is a trifle more tolerant of the progenitors of such prodigies. In this respect, however, the general public is not to be too severely censured, for it is unfortunately true that many medical men, when they meet with specimens of antenatal malformation, describe them in a fashion that they would certainly never employ if the case were one of nervous disease or tumour, using a terminology which might with reason be called mediæval. A monstrous fœtus may, it is true, resemble, although the likeness is often far to seek, a dog or a cat or an ape; but in describing no other pathological specimen would it be considered as sufficient or satisfactory to rest content with such a comparison. Yet in many reported cases of monstrosity the morbid anatomy is dismissed with a brief reference to a dog-like or frog-like look, while many lines of print are devoted to the story of an alleged maternal impression during the pregnancy of which the malformed infant was the product. If this be so in the profession, what reason, then, is there for wonder if in the public mind a veil of mystery shroud the birth of a monstrous fœtus?

Literature of Antenatal Pathology.

It has to be borne in mind that Antenatal Pathology has not emerged directly out of the ignorance of the Middle and Dark Ages; it has not sprung full of life immediately out of dead superstitions

and curious questionings of the folk-lore kind. Rather has it arisen out of a sea of books and monographs, out of a perfect ocean of literature. In this ocean, as may well be imagined, there is much that is of little worth; nevertheless, the searcher will now and again bring up in his net something that is of prime import. In its abysmal depths are the teratological records of Chaldea (70),[1] written in cuneiform character on the brick tablets of the great mound of Koyunjik near the Tigris, containing a long list of monstrous infants, with the divinatory meaning of each one of them; for teratoscopy had reached a high development in Babylonia, and the fall of a kingdom, the winning of a battle, and the occurrence of a famine, and much else, were foretold from the birth of a malformed fœtus. Vanishing traces of the teratological occurrences of primitive times among primitive peoples are also to be found in the deformed deities which the heathen ignorantly worship, and in the folk-lore of many nations. Of all the valuable things rescued from the bibliographic sea of teratological literature, nothing is of just so much value as the part of Aristotle's works which deals with monstrosities, both human and of animals. In the "Generatio" and the "Historia Animalium" is displayed a knowledge of the meaning and cause of malformations such as was not equalled in later history till the times of the Saint-Hilaires, in the dawn of the nineteenth century. In the writings that have come down to us under the name of Hippocrates, there is not much that concerns monstrosities, but there are admirable descriptions of congenital dislocations, and disquisitions on morbid heredity, which cannot fail to interest the antenatal pathologist (83). These things, however, are all deep down in the ocean of literature, and it is not till we come near to the surface that there is again much of value to reward our search. From 300 B.C. to 1700 A.D., works on monstrosities (it is impossible to mention works on fœtal disease and morbid predisposition, for they did not exist) have a value which is quite apart from the cases and specimens which are described in them; they throw interesting side-lights upon the manners, customs, and beliefs of the times; but as to scientific Teratology they are singularly dark. During these centuries deformed fœtuses took their place alongside comets, earthquakes, showers of frogs, mock suns, and the like; and were commonly regarded as prodigies, or as warnings of impending evil, or as manifestations of the divine anger. From the beginning of the eighteenth century scientific works on monstrosities began to appear, and have continued to appear, until now one may easily gather together many hundreds of treatises, atlases, monographs, theses, and articles dealing with teratological subjects. In 1702, also, there appeared the first separate work treating of fœtal diseases, as distinguished from monstrosities, the treatise namely of Düttel, entitled "De morbis fœtuum in utero materno," and presented for the degree of medicine in the University of Halle, under the presidency of F.

[1] The figures within parentheses refer to the bibliographical list of the author's published works.

Hoffmann (66). Since then the study of the diseases of the fœtus, as distinct from the monstrosities, has made great advances, until now there has been accumulated a large library of books bearing on this subdivision of Antenatal Pathology. Still more near the surface of the ocean of literature (to return for a moment to our comparison) lie the works in which the morbid predispositions to diseases and deformity, and the mysterious phenomena of heredity, are considered; in them is to be found much that is of value, along with much that is at the best hypothetical.

This, then, is the literature of Antenatal Pathology, or rather it is the literature upon which it is hoped that the subject of Antenatal Pathology may yet be built up; for few, if any, attempts have been made to bring together the monstrosities, and the fœtal diseases, and the morbid predispositions, and treat them as subdivisions of one separate and self-contained department of medicine. It is in this that the novelty of Antenatal Pathology consists; the subject is surveyed from a new point of view, with a vastly widened horizon.

The Age-Incidence of Morbid Processes.

It is conceivable that morbid influences may act upon the individual during three epochs in his existence: they may act after, during, or before birth. In other words, their influence may be exerted in postnatal, in intranatal, or in antenatal life. The results of their action vary with the period during which they act, and hence it comes that there is a postnatal, an intranatal, and an antenatal subdivision of pathology. It goes without remark that it is about postnatal pathology that most is known, for from birth up to death morbid causes are seen at work, and their effects are patent to all. Injuries, poisons, microbes, and parasites all play a part in producing the numerous and varied changes in the structure and functions of the body so fully described in medical and surgical text-books. When pathology is spoken of, it is usually postnatal pathology that is meant.

Even in postnatal pathology the age-incidence of morbid processes can be recognised as an important subdividing factor; differences there are between the pathological changes which are characteristic of advanced age and those which occur in adult life, or in childhood, or in infancy. The rheumatism of childhood, for instance, is very different in its clinical manifestations from that of adult life. In the former, erythema marginatum and papulatum, painless subcutaneous nodules situated over the bony prominences of the knee, elbow, ankle, and spine, and endocarditis and chorea are marked symptoms; while acute pain and tenderness in the joints, high fever, and profuse sweating are often entirely absent. In the rheumatism of adult life, on the other hand, erythemata, nodules, and chorea are uncommon, while grave arthritic developments are frequent. Heart disease also differs in its characters according as it is met with in the child or adult; and there is the typical senile heart.

The differences, however, which mark off these epochs of post-

natal pathological life from one another are small when contrasted with the characters which serve to distinguish neonatal from postnatal morbid changes, and very small indeed when put alongside the deep-seated diversity of antenatal pathology. The differences found in the diseases of the new-born have given origin to a separate nomenclature for them, a neonatal nosology; and we speak of icterus neonatorum, syphilis neonatorum, and melæna neonatorum as if they were superficially different, at any rate, from the jaundice and the syphilis and the melæna of the adult. But such dissimilarity exists between the pathological phenomena which occur before birth, and those which are met with after it, as to suggest essential differences in nature and causation. This is specially true of teratological phenomena. They are startlingly unlike anything else in the whole range of pathology. It is to this peculiarity more than to any other that Teratology owes the isolated position that it has so long occupied. Like Corea among the nations has Teratology been among the sciences: a hermit kingdom, a hermit science! To the onlooker it has seemed as if neither had any part to play outside its own narrow limits. Yet is the whilom hermit subject capable of profoundly influencing the other departments of medical research and of being influenced by them. As the subject opens out we shall see in detail what these age-incidence differences in pathology consist in; meanwhile, it may be repeated that from this standpoint there is a pathology of postnatal life, of intranatal life, and of antenatal life.

The Divisions of Antenatal Life.

On first thoughts, the nine months of intrauterine life and the twelve hours of intranatal transition seem small and of little import in comparison with the threescore and ten years to which it is expected that postnatal life may be prolonged. It is doubtful, however, if any twelve hours after birth are just so full of possibilities, physiological and pathological, as is the time during which the fœtus is passing through the maternal canals; and it is certain that no period of nine months in childhood, in adult life, or in old age is so replete with occurrences, so diverse in kind, and of such far-reaching importance as is that spent by the unborn infant in utero. There is an intensity and a variety in the processes of antenatal life which have no equal at any other time. Therefore, notwithstanding the shortness of intrauterine existence, it has become necessary to subdivide it into at least three periods, and between these there is the same deep-seated diversity as that which marks off antenatal life from the rest of life. Further, it is no exaggeration to say that few medical men have a very clear conception of the progress of events during antenatal life. The drama of embryonic and fœtal development and growth is, so to speak, going on, but the curtain has not been rung up, and the spectators get only confused impressions from the swaying of the drop-scene and from vague sounds, excursions and alarms, coming from behind it; yet no one doubts the existence of great activity *post cortinam theatri*, and some from superior know-

ledge can judge how preparations are progressing. The accompanying scheme of the divisions will serve, taken in conjunction with the descriptive notes, to give to the mind a somewhat clearer conception of the chronology of the period of preparation for the great events of postnatal life; it will take the place of the prologue in explaining the action of the to be enacted drama (Fig. 1).

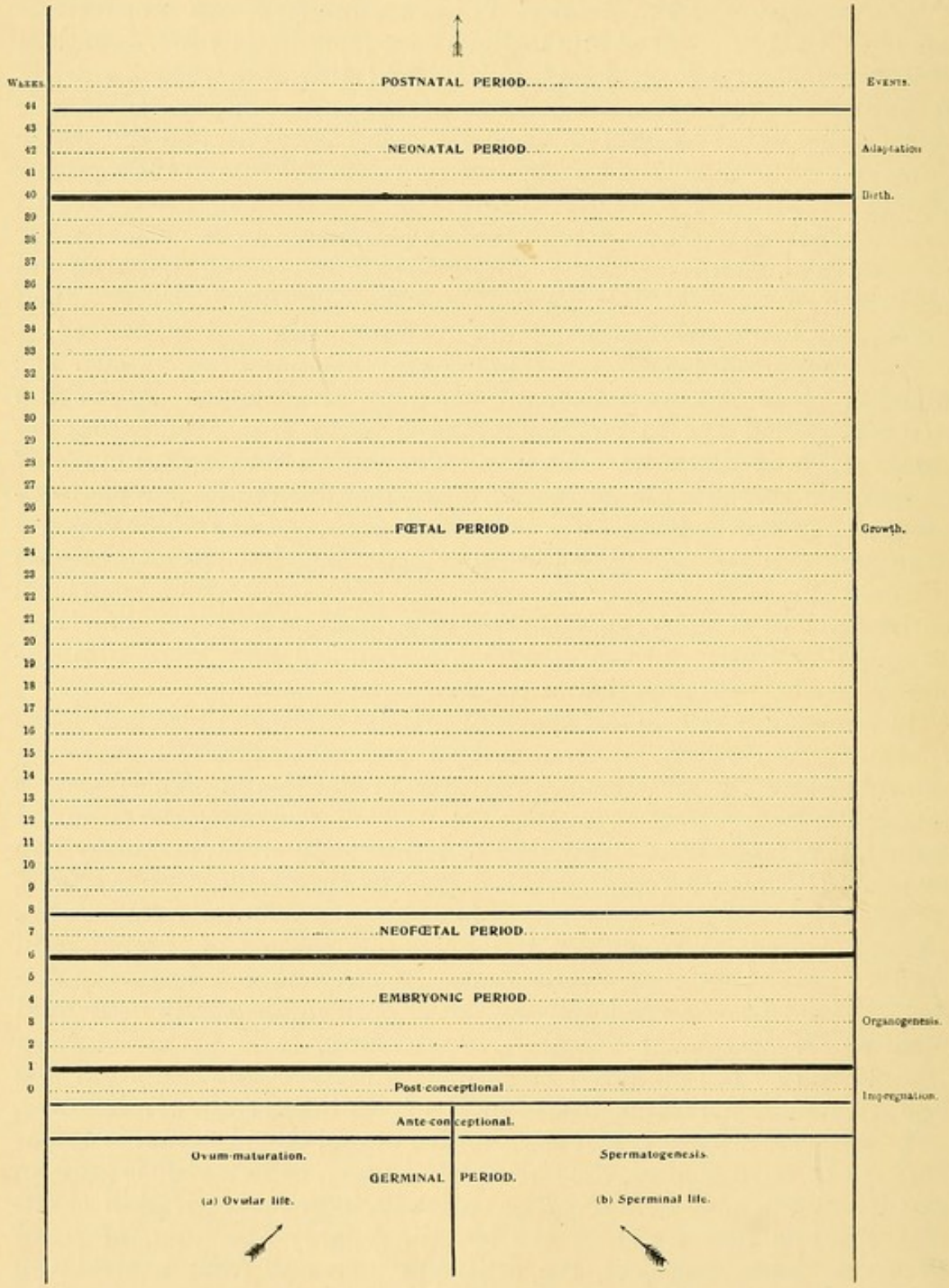
In constructing the scheme I have employed the "space-for-time" method introduced into medical case-recording by Mr. Jonathan Hutchinson, and described by him in 1896 (*Arch. Surg.*, 1896, vol. vii. p. 199). By this plan, all periods of time are represented in the schedule by equal extents of space, no time is left out, and the whole duration of the antenatal epoch, with its various events in their proper places, is brought correctly before the eye. Each interspace in the scheme represents a week; and as pregnancy lasts normally for forty weeks, there are forty interspaces intervening between its beginning and end; but as the month following birth is much influenced by what has happened before birth, and is, indeed, a transition period between antenatal and postnatal life, it also has found a place in the scheme, and has four interspaces. Above the *neonatal* period are to be imagined the many spaces indicating the many weeks of postnatal existence. The great physiological event of neonatal existence is the adaptation of the organism to its new environment; the fœtus is suddenly brought into surroundings which demand the functional awakening of several organs which have in intrauterine life been almost if not quite dormant, and structures which have been active have to atrophy, be absorbed, or be utilised for other than their antenatal purposes. Extrauterine life is linked, as it were, to intrauterine by this short period of the new-born infant.

Immediately before the neonatal period (below it, therefore, in the schedule), and separated from it by the event of birth (indicated in the schedule by a thick black line), is the *fœtal* epoch. This occupies by far the largest part of pregnancy; without reckoning the neofœtal period, it extends from the eighth to the fortieth week, or thirty-two weeks. During its progress the organism shows its vitality chiefly by growth along lines which have been already definitely laid down. In this respect it resembles the postnatal periods of infancy and youth. It is true that the intrauterine environment has very distinctive and peculiar characters—the unborn infant exists in a fluid medium of practically constant temperature, it is protected from traumatism by the maternal structures, and it is shut in from the light; further, the fœtus has several of its organs almost inactive, and its most important and most active organ, the placenta, is extracorporeal; nevertheless, the chief phenomenon of fœtal life is growth, rapid and continuous, along lines already indicated. Within seven (calendar) months, which is the length, roughly speaking, of fœtal life in the human subject, the organism increases from a structure 1 in. in length to one measuring 20 in., and its increase in weight is from 1 oz. to 7 or 8 lbs.

During the *embryonic* period of antenatal life, which may be said to begin with the laying down of the first rudiments of the embryo

FIG. 1.

THE DIVISIONS OF ANTENATAL LIFE.



in the embryonic area of the blastodermic vesicle, and to end about the close of the sixth week of intrauterine life, a very different process is going on. There is growth, as in the fœtal period; it is not, however, simple increase, but evolution or development that is the striking feature of the life of the embryo. The lines along which future growth is to take place are nearly all fixed during the embryonic period; the outstanding phenomenon is the putting up of the scaffolding of the future body; the vitality of the period shows itself in organ formation or organogenesis. As in the history of the rise of a great modern city, there is record of a stage in which the main avenues of traffic are sketched out, and natural obstacles overcome or utilised, to be followed by a period during which growth goes on along the lines of the plan; so in the story of antenatal life there is the embryonic period, in which the cellular elements are arranged in groups to form organs, to be followed by the fœtal, in which these organs simply increase in size, and by their functional activity (in some instances) lead to the growth of the whole organism. This embryonic epoch has a duration of about five weeks, or, if the neofœtal period be included, of about seven weeks. The *neofœtal* is a sort of transition time during which the placental circulation and economy are being fully established; in the scheme it has had two interspaces (two weeks) allotted to it. Embryonic life, therefore, like fœtal life, ends with a transition time or period of adaptation to new conditions; in the one case, to the changes consequent upon the organism becoming a placentally nourished one, and in the other to the much more radical changes which atmospheric respiration and gastric digestion entail.

The earliest period of antenatal life is the *germinal*, and only a small part of it, at its close, comes into the epoch of intrauterine existence. It has a long, a very long primary dual period, during which a semi-independent life of a cellular kind is going on in the male and female reproductive cells, the ovum and the spermatozoon. In the scheme a dividing line indicates this primary dual character of early germinal life. The close of the dual period is marked in the case of the ovum by the phase of maturation, and in that of the sperm by the little known but probably analogous phenomena of spermatogenesis. Then follows the anteconceptional period, during which there is dehiscence of the ovisac in the female with passage of the ovum along the Fallopian tube towards the uterus, and the spermatozoa are deposited in the vagina; insemination ends this and begins the next period (intraconceptional), in which it may be said that ovular and sperminal life run together in impregnation. Inasmuch as it is known that insemination and impregnation are not of necessity simultaneous, I have thought it well to leave half an interspace (half a week) in the scheme for this event. The rest of germinal life is the unified postconceptional period, during which the morula mass and the blastodermic vesicle are forming, and the first traces of the embryo appearing in the embryonic area. In the scheme, therefore, the dividing line is absent in the postconceptional period, to signify its unified character. Germinal life may be said to pass into embryonic

about the end of the first week of intrauterine existence, a fact marked by a thick black line in the chart.

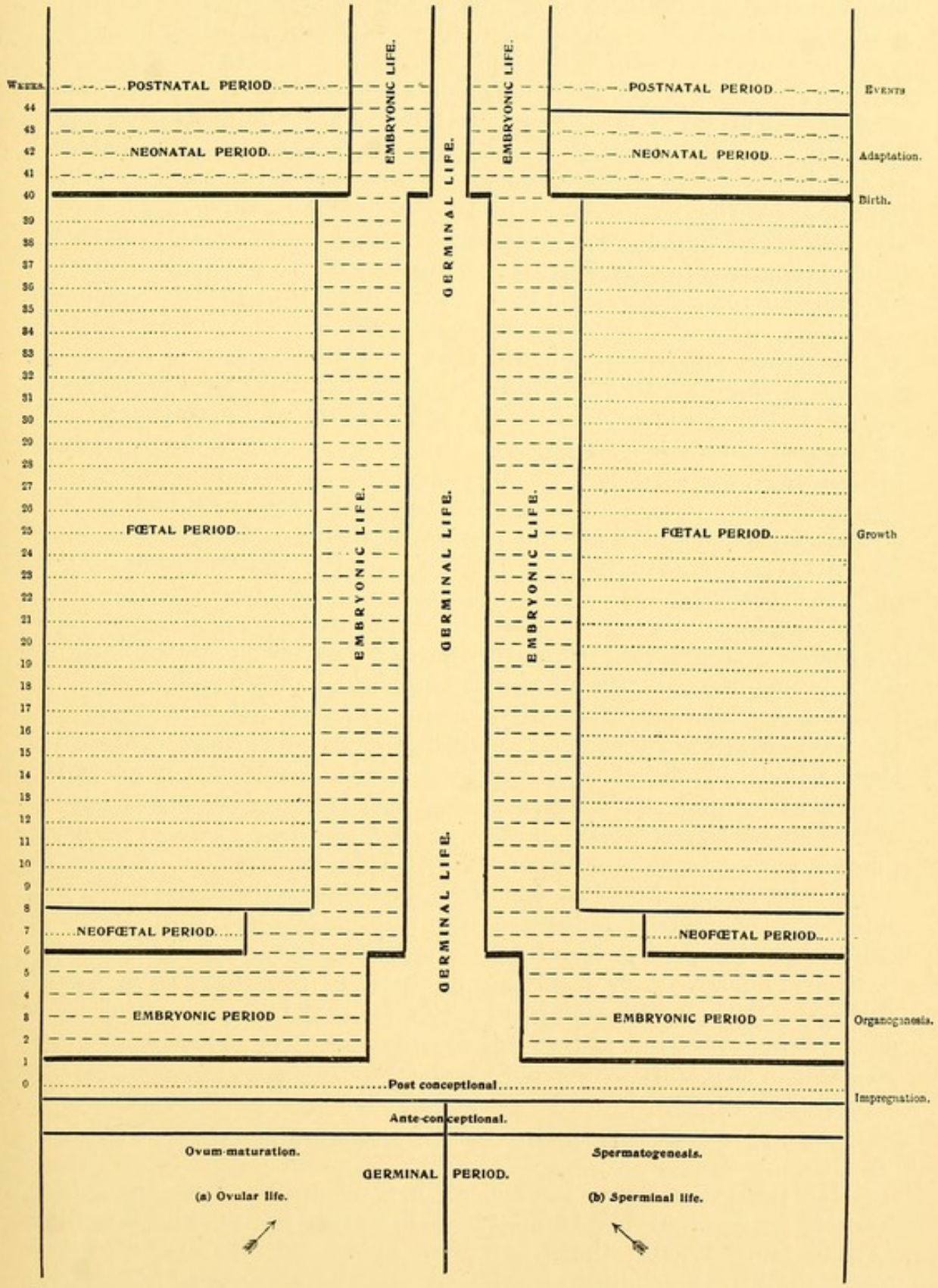
Thus it is seen that antenatal life can be marked off into three subdivisions—fœtal, embryonic, and germinal—of which two only (the fœtal and the embryonic) fall entirely within the period of intra-uterine existence, while one (the germinal) stretches back in its beginnings into the cellular life of the parents of the individual. It will become evident, as the study of Antenatal Pathology is pursued, that each of these three periods is liable to morbid changes which are in a sense peculiar to itself, that there is in fact a fœtal, an embryonic, and a germinal pathology; but before this matter can be more fully considered, it is necessary to note a somewhat important modification which must be made in such a scheme of antenatal life as that which has been described, if it is to represent what actually occurs.

Scheme of Antenatal Life.

The second schedule (Fig. 2) gives what may be called the corrected scheme of antenatal life. It will probably have already struck the reader that the division of antenatal existence by hard-and-fast lines into germinal, embryonic, and fœtal periods is not free from error. It is quite evident, for instance, that all the setting up of scaffoldings is not ended at the end of the sixth week, nor yet indeed at the end of the thirteenth; all organogenesis does not take place in the embryonic period, some of it is still going on in the fœtal. One part of the organism may be in the embryonic stage while the others are in the foetal phase. In order to represent this fact graphically, I have carried a projection of embryonic life up through the neofœtal, fœtal, and neonatal periods into the postnatal. The skeleton and the limbs are good examples of parts of the body whose embryology, so to speak, does not end with the embryonic epoch; the uterus and teeth are instances of the projection of the embryonic still further onwards, *i.e.* into postnatal life. Probably no two parts of the developing organism pass out of the embryonic into the fœtal condition at just the same time. To revert to the comparison I have already instituted, the progress of the growth of a city is not equal throughout; one part, *e.g.* the suburbs, may be little more than planned when another, *e.g.* the centre, is already built; so in the body, the evolution of the limbs is slower than the development of the head and trunk. Again, the germinal period does not abruptly stop at the end of the first week of pregnancy: the character of abundant luxurious cell formation which so specially belongs to it is projected through the embryonic and fœtal periods, and is seen in postnatal life normally in one organ, the reproductive gland, testicle or ovary. This is indicated in the scheme, which also represents in a graphic form the continuity of the germ plasm and of germinal life.

FIG. 2.

SCHEME OF ANTENATAL LIFE.



Subdivisions of Antenatal Pathology.

Just as in postnatal life there is an age incidence in disease, so that the maladies of the infant, the adult, and the aged differ from each other in certain details, so in antenatal life morbid processes take on different characters, according as they occur in the fœtal, in the embryonic, or in the germinal period. There are three main subdivisions of Antenatal Pathology corresponding to the three main subdivisions of antenatal physiological life. There is *fœtal* pathology, which is concerned with the diseases of the fœtus; and the diseases of the fœtus are in great measure the diseases of the child or adult, modified by the peculiarities of the intrauterine surroundings and the fœtal economy. There is *embryonic* pathology, or, as it is more commonly called, Teratology, which deals with the monstrosities of the embryo, for there is good reason to believe that morbid agencies acting on the embryo produce not diseases but malformations and monstrosities. When the malformed embryo becomes a fœtus, it carries its malformation with it into the fœtal period, and is born with it at the full term of antenatal life; but the malformation is not, as has sometimes been supposed, the product of late but of early intrauterine pathology. A third part of antenatal pathology is concerned with the action of morbid causes upon the organism in the germinal period, and with the results produced thereby. This may be termed *germinal* pathology. It includes the consideration of the morbid processes which occur in the ovum at and immediately after impregnation, and also of those that affect the reproductive cells (sperm as well as germ) before fertilisation; and it has probably to do with double monstrosities (or diploteratology), hydatid moles, included fœtuses, blastoderms elliptically deformed and without embryos, and the like. Here must also be considered the very springs of life with their jealously guarded secrets and the hidden mysteries of heredity. Roughly speaking, antenatal pathology may be regarded as embracing the study of congenital diseases, of monstrosities, and of morbid predispositions to disease or deformity. This subdivision of Antenatal Pathology is not fanciful but real, more real certainly than the separation of postnatal diseases into those of old age, adult life, and childhood. Further, just as in antenatal life the three periods cannot be sharply marked off from one another, so the three divisions of Antenatal Pathology cannot be clearly delimited, but show a projection one into another; but of this full details will be forthcoming in later chapters of this work.

Increased Interest in Antenatal Pathology.

Of late years there have been several signs of an increasing interest in Antenatal Pathology. A literature has grown up around morbid heredity, and there has been much written on the vexed question of the possibility of acquired characters becoming hereditary. In the medical journals the number of articles devoted to subjects of antenatal interest has greatly increased, and this has been specially

noticeable in the journals of France, Italy, and the United States. Some periodicals[1] now publish occasional periscopes of both Teratology and Antenatal Pathology, and the subject bulks largely in the yearly epitomes of scientific and medical investigation and progress. In Edinburgh there is now (1900) a University Lectureship on Antenatal Pathology, and lectures on the subject have also been given (1899) in connection with the Medical Graduates' College and Polyclinic in London; and some years ago a quarterly journal entirely devoted to Antenatal Pathology appeared and was continued for two years, living long enough to demonstrate that there was at any rate no lack of material wherewith to fill the pages of such a periodical. In a less evident but more permanent manner the antenatal factor has been making its presence felt in many of the branches of medical study; and in the diseases of the nervous system, for instance, what may be called the teratological theory of degeneration has of late excited much interest.

The causes of this increased attention to matters of antenatal interest are many and various; they are economic, scientific, sentimental, practical, and political. In the first place, to take an eminently practical cause, there has been an increase in the value set upon fœtal life, due to the fact that in certain countries the population is no longer going up by leaps and bounds. A falling birth-rate and an increasing interest in Antenatal Pathology are matters which have come together, not quite fortuitously, in the dawn of a new century. When the birth-rate begins to go down, the value, economic as well as sentimental, of the unborn infant begins to go up. When few infants are being born, it becomes important that they shall come living to the light at the full term, well-formed and healthily capable of independent extrauterine existence; and these desirable conditions are evidently largely the result of normal antenatal circumstances. When parents are unnatural enough to determine voluntarily to limit their progeny to two or three, it is natural enough that they should desire that the limited family be a healthy family. "The infants are to be few," they say, "let them then be fine." An unworthy motive, doubtless, but one that has drawn the attention of a nation to puericulture! Paris has now hospitals where women can rest during the last two months of pregnancy, for it has been found that the women who have to do hard manual labour up to the term of gestation do not have such healthy or such heavy infants as those who are able to rest. Further evidence of the appreciation in the value of fœtal life which has of late taken place, is seen in the crusade amongst obstetricians against what is called therapeutic fœticide; that is to say, against the operations carried out on behalf of the mother which condemn the fœtus to certain or to probable death. Among such fœticidal operations are reckoned craniotomy (and other embryulcic procedures) upon the living fœtus, prolonged and difficult forceps and version cases in contracted pelves, and artificial premature labour. Into the questions which this crusade has brought to the front it is not my purpose

[1] *Archives of Pediatrics; St. Louis Medical and Surgical Journal*, etc.

here to enter; that there is a crusade is evidence that the life of the fœtus is more highly valued. Greater care is now taken to save alive prematurely born infants, and Maternity Hospitals are in many cases provided not only with *couveuses* but even with specialised wet-nurses; for with a falling birth-rate even the six-months fœtus has a certain, if undetermined, value. All these attempts to conserve fœtal life have brought in their train a closer inquiry into fœtal physiology, and more direct investigation of the causes of fœtal disease and death.

In the second place, the increasing burden, financial and otherwise, upon the State, due to the presence in the community of the "unfit," has done something to direct attention more particularly to Antenatal Pathology and Antenatal Therapeutics. There can be no doubt that many of the unfit are congenitally unfit; they come into the world epileptics or criminals or idiots or paralytics, from their mother's womb. Manifestly it would be much better for the public health and less expensive for the State, if the projection of the congenitally unfit into society could be prevented. Preventive medicine will not have attained to its highest developments until it has solved the problem of antenatal prevention. Prevention in order to be truly prevention must be antenatal. Within recent years the attempt has been made, by means of the legal restriction of the marriage of the unfit, to prevent the procreation of the unfit. The attempt has had no conspicuous success, a result due in part to the absence of accurate knowledge regarding the laws that determine antenatal health and disease, so that it was impossible to predict that the children of the unfit would of necessity be equally or in the same way unfit. Its failure has at least stimulated investigation into the problems of Antenatal Pathology. In some cases, no doubt, the unfitness of the offspring is the result of intranatal rather than antenatal causes, as is seen in some of the obstetrical or birth paralyses; but this fact increases rather than diminishes our interest in the truly antenatal cases, for the intranatally produced morbid conditions are generally more amenable to treatment.

In the third place, advances in other, but cognate, branches of medical and biological science have directed attention to Antenatal Pathology. There can be no doubt that the Darwinian hypothesis of evolution, with all the supporting or opposing theories to which it has given rise, has, by exciting interest in heredity, turned the attention of many scientists to the problems of morbid heredity, predisposition, and immunity. Advances in embryology and in fœtal physiology have also done much to render possible the promulgation of correct views on fœtal and embryonic pathology. At first the discovery of the microbic origin of many diseases, such as tuberculosis, tended to divert attention from the older views of heredity; but now the interest is shifting again, and discussion is rife regarding, not so much the germs of disease as the antenatally prepared soil into which these germs may fall. After many years, in which the seed has monopolised attention, a time has arrived in which our thoughts are directed to the soil. Even apart from this aspect of the subject, the scientific

interest and attraction of many of the problems of Antenatal Pathology, not excluding the causation of monstrosities, are very real.

In the fourth place, and finally, it is to be hoped that the humane desire to carry to the infant yet unborn some of the benefits of modern medicine and hygiene has been and is instrumental in attracting many members of the medical profession to the study of antenatal affairs. In a retrospect of the medicine of the nineteenth century, two lines of progress stand very prominently out; that which has led to the development of gynæcology and so benefited many millions of suffering women, and that which has produced pediatrics and the pediatrist, and so saved much child life and ameliorated much child suffering. May it not be that the twentieth century will witness, among other good things, a wonderful extension and development of beneficent Antenatal Therapeutics.

UNIVERSITY OF CALIFORNIA

CHAPTER II

The Relation of Antenatal Pathology to the other Branches of Study; Scheme of Relationships; Relation to General Pathology; Relation to the Biological Sciences—Anatomy, Embryology, Physiology, Botany, and Zoology; Relation to the Medical Sciences—Obstetrics, Public Health, Pediatrics, Medicine, Psychology, Dermatology, Surgery, Orthopedics, and Medical Jurisprudence; Relation to Gynecology and Neonatal Pathology.

ANTENATAL PATHOLOGY does not stand in splendid isolation among the other departments of medical and biological science. If there be any degree of aloofness, it is rather exhibited by the other departments. There is indeed a very evident and constant antenatal factor in most of the branches of medical and biological study; congenital diseases and deformities and morbid predispositions are found, if looked for, playing their part and producing their effect in many ways in the various subdivisions of the healing art. Why, then, bring together into one subject what is present in all the other subjects? Why make a new subject, when the subdivisions of medicine and surgery are already so numerous? For the reason, that there is much to be learned from such a centralisation of knowledge regarding antenatal affairs, much that cannot be learned in any other way. Facts about antenatal conditions in Medicine, or Surgery, or Dermatology, or Psychology, standing by themselves, have not been of use in throwing light upon each other, and have not had enough light in themselves to make their nature and origin plain. The gathering together of all these scattered facts into one subject, Antenatal Pathology, and the comparing of them there, one with another, have not only added to our knowledge of the whole subject, but have again increased our acquaintance with each part of it. The alternate assembling together and diffusing of information have increased the sum of knowledge. In this respect Antenatal Pathology may be compared to a river like the Nile, which by its tributaries, White, Blue, Bahr-el-Gebel, and the others, draws supplies from various soils and different geological formations, sweeps them down in one broad stream, to be again broken up and redistributed as a fructifying flood over all the Delta lands. It is for the good of each department of Medicine that the contribution which it is able to make to Antenatal Pathology be brought alongside the contributions from the other departments, and contrasted and compared with them. Congenital conditions of the eye, or the ear, or the skin, all help in making it possible to understand the general laws

which govern Antenatal Pathology, and the understanding of these laws again makes it far easier to understand the special working of them in each individual subject. In this way centralisation, with a view to further decentralisation, and again to recentralisation, makes progress possible, and helps to read many a hard riddle.

But Antenatal Pathology is not equally related to all the departments of Medicine and Biology; it is more immediately bound up with some than with others. Its connections, near and remote, are represented in the accompanying scheme (Fig. 3).

With General Pathology the subject of Antenatal Pathology has a very intimate relation, for it is truly a part of it, although it has received but scant recognition in many of the text-books. In the same sense that the pathology of the skin or of the female organs of generation belongs to Pathology, the study of the morbid changes of the fœtus and embryo belongs to Pathology; but in the case of the latter the union is or ought to be an even closer one. Nearly every pathological problem has an antenatal aspect, and it may soon be found necessary to revise the current views on Pathology in the light of recent investigations into the morbid processes of embryonic and fœtal life. It seems more than likely that the whole question of tumours and their origin will require to be approached from this side; while, in such matters as immunity and predisposition, the antenatal element must always play an important part. The relation of Antenatal, Neonatal, and General Pathology to one another is represented in the scheme by concentric circles. Antenatal Pathology is also related to the biological sciences. With Anatomy it has a very real connection through Embryology, for the normal and the abnormal throw light upon each other; with Physiology there is a bond in Fœtal Physiology, a subject as yet comparatively unworked, but certain to be fertile in results, and through it with Chemistry. It is chiefly through the existence of a Teratology of Plants that the subject comes into relation with Botany; possibly the botanist and the pathologist have not proved so mutually profitable as they might have done; certainly Vegetable Teratology, dealing as it does with comparatively simple structures, may be expected to elucidate the problems of malformations in the animal world. With Zoology there exists a firm bond of union in Comparative Teratology (the study of fœtal *diseases* in animals, or Comparative Fœtal Pathology, has scarcely yet made a beginning); in fact one can hardly separate Human and Comparative Teratology even in thought. Over and over again Comparative Embryology has proved of great value in clearing up moot points in Teratology, and conversely Teratology has helped in the study of Zoology. It may be noted here, in passing, that of late the invertebrata have been much employed in experimental work in Teratology (Teratogenesis). In the scheme the relations of Antenatal Pathology to the biological sciences are represented by adjacent circles with connecting lines; the arrangement speaks for itself.

But Antenatal Pathology is related not only to the biological but also to the purely medical sciences, and its relations in this

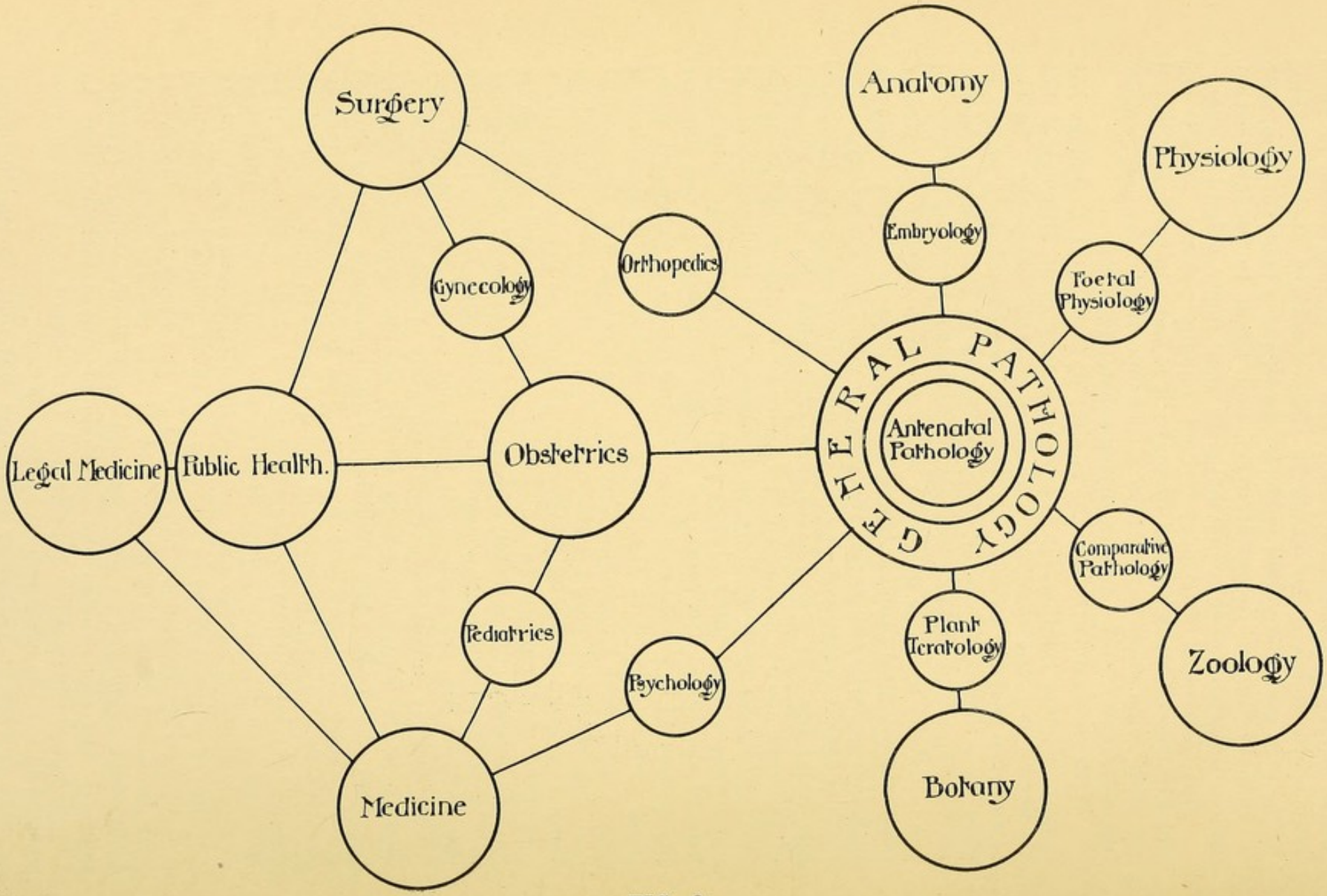

Surgery
Anatomy
Physiology
Embryology
Orthopedics
Gynecology
Foetal Physiology
GENERAL PATHOLOGY
Antenatal Pathology
Legal Medicine
Public Health.
Obstetrics
Comparative Pathology
Pediatrics
Plant Teratology
Zoology
Psychology
Medicine
Botany

FIG. 3.

direction are indicated diagrammatically likewise. From time immemorial the obstetrician has looked upon the diseased or monstrous fœtus as peculiarly in his field of study; although, doubtless, he has too often neglected to study it, and simply recorded, or (still worse) only bottled it. He is the first in order of time to see specimens of Antenatal Pathology, and he can enjoy the great privilege (of which, unfortunately, he does not often avail himself) of examining the parts of his intrauterine environment which the new-born infant brings with him into the world, namely, the placenta, membranes, and cord. Apart from the unworthy tendency to hoard, without dissecting, the specimens which come into his possession, the obstetrician has done much to forward the understanding of antenatal problems. It must not be forgotten, also, that he knows the clinical details of the case, which are often conspicuous by their absence in reports from the pathological laboratory; and that by him the way must of necessity be opened up for antenatal diagnosis. The connection between Antenatal Pathology and Obstetrics is one which affects not only the fœtus, but also the mother; for in the maternal organisms may be found the results of morbid processes which occurred before birth, and which are now interfering with the birth of the next generation. Among them may be mentioned the congenital deformities of the pelvis, due to mal-development of the sacrum, to premature ossification of the sacro-iliac synchondroses, to dislocation of the hip, and to the presence of antenatal exostoses growing from the margin of the pelvic inlet; labours complicated by these anomalies are necessarily delayed and thus rendered dangerous. Uterine malformations, also, such as the didelphic and subseptate or septate condition, do not exist in parturition without disturbance of its mechanism. In these ways the antenatal pathological history of the mother projects its influence into her later postnatal life.

Through Obstetrics, Antenatal Pathology finds a connecting link with Public Health, for it is obvious that if the community is to be strong and well able to resist epidemics, it must be constantly reinforced by the healthy offspring of normal pregnancies. It is doubtful if this, the highest development of preventive medicine, has yet received the attention that it certainly deserves. At any rate, the tremendously high mortality among infants of less than a year old which prevails, goes to show that many children are brought into the world very little fit to cope with the environmental trials that there await them. Some progress has been made in the hygiene of antenatal life, and it is recognised that certain trades and occupations are injurious to pregnant women, not solely because they interfere with the maternal health, but because they have an evil influence upon the infant unborn. There is, however, much still to be done in this branch of Public Health.

Obstetrics is linked on to Medicine by means of Pediatrics, and in this way a connection is established between Antenatal Pathology and Medicine, for the study of the diseases of the child serves to explain both the diseases of the adult and the maladies of the fœtus,

and helps also to reconcile apparent differences between the pathological processes of advanced postnatal life and of early antenatal life. But Medicine is directly united with Antenatal Pathology in several ways, apart from the connection through Obstetrics. One of these ways is Psychology and the Diseases of the Nervous System; in fact, it is specially in the department of the maladies of the brain and cord that the antenatal factor in medicine has been recognised. Without referring to conditions such as idiocy and deaf-mutism, the congenital nature of which is undoubted, instances may be cited in the so-called obstetrical paralyses, Thomsen's disease, epilepsy, Friedreich's disease, and syringomyelia. Dana, in his contribution to the pathology of hereditary chorea (*Journ. Nerv. and Ment. Dis.*, xxii. 565, 1895), comes to the conclusion that "the disease belongs to Teratology"; and Féré has advanced a teratological theory to explain the neuropathic family and its relations with heredity, morbid predisposition, and degeneration. In other departments of medicine the presence of the antenatal factor can also be noted if looked for. In Dermatology, for instance, it is present, for it is admitted that many skin diseases, even if not actually evident at birth, are predisposed to antenatally. To name only a few, there are the various forms of ichthyosis, tylosis palmæ et plantæ, hypertrichosis, hypotrichosis, albinismus, and the nævi. Congenital heart disease, hæmophilia, and syphilis are conditions which profoundly influence the whole life of the individual who is unfortunate enough to be thus handicapped antenatally; and recent observations go to show that congenital tuberculosis is a much more important factor in pathology than has been hitherto supposed. Chlorosis also, and other blood disorders, are now known to be often associated in a very striking way with antenatal malformations.

Little requires to be said about the relation in which Antenatal Pathology stands to Surgery. The two subjects are connected together very obviously by the department of surgical practice known as Orthopedics. It is a striking fact that many of the most recent advances in surgery have been made in the reparative treatment of congenital deformities and malformations, so that at the present time Orthopedics is one of the most progressive branches of practice. Hare-lip, cleft palate, club-foot, ectopia vesicæ, imperforate anus, phimosis, congenital dislocation of the hip, and cervical fistulæ are some of the antenatal morbid states that are constantly forcing themselves upon the notice of the surgeon, and there are many more, including several for the repair of which the operator has yet to find a successful method. There can be no doubt, also, that the more the causation and mode of production of deformities are understood, the more rational will their treatment become. What has been said with regard to General Surgery might be repeated in reference to the Special Surgery of the Eye, Ear, Throat, and Genitals, for in all these specialities the antenatal factor can be traced in the form of malformations or of congenital diseases.

Even Medical Jurisprudence or Legal Medicine must be counted as a subject containing many matters (*e.g.* the social and political

rights of so-called hermaphrodites, questions of identity, and of concealment of pregnancy, etc.), upon which Antenatal Pathology can throw light.

It is therefore clear that Antenatal Pathology occupies no isolated position among the other subjects of study, but is related, in some instances closely, with them all. The degrees of relationship have been diagrammatically represented in the scheme (Fig. 3). There is, however, a somewhat noteworthy fact about these relations which is not brought out in the scheme; it is with regard to the time after birth when the antenatally determined morbid state may make its influence felt. In some cases, as in the diseases of the new-born infant, the effect of antenatal states is practically immediate; in other instances, as in the pathology of the female genital organs, the antenatal factor is during many years inactive, or at least hidden in its action, and it is only when reproductive life begins that malformations or congenital diseases of the uterus and its annexa commence to show themselves in disordered function. In the next chapter the antenatal factor in Gynecology will be taken as a type of the postponed action of states determined before birth upon conditions existing long after birth; the following three chapters will be devoted to the immediate relation of Antenatal to Neonatal Pathology.

CHAPTER III

The Postponed Effect of Antenatal Pathology: the Antenatal Factor in Gynecology; Traumatism, Infection, Antenatal Conditions; the Antenatal Factor in the Morbid Anatomy, Symptomatology, Etiology, Diagnosis, Prognosis, Therapeutics, and Jurisprudence of Gynecology.

As was pointed out in the preceding chapter, Antenatal Pathology has with some of the subjects of medical practice an immediate relation, and with others what may be termed a remote or postponed connection. It is on account of the postponed rather than of the immediate action of the antenatal factor, however, that the attention of the medical profession has hitherto been drawn to the consideration of Antenatal Pathology. The reason is evident: in its postponed action the science is dealing with the morbid states of adults, or at any rate of children and youths, while in its immediate effects the fœtus or embryo, or at most the new-born infant alone, is interested. The postponed action of the antenatal factor, or, as it may be called, the projection of the antenatal into the after life of the individual, has, at least at first sight, the greater economic importance, inasmuch as the life of the adult or child is of more value than the life of the fœtus or new-born infant. Without admitting that this is the right view, either from the high standpoint of science and morality or from the more prosaic one of practice, it will be convenient here to consider this postponed action of Antenatal Pathology. I select the antenatal factor in Gynecology simply because it will serve as a very clear instance of the element of postponement to which I have been referring.

The Antenatal Factor in Gynecology.

While it is generally conceded that in the etiology of gynecological affections there are two factors of paramount importance, the traumatic and the infective or toxic, it is probable that too little heed has been given to a third factor, the antenatal. Evident traumatic and infective causes have overshadowed less evident predisposing causes; etiological factors immediately preceding the resulting diseases have bulked more largely in the mind of the gynecologist than antenatal causes, which had their origin years ago before the uterus and ovaries awoke to functional life. Yet such exist, and it is necessary for the full understanding of gynecological problems that attention be paid to the antenatal factor.

Traumatism and Infection.

In cervical, vaginal, perineal, and vulvar lacerations every one recognises the traumatic factor. Year by year such lacerations have diminished in frequency, as the direct result of improvements in the construction of obstetric instruments, and of the growth of correct opinions as to their use. There has been in the last decade a noteworthy decrease in the number of cases calling for operation for repair of vesico-vaginal fistulæ, and instances of grave laceration of the perineum are not so common. The great importance of the rôle of the infective factor in gynecological etiology is now well established. Every text-book devoted to gynecology and every medical journal teems with allusions to the part played by sepsis, gonorrhœa, and tubercle in the production of inflammatory processes in the uterus, its annexa, and in the vagina, vulva, and pelvic cellular and peritoneal tissues. Uterine and ovarian displacements, and hypertrophic, atrophic, and hæmorrhagic changes in the generative organs, must in many instances be ascribed to this cause, acting either alone or in conjunction with traumatism. In this group are included not only the morbid states due to the action of micro-organisms, such as streptococci and gonococci, but also those caused by parasites such as echinococci and pediculi. A great part of the work of the gynecologist of the present day consists in the making of attempts, sometimes by medicinal means alone, but more often and more effectively by operative procedures, to undo the results of acute and chronic infective conditions of the genital organs. Most of the cases which he is constantly meeting can be traced in their origin either to immediate infection or to infection following after traumatism. Further, even in the cases in which operative interference is required for non-infective states, such as ovarian cystomata and uterine neoplasms, it is still infection, septic or otherwise, that the operator most dreads, and it is against infection that his best efforts are directed. Nevertheless, while all this is perfectly true, no gynecologist can be long in active practice without perceiving that traumatism, microbic and parasitic infection, and toxic influences do not serve to explain all the morbid conditions and all the phenomena connected with them, which he is every day encountering and having to treat. Ere long he suspects the existence of another factor; this is the antenatal.

The Antenatal Factor.

By the antenatal factor in gynecology, I mean something more than the existence of gross malformations of the uterus, with their effects upon the performance of the functions of reproductive life. These, of course, are included; but I mean, also, all those abnormalities in structure, predispositions towards certain diseased processes, and inherited functional peculiarities, which there is good reason to believe are determined antenatally, and which have oftentimes so powerful an effect upon the progress of gynecological cases.

The occurrence of such anomalies as atresia of the vagina, double uterus, and defective formation of the ovaries, is well known to every gynecologist; every one is able fairly accurately to forecast what the probable result of this or that malformation will be. But there are other and more subtle ways in which conditions and tendencies, produced before the birth of the individual, project themselves into her later life; these are not so generally known, at least their far-reaching effects are not so fully appreciated. It may at once be admitted that it is not possible to arrange all the morbid states which affect the female generative organs under one or other of these three factors; an etiological classification of gynecological complaints is not so simple a matter. It is not practicable, for instance, to group together all the diseases of the uterus that are due to infection, and then all those that are due to traumatism, and then all those due to antenatal states, in a linear series. It would be coming more nearly to the truth if the three factors were represented by three circles, two of which (the traumatic and the infective) bisected one another, while the third, the antenatal, touched the circumferences of the first and second, thus:

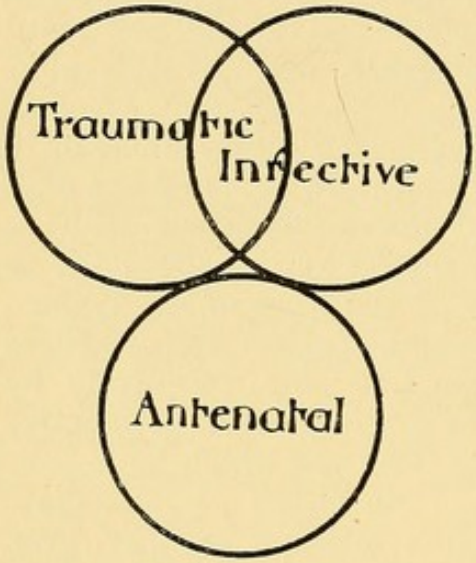


Fig. 4.

I do not forget that other causal factors than the three just named have been recognised in gynecology; they act chiefly through the nervous system, and consist chiefly in unhygienic methods of education, in delayed marriage, in prevented conception, and in irrational modes of dress. These errors practised by one generation of women become the antenatal causes of defective development of the whole system, and especially of the reproductive organs of the individuals of the next generation.

The Antenatal Factor in the Morbid Anatomy of Gynecology.

The antenatal factor is very evident in the morbid anatomy of gynecology. All the major malformations of the female generative organs and nearly all the minor ones are truly antenatal in origin. Trifling exceptions are found in the uterus pubescens, in atresia vulvæ superficialis, arising from adhesive vulvitis in infancy, and in some hypertrophic conditions of the labia and clitoris. The various types of double uterus (didelphic, bicornate, septate), the uterus unicornis, the uterus rudimentarius, the uterus fœtalis, the minor uterine malformations (incudiformis, parvicollis, etc.), and absence of the uterus; absence and atresia of the vagina, double vagina, unilateral vagina, and stenosis vaginæ; vulvar and hymeneal anomalies; absence and rudimentary development of the ovary, accessory ovaries, accessory tubal diverticula and ostia, and rudimentary tubes; and the various

forms of pseudo-hermaphroditism ;—these are some of the admittedly antenatal morbid states of the female genitals. They are dealt with in greater or less detail in all the text-books of gynecology (6, 13, 14). It may be noted in passing that all these anomalies are arrestments of normal embryological processes ; they are the expression of the pathology of the genital organs during the stage of their evolution or construction ; they represent morbid embryogenesis ; and, judging by what is known of the causation of malformations of other parts of the body in the human subject and among animals, it may be presumed that the disturbance of embryogenesis is brought about by the action of traumatism, microbes, or toxines upon the embryo in utero.

But antenatal diseases, as well as antenatal malformations of the female generative organs, are met with and leave their impress upon the later history of the individual in whom they occur. I have recorded several cases (131, 197, 221) of fœtal peritonitis, and in two of these there was displacement of the ovaries and Fallopian tubes of such a nature that, had the infants lived to the years of reproductive activity, they could hardly have escaped much suffering during menstruation, and would probably have been sterile. Fœtal pelvic peritonitis may also be instrumental in producing congenital or pathological retroflexion or anteflexion of the uterus, with or without concomitant shortness of the vagina and conical cervix with pin-hole os ; the far-reaching effects of these morbid conditions are well known to every gynecologist. Even prolapsus uteri, with or without hypertrophic elongation of the cervix, has been found so soon after birth as to prove that it existed potentially before birth. Two cases of this congenital form of prolapsus uteri were reported by J. Thomson and myself in 1897 (23) ; these were the seventh and eighth known examples of the anomaly, and since then four or five further cases have been recorded ; and it is a striking fact that in nearly all the uterine displacement coexisted with spina bifida in the lumbo-sacral region. These occurrences suggest that perhaps some of the instances of prolapsus in the unmarried and in nulliparous married women may have an antenatal origin or be antenatally predisposed to ; and, bearing in mind the association of the prolapsus with spina bifida, it will be well in future to examine cases of procidentia and descent of the uterus for spinal defects and especially for spina bifida occulta.

Even the tumours which affect the female organs of generation may in some instances have an origin in antenatal life. This is especially true of the dermoid cysts, or teratomata of the ovary. These growths are generally met with in early reproductive life, even in some cases in childhood. Recent researches have revealed the existence of a long series of types of dermoid cysts, showing all the gradations, from a growth containing only some hairs and skin, to one containing a rudimentary but perfectly recognisable embryo. Their origin may be explained by regarding them as the result of fœtal inclusion or enclavement, or of parthenogenetic and imperfect segmentation of ova in Graafian follicles ; in any case, the antenatal factor is invoked in one form or another. Further, many of the

neoplasms which call for abdominal section for their removal in gynecological practice, arise in the cystic degeneration of structures which existed in antenatal life, and ought to have completely atrophied. I refer to paroophoronic and parovarian cystomata.

The Antenatal Factor in the Symptomatology of Gynecology.

It is true that the symptoms that call attention to the maladies of the female generative organs are usually separated by a long interval of time from antenatal life, nevertheless they are not very rarely due to conditions developed before birth. The dysmenorrhœa and sterility associated with congenital flexions of the uterus, and with defective developments of the Graafian follicles in the ovary from fœtal pelvic peritonitis, may be justly ascribed to the antenatal factor. Similarly, dyspareunia and profuse hæmorrhage during the first attempts at coitus are sometimes due to antenatal anomalies in structure or form of the hymen and external genitals. Amenorrhœa, although most frequently due to physiological conditions, is yet sometimes caused by such antenatal states as rudimentary development of the uterus, tubes, and ovaries, vaginal atresia, or hymeneal imperforation, in cases of amenorrhœa in the unmarried; therefore, the physical examination of the genitals ought not to be too long postponed; for one or other of these congenital states may exist, and, if this be so, medicinal treatment need be no longer persisted in and time wasted. Irregularities in menstruation also may be due to malformations, especially of the uterus; thus, in the double uterus, menstruation may occur every fortnight, every month, or once in two months. Fortnightly menstruation may be explained by the monthly occurrence of a discharge from each horn of the uterus, the dates, however, of the occurrence not synchronising. Menstruation once in two months, again, may be due to a flow from one half of a double uterus at intervals of two months, the other half of the uterus being imperfectly developed or imperforate, and therefore giving rise to no discharge. It is possible that the anomalous form of dysmenorrhœa known as the mid-pain, or *Mittelschmerz*, may be occasionally caused by uterine contractions in the imperforate half of a double uterus, striving ineffectually to expel menstrual blood. Symptoms pointing apparently to disease of the nervous system may in certain cases be the result of congenital anomalies of the genital organs, such as adhesion of the clitoris, a condition resembling in many ways phimosis in the male. The history of the passage of fæces from the vagina probably points, in the case of the nullipara at any rate, to the existence of the antenatal anomaly known as vulvar anus. Bleeding from the bladder at intervals of a month has been known to be due to vaginal atresia, and the existence of a congenital communication between the uterus and the bladder. Examples might be multiplied, but sufficient instances have been cited to prove that even in the symptomatology of gynecology the antenatal factor must not be neglected.

The Antenatal Factor in the Etiology of Gynecology.

I have already referred to the presence of an antenatal factor in the causation of the malformations of the uterus and the other organs of generation, of the so-called pathological flexions of the uterus and displacements of the ovaries and tubes, and of the ovarian dermoids and parovarian and paroophoronic cystomata; but there are yet other gynecological morbid states, of which the cause must be looked for in the life that precedes birth. For instance, extrauterine pregnancy has recently had two new theories advanced to explain its etiology, and both of these may be correctly described as antenatal. According to one, it is occasioned by the presence of an accessory tubal ostium abdominale or of a tubal diverticulum, and cases have been reported of ectopic gestation in which these malformations have been found (Henrotin, F., et Herzog, *Rev. de gynéc. et de chir. abdom.*, ii. 633, 1898). According to the other theory, the power to form a decidua is normally confined to the mucous membrane of the body of the uterus, but under certain circumstances this power may be possessed also by the mucosa of the Fallopian tube, for both the tube and the uterus are derived from the duct of Müller: it may be that through an arrest of the development of the tubal mucous membrane it retains this decidual reaction or power of responding to the genetic influence by the occurrence of decidual changes. As it has been stated by J. C. Webster ("Ectopic Pregnancy," 12, 1895), "this is probably because of some developmental fault, whereby there is reversion either of structure or reaction tendency in the tubal mucosa to an earlier type in mammalian evolution—I mean that in which a larger portion of the Müllerian ducts showed decidual reaction."

Even fibro-myomata of the uterus have of late years come to be regarded as occasionally due in some measure to antenatal causes, and a very curious family history of the heredity of fibroids has been put on record by T. Spannochi (*Annali di ostetricia e ginecologia*, xxi. 331, 1899). There were three brothers, called M., S., and P.; of these M. and S. married two sisters, A. and B. The descendants of M. and A. were free from abdominal tumours, but those of S. and B. showed in a very striking way the tendency to uterine fibroids, and also to heart disease. There were nine children, of whom seven were females, and of the seven four had fibroids, and two had also concomitant heart disease, while one of the three who had not fibroids had a daughter who developed a fibroid; and of the four daughters who suffered from fibroids one had three daughters, all of whom had fibroids and heart disease, and of these two were twins. The third brother, P., married a woman, E., not related to A. and B.; there were five daughters and six sons from this marriage, in which, let it be remembered, that the mother had no fibroid herself; two of the daughters had fibroids, while a third suffered from heart disease, and gave birth to three daughters, one of whom suffered from a fibroid; further, one of the six sons married

and begat a daughter, who had both a fibroid tumour of the uterus and a cyst of the ovary, and she in her turn gave birth to three daughters, one of whom had now been operated upon for a uterine fibro-myoma. In this remarkable family history, not only does there seem to have been a tendency to the production of female children, with a predisposition to develop fibroids; but this tendency, curiously enough, seems to have been transmitted through the males, for it affected the progeny of two brothers married to women of different families, and again one of the sons handed it on to his daughter. The association of heart disease in the family pathological legacy is also of interest, as is the twin-bearing. Of course, this antenatally transmitted tendency to produce fibroids is not incompatible with the theory of origin of such tumours from the muscular coat of the small uterine arteries or from proliferating congenital germs. It may be objected that uterine fibroids are so common in women that the occurrence of them in the above history might be explained in that way; but the ordinary degree of frequency of noticeable and symptom-producing myomata is not nearly so great as that which prevailed in the progeny of S. and P. with B. and E. Engström (*Finska Läkaresällskapets Handlingar*, No. 12, 1899) has also noted family prevalence and heredity in cases of myoma uteri; in eight instances two sisters were affected, in one instance three sisters, in two instances two sisters and their mother, in one instance three sisters and their mother, and in yet another instance four sisters and their mother, had uterine fibroids.

In this relation reference may also be made to the curious family histories in which all the female offspring either developed cancer or were twins; and this is but another suggestion that cancer or the tendency to it is prenatally predisposed to. Deciduoma malignum stands in an altogether peculiar relation to antenatal life. It would seem, according to one theory of origin at any rate, to be the result of an engrafting of the remains of an abnormal antenatal formation, the syncytium of a hydatid mole, in the wall of the maternal uterus. It is, therefore, the consequence of abnormal developments, not in the antenatal life of the woman who suffers (and may die) from it, but in that of her progeny in utero.

The Antenatal Factor in Gynecological Diagnosis.

It is perhaps unnecessary to insist upon the necessity, in making a diagnosis in a gynecological case, to keep in mind the possible presence of antenatal malformations of the genital organs; at the same time many of these malformations are so rare that even an experienced gynecologist may not have had the chance of seeing more than one or two of them in a life-time. Further, the medical periodicals contain not infrequent records of errors in diagnosis which have arisen through a want of a just recognition of the possibility of the antenatal factor. Thus the abdomen has been opened for the removal of a uterine or ovarian tumour, to find a pregnancy in the rudimentary half of a uterus bicornis; fibroids of the uterus have been mistaken

for malformations of that organ, and, more frequently, malformations have been mistaken for fibroids; and atresia of the vagina leading to hæmatometra has been diagnosticated (through insufficient examination) as a normal pregnancy, and has led to unjust imputations upon the moral character of the girl who has been the subject of the vaginal anomaly. But doubtless the worst errors in diagnosis have been due to the non-recognition of male pseudo-hermaphrodites in early life. The association of amenorrhœa with the secondary sex characters of the male in an individual apparently of the female sex should always excite the suspicion of the gynecologist who may be consulted, and he ought to insist upon a physical examination of the patient. J. Halliday Croom (*Trans. Edin. Obst. Soc.*, xxiii. p. 102, 1899) and Chiarleoni (*Gynécologie*, v. p. 55, 1900) have both reported cases in which supposed sisters turned out, on physical examination, to be really hypospadiac brothers. It is interesting to note the family prevalence in these two cases, for in this, as in other morbid states which the gynecologist may be called upon to diagnose, more than one member of the same family may be affected with the same condition. Thus, Löhlein (*Monats. f. Geburts. u. Gynäk.*, iii. p. 91, 1896) has referred to an instance in which three sisters all suffered from bilateral ovarian cystoma, and in two of them development of the cyst was homochronous, *i.e.* commenced when the patient reached the same age in life.

It is well to bear in mind that truly antenatal anomalies of the genitals are apt to be found in association with want of postnatal sexual evolutionary change, and with minor malformations of the other parts of the body. Women showing this condition of infantilism, as it has been termed, may therefore be expected to possess a more or less malformed uterus, and tubes, and ovaries, an important fact for the gynecologist to remember. They present the picture of a weakly vertebral column, with a marked anterior concavity; a narrow or kyphotic pelvis; flat nates, and a slightly marked mons; poorly developed labia majora leaving the labia minora and clitoris exposed; a vagina with some traces of its original duplicity; a congenitally anteflexed uterus with a cervix showing a long posterior lip and a shorter anterior one, leading to a long and curved cervical canal, and a small corpus with a thick and convex posterior wall, and a thinner and concave anterior one; Fallopian tubes showing fœtal spirality; thin ligamenta rotunda and small pointed ovaries; a cylindrical bladder, with a pointed urachal end; a narrow rectum; hypoplasia of the heart and aorta; a marked representative of the thymus gland; a small and transversely placed stomach; a long vermiform appendix with a wide entrance and lobulated kidneys (W. A. Freund, *Samml. klin. Vorträge, Gynäkologie*, No. 93, p. 2338, 1888). In the presence, therefore, of a woman with such a habitus, the gynecologist will be able to form a provisional diagnosis of the state of the internal organs, and may simplify the further management of the case.

The Antenatal Factor in Gynecological Prognosis.

The antenatal factor has occasionally intervened in a somewhat unexpected fashion in gynecological prognosis. Thus, a case (Blondel, *Ann. de gynéc.*, l. 137, 1898) was reported in 1898 in which an operator, engaged in curetting a uterus, thought that he felt the curette pass through the wall of the organ; in alarm he ceased his interference, and awaited results with considerable fear; but no ill effects followed, and on a subsequent occasion he discovered that he had been dealing with a double uterus, and that the curette had simply passed from one cavity of the viscus into the other, giving to the hand of the operator the sensation of perforation. The removal of the ovaries, to induce a premature menopause in cases of uterine hæmorrhage and in some kinds of nervous disease, has not always been followed by the anticipated results, and it has been suggested that sometimes the error in prognosis has been the outcome of the existence of an accessory ovary or of a constricted piece of an ovary. It must not be forgotten that in gynecology, as in other departments of medicine, antenatal conditions have seldom so hopeful a prognosis as have the maladies which are developed during post-natal life; instances of this are forthcoming in the congenital displacements of the uterus, and in malformations of that organ and of the ovaries. Freund (*Loc. cit. supra*) specially dwells upon the prognostic importance of evolutionary anomalies of the Fallopian tubes in the diseases of these structures which arise in later life. For instance, if the tubes retain the fœtal spirality, which normally reaches its maximum degree about the thirty-second week of antenatal existence, it will not only interfere with the normal function of the tubes in adult life, but will seriously modify the chances of successful treatment of diseases arising in the tubes from other causes. Secretions, both normal and pathological, will tend to accumulate in such twisted organs, and so infection will more readily occur, or, having already occurred, will be more intense and more widely diffused. Freund does not hesitate to divide all the diseases of the Fallopian tubes into two classes, those with and those without developmental anomalies; the prognosis for all things is worse in the former than in the latter.

The Antenatal Factor in Gynecological Therapeutics.

Considerable progress has been made in the rectification of the malformations of the genital organs which arise from antenatal causes. The operation for imperforate hymen may be described as perfected, and the treatment of atresia vulvæ superficialis may also be regarded as satisfactory. Further, recent improvements in the management of atresia vaginæ and of vulvar anus have been introduced; and it may be noted that the opening into the peritoneal cavity, once so dreaded in the operation for the construction of an artificial vagina, is now rather the auxiliary object aimed at than

the *contretemps* avoided. At any rate, it is found advantageous to open into the pouch of Douglas, in order to determine at once the condition of the uterus and ovaries, and thus gain a guide as to the future steps of the operation (27). It must, however, be confessed that much still remains to be done in the reparative surgery of antenatal defects of the genital organs in women. Even in the management of the congenital flexions of the uterus and of the results of fœtal peritonitis there is great room for improvement in present-day therapeutics. Not only are the embryonic malformations and the fœtal diseases of the genital organs difficult in themselves to treat, but the inflammatory and other morbid conditions of these parts which arise in later life are always less tractable when associated with these antenatal anomalies. For instance, salpingitis is a more formidable process, and requires a more radical method of treatment, when it is found in a tube with the spiral twists of fœtal life fully preserved. When the normal process of pregnancy takes place abnormally in the rudimentary horn of a bicornate uterus, it calls for the same interference as does the worst case of ectopic gestation.

The problem of the prevention of the malformations of the uterus and its annexa has scarcely yet been seriously investigated, for the sufficient reason that little has been known of the mode of origin of these anomalies. Of course, it has been recognised that arrest in the normal process of development of the ducts of Müller and of the mesonephros and the *anlage* of the ovaries, explains the nature of most of the malformations; but in the absence of information concerning the causes of the arrest, this knowledge avails little. Some light, perhaps, has of late years been thrown upon the whole question of malformations and monstrosities, more especially by the methods of experimental teratogenesis; and clinical observation has so far given some support to the conclusions thus arrived at, namely, that malformations are due to the causes of disease acting on the organism during the embryonic or formative period. It is therefore to be expected that it will yet be shown that microbes and their toxines, and toxic agencies such as alcohol and lead and other poisons, and possibly also traumatism, are the ultimate causes of malformations. It may also be expected, therefore, that the anomalies of the genital organs will be more commonly met with in the descendants of parents who have been alcoholic, syphilitic, tubercular, or otherwise unhealthy. The true antenatal therapeutics of gynecology will therefore come to be the prevention of the causes of disease in the preceding generation and the raising of the standard of health in marriage. In this respect the antenatal factor in gynecological therapeutics does not differ from that in general therapeutics.

The Antenatal Factor in Gynecological Jurisprudence.

Certain questions in medical jurisprudence in which the antenatal factor plays a part have already been alluded to, namely, the registration of the sex of pseudo-hermaphrodites, nullity of marriage for

malformation, etc.; but there are several other questions, besides those connected with individuals of doubtful sex, which may come into the law courts and require an answer from the specialist in gynecology. It has, for instance, been affirmed that a woman with a split or lacerated cervix uteri must have been pregnant at one time or another; but it is plain that she might have had the cervix split artificially to permit the removal of a fibroid tumour or intrauterine polypus. It is not, however, so plain or so generally known that laceration of the cervix may be present in a new-born infant as a congenital condition; yet this is true, for Penrose (*American J. Med. Sc.* N.S., cxi. 503, 1896), Jefferson (*Med. Sentinel*, iv. 552, 1896), and Edwards ("Keating's Cyclopædia of the Diseases of Children," v. 899, 1899) have all met with undoubted cases of congenital split of the cervix uteri with erosion. The condition is probably an abnormality in the arrangement of the mucous membrane of the cervical canal, a congenital histological ectropion. In addition to its purely medico-legal importance, it may also be that congenital laceration of the cervix has some bearing upon the later development of cervical erosions in women, and even upon the origin of cancer of the cervix uteri. One must take great care in the witness-box not to be too emphatic in stating which structural conditions may and which may not be compatible with chastity. As has been shown, even prolapsus uteri may be met with in an infant of a few hours!

There is, therefore, in many directions a projection of Antenatal Pathology into gynecology, although years must elapse before the results of the events which occur before birth are seen in the consulting-room of the gynecologist.

CHAPTER IV

The Immediate Effect of Antenatal Pathology; The Antenatal Factor in Neonatal Pathology. The Neonatal Period of Life; Physiology of Neonatal Life; Physiological Traumatism of Birth, including the Pressure Effects and the Separation Effects; Physiological Readjustment at Birth, and its Influence upon the Characters of the Maladies of the New-born Infant; Anatomical Readjustment; The Antenatal Factor and its Influence upon Neonatal Pathological Processes.

As has been pointed out in the preceding chapter, the effect which antenatal morbid states exert upon gynecological disorders is a postponed one and is not manifested for many years, during which the genital organs and their abnormal or normal potentialities are dormant. In this and in the following chapters fall to be considered the immediate effects of antenatal pathological conditions, those which have a bearing upon the characters of the diseases of the new-born infant.

On the dividing line between Antenatal and Postnatal Pathology lies Neonatal Pathology, a sort of unexplored territory, a "No Man's Land," liable, however, to incursions from both sides, those of the weaker kind coming over the antenatal boundary. Between the surgical injuries and maladies of the life that is after birth, and the diseases and deformities of the fœtus and embryo, are situated the morbid conditions of the new-born infant, conditions which interest both the pediatrist and the obstetrician. Investigation of them has indeed gone on from both the pediatric and the obstetric standpoint, but with more activity, it has seemed, from the former than from the latter. Nevertheless, it is well to bear in mind that the maladies of the new-born have relations, not only with the diseases which occur later, but also with the pathological states which have happened earlier in life. Just as neonatal life is the link between postnatal and antenatal life, so Neonatal Pathology is the link between Postnatal and Antenatal Pathology. It offers problems for solution which require that we take into account both the conditions which precede and those which follow birth; its study, further, is helpful in throwing light on them both. That neonatal morbid states offer peculiarities of a very marked kind hardly calls for proof. It need only be pointed out that, in order to emphasise these peculiarities, a nomenclature has come into use which adds to the name of the disease the word "neonatorum." In this way the terms "cephalhæmatoma neonatorum," "pemphigus neonatorum," "icterus neonatorum," "melæna neonatorum,"

and many others have got a place in medical terminology. Sometimes the word is "nascentium," as in "trismus nascentium," but the meaning is the same. That peculiarities exist is not questioned, but attempts to explain them have not been altogether satisfactory; possibly this failure has been due, in part at least, to the want of recognition of the antenatal element in their origin. It will be well to consider the various possible influences which may determine the characters of the maladies of the new-born infants, and among them the antenatal influence.

The Neonatal Period.

In every period of life physiology largely dominates pathology; the diseases of the child or of the aged reflect in their characters the physiology of childhood or of old age. The age peculiarities of disease are in great measure the expression of the age peculiarities of health. The greater the difference between the physiological conditions of two epochs of life, the greater will be the differences between their pathological manifestations. The physiology of the new-born stands out very prominently from that of all other periods of extrauterine life, and in like manner its pathology differs markedly from that of childhood, adult life, and age.

Physiology of Neonatal Life.

The period of life which has been termed that of the new-born infant may be regarded as beginning with the first maternal labour pain, and ending about the close of the first month of infantile life. It includes, therefore, a period of time which may be called intranatal, that during which the infant is passing through the birth canal; and another, truly neonatal, during which the infant's body is adapting itself to its new environment. These two periods of the infant's life correspond in time to the periods of labour and the puerperium in the mother's life; it is for this reason that sepsis of the new-born infant has, somewhat unfortunately, been termed by some writers "puerperal sepsis" of the infant, "sepsis neonatorum" being a name in every way preferable. The intranatal period is of varying length (from a few hours to two or three days), but is always much shorter than the truly neonatal period. Theoretically, it may be objected that the intranatal and neonatal periods ought not to be put together under the one heading of neonatal, as they are separated by the momentous occurrence of the commencement of extrauterine life; but, practically, there is no sharp line of demarcation, for the infant, during his passage through the birth canals, may use his lungs in breathing, may pass meconium and urine, and may even cry before he is quite free of the vagina. Further, the two epochs are very closely connected, the neonatal being the complement and continuation of the intranatal; the infant during his neonatal life is occupied in recovering from the effects of his birth, or, we may say, in learning to utilise the possibilities thrust upon him by his birth.

Neonatal life is the period of adaptation to the new conditions brought about by intranatal life. We may call the morbid phenomena of this period of life "intranatal" or "neonatal" pathology; it matters not which, so long as we realise that they possess characters which are in many ways peculiar.

Physiological Traumatism of Birth.

To the infant the intranatal period of his life, short though it be, is one of much strain and stress. Is is true that he does not, as was erroneously supposed by the ancients, have to make his way, by his own little aided efforts, to the world outside the womb; and nowadays we do not admit that he has much to do with his birth, save in a sort of passive fashion, by means of his weight of 9 lb. or less, which, by gravity, may possibly to some slight extent expedite his progress, if his mother be erect; but, none the less, his transit from intrauterine to extrauterine surroundings is to him an eventful and often a dangerous time. By uterine efforts, the sum total of which is by no means inconsiderable, he is propelled through curved canals, with unequal diameters, encountering no little resistance by the way. His body is not a plastic mass; but it is capable of a certain degree of moulding, even in its hardest part, the head; and the maternal canals, which are denominated soft, are in their turn slightly moulded by the fœtal structures which they surround. Thus, by means of uterine propulsive forces, with the help of head and body moulding, the fœtus is driven along the canals, undergoing some rotation in his passage, and expelled into a new and trying environment. Birth, then, without being abnormally difficult, is the traumatic transition from an intrauterine to an extrauterine existence; this may be termed the physiological traumatism of birth. Under certain circumstances, as in the multipara with a large roomy pelvis and a fœtus of moderate dimensions, the traumatism is reduced to a minimum; possibly at one time in the history of the human race there was little or no traumatism at all; but the effects of civilised life and other causes have exacted payment in the form of increased birth traumatism, and to this the headward development of the fœtus has in no small degree added. Natural labour, then, is a traumatism; not, of course, a necessarily or even probably fatal one; but none the less a traumatism. It will be convenient here to look a little more particularly at the details of this traumatic transition.

It consists, in the first place, of the effects produced by pressure upon the fœtus, and more especially, but not solely, upon the head of the fœtus; and, in the second place, of the separation of parts in structural and vital continuity, with resulting hæmorrhage. The pressure effects may be described as contusions, and the separation results as injuries to the effusion of blood.

1. The *pressure effects* of labour are most evident upon the fœtal head, for in the large proportion of cases it passes first through the canals; and for the reason that it is resistant to pressure and has large

diameters. The effects consist of the formation of the caput succedaneum, or birth-bruise, and the moulding of the head, with displacement of the bones. The former is the serous or serosanguineous effusion, which takes place into the tissue of the skin of the presenting part of the fœtus; usually the area of the cranium in the neighbourhood of the posterior fontanelle, which lies within the girdle of contact of the maternal canals. Every part of the surface of the fœtus save this is under great pressure, so into this unsupported part the effusion of serum takes place. It forms, as might be expected, during the second stage of labour; but it is noteworthy that it has been found occasionally before the rupture of the membranes (Barbour, A. H. F., "Anatomy of Labour," 2nd edition, p. 192, 1899). It differs from the ordinary postnatal bruise, in being the result, not of pressure applied directly to it, and quickly removed, but of long-continued circumferential pressure; nevertheless, it is essentially a contusion. Further, there is some reason to believe that it is sometimes caused by direct pressure also; but this is exceptional. The epidermis covering it is often found raised in blebs, or separated altogether. When the face presents, the caput forms over the cheek, the eyelids are swollen and discoloured, and there is congestion of the conjunctiva; but the nose and chin are not much affected, as the skin is there tightly fixed to the underlying parts. The caput, in ordinary labour, elongates the cephalic ovoid, and in some measure serves a useful purpose in the mechanism of parturition; but the greater part of the moulding of the head is due to changes in the relation of the cranial bones to each other. In a communication on the "Head of the Infant at Birth," made to the Edinburgh Obstetrical Society some years ago (37), I gave a series of cranial measurements, which showed that five or six days require to elapse after birth before the head returns to the form which it had anterior to the commencement of labour. To ascertain the shape of the unmoulded head, I took the head diameters of infants removed by the Cæsarean section; of fœtuses in published cases, where maternal death had occurred in the later months of pregnancy, and where frozen sections had been made; and of an infant removed post-mortem from the uterus of a woman, who had died of pneumonia before labour set in. It appeared that, although the heads differed in actual size, their cranial diameters (maximum, occipito-mental, occipito-frontal, suboccipito-bregmatic, biparietal, and bitemporal), all had the same relative length, bore the same proportion to each other. I then measured a series of heads, at or soon after birth, and found that these cranial diameters no longer had the same relation to each other; in all the cases there was a diminution in the occipito-mental, occipito-frontal, and suboccipito-bregmatic diameters, and an increase in the maximum. In other words, the birth traumatism had produced a compression of the head in the suboccipito-bregmatic plane, and a compensatory enlargement in the plane of the maximum diameter. This moulding of the fœtal head is, as is well known, due to the overlapping of the bones at the

sutures (one parietal over-rides the other at the sagittal suture, the two halves of the frontal underlie the contiguous parietals anteriorly, and the occiput underlies the parietals posteriorly); and it is accompanied by a bulging of one side of the head (that which lies anterior in the mother's pelvis) producing asymmetry. So constant is this head-moulding, that it forms part of the physiological traumatism of birth; but it is very certain that the same amount of distortion of parts, occurring at a later period of life, would be termed pathological. At the end of about a week the head has again taken its normal (or antenatal) form; the effects of the birth-traumatism have then passed off, and the cranial diameters have regained their antenatal relative length.

To a less evident extent the pressure effects are visible upon the trunk of the fœtus. At the end of pregnancy (as Barbour describes it, *op. cit.*, p. 23), "the general contour of the fœtus is an oval, of which the long axis is not greatly in excess of the short; the flexures of the different parts are not acute, the limbs being not compressed; but, so to speak, comfortably disposed, and the spine gently curved." In the second stage of labour all this is changed, for the fœtal contour is now an elongated oval, the flexures of the limbs are increased, and the appearances suggest compression, the outlines being more regular. The pressure effects upon the fœtal trunk and limbs disappear almost immediately after birth, and in this respect contrast with the head changes. When any part of the trunk presents (*e.g.* breech, shoulder) a caput succedaneum forms upon it; but even in this respect the deformity thus produced is much more transitory than that seen in the case of the head. Such are the plastic phenomena of the birth traumatism.

2. The *separation results* of the physiological traumatism of birth have an importance not less than that of the pressure effects. In some of the mammalia placentalia the connection between the maternal and fœtal parts in the placenta is very slight, the fœtal villi being simply withdrawn from the maternal crypts; the separation in them cannot be termed traumatic, for it involves no laceration of tissues. In the mammals, however, with a caducous or deciduate placenta, and more especially in the human female, the maternal and fœtal portions of the placenta are intimately interwoven, and almost fused together; a real tearing apart takes place in labour, with a blood loss varying considerably in amount but of constant occurrence. As a result of this separation, an exposed surface (placental site) of at least 4½ by 4 in. is left in the interior of the uterus; this is the maternal side of the traumatism; and Nature diminishes as much as possible the consequent risks by the property of the uterine muscle called retraction, whereby the exposed surface is lessened in extent. The separation of the placenta takes place through the spongy layer which is derived from the maternal decidua serotina. To what extent the fœtal portion of the placenta (the villi) is exposed in this surface of separation (placental area) is uncertain, but doubtless

some of the chorionic villi reach down as far as the spongy layer; it may therefore be said that here is the fœtal side of the traumatism. At the same time, it must be borne in mind that changes have been occurring in the villi, during the last weeks of pregnancy, which tend to obliterate the vessels, and so lessen the risks following the separation (hæmorrhage and septic absorption). As stated by Eden (*Journ. Path. and Bacteriol.*, p. 466, Jan. 1896), the villi which become embedded in the serotina "are devascularised and functionless"; further (*ibid.*, p. 268, Dec. 1896), the same author has found that "the fœtus takes decided measures to cut itself off from its placenta during the last weeks of intrauterine life." It is therefore very probable that by natural processes the separation of the placenta is prevented from bringing much risk to the fœtus, and we cannot look upon the uterine aspect of the placenta as an exposed fœtal surface; but, artificially, the obstetrician produces an exposed surface when he cuts the cord, although he diminishes the risks resulting from it (hæmorrhage and septic absorption) when he ligatures it before section.

It is evident, then, that birth is traumatic. In the best circumstances, however, by a wonderful series of precautions, the dangers of the traumatism are reduced to a minimum, justifying the description of it as physiological. It is physiology, however, which very readily passes over into pathology; for both the pressure effects and the separation results may very easily set up morbid changes in the fœtus, or bring pathological conditions as their sequelæ. These morbid processes will be described in the next chapter.

Physiological Readjustment at Birth.

Birth, then, is the more or less traumatic transition from the protected semiparasitic life of the fœtus to the more exposed and ultimately independent existence of the infant; but traumatism is not the only occurrence in the physiology of this neonatal period of life, for it is during the three or four weeks that follow birth that the organs of the new-born infant take up the work now thrust upon them, and formerly performed in great part by the placenta. It is a time of readjustment, of adaptation, of alteration, and of metamorphosis.

Birth, it must be remembered, does not mark a beginning, but a stage in life's progress; at any rate, it marks only the beginning of a stage—the beginning of postnatal life. The transition is abrupt, and the surroundings are very unlike, nevertheless the life is continuous. The more perfect and complete our knowledge of the physiology that precedes and of that which follows birth becomes, the more clearly and undeniably this principle is established. There are differences between the life of the fœtus and that of the new-born infant; but by means of a marvellous series of adaptive mechanisms, the life that is before birth becomes continuous with the life that is after birth, and the transition is accomplished with a minimum of change and with but a passing dislocation of function. Some only of the organs of the infant are truly born at birth, in the sense that they begin

then for the first time to perform the special functions for which they are intended; most of them continue to functionate in postnatal life in nearly the same way as was foreshadowed by their antenatal activities, in some instances with increase, in others with diminution, and in yet others with some modification of the special activity; some few of the organs may be said to die at birth, as far as physiological activity peculiar to them is concerned. To this complicated series of adaptive processes the name of the physiological readjustment of birth may be given; and since it has much to do with the peculiarities of the pathology of the new-born infant, it demands further consideration.

The adaptive functional changes at birth may be grouped in three classes:—

1. Increase or commencement of function } Quantitative.
2. Decrease or abolition of function }
3. Alteration or modification of function—Qualitative.

There is much that is yet uncertain about the functions of the fœtal organs and tissues, and even the physiology of the new-born presents unsolved problems, so that what follows must be regarded as in some degree hypothetical and liable to correction with advancing knowledge.

The abolition of the functional activity of the placenta is the most outstanding of the birth changes, and all the other alterations and modifications are directly or indirectly the results of it. At the end the transition is sudden, and the placental economy ceases, as it were, with the tying of the umbilical cord; but it is well to remember that there has been a period of a few weeks during which vascular changes have been occurring in the placenta which have slowly been cutting it off from the fœtus. The placenta, so to speak, has not been abolished without warning; herein possibly lies one of the many reasons why premature delivery is borne so badly by the fœtus, the preparatory changes in the after-birth not having had time for their completion. Now, the cutting off of the placenta, with the consequent stoppage of all the functions performed by it in intrauterine life, necessarily entails the awakening to functional activity or increased activity of intracorporeal organs belonging to the new-born infant; and if all the functions that are performed by the placenta were definitely known, then it might be possible to distribute and rearrange these functions among the infantile organs. In the meantime, there are many lacunæ in our knowledge, and it is not, for instance, clearly made out to what extent bio-chemical changes actually take place in the placenta, and to what extent that organ acts simply as a means of conveying the results of maternal bio-chemical changes to the fœtus. All that can be said with any assurance is that the cessation of placental activity synchronises with the commencement of pulmonary respiration, and with the increased action of several other organs, such as the kidneys and stomach.

The first group of the adaptive functional changes at birth includes those characterised by increase or commencement of function. The lungs at once suggest themselves as organs which commence to

functionate at birth. Very evidently and almost constantly the infant gives a cry and begins to breathe as soon as he is fully expelled from the maternal passages, and before the complete severance from the placenta has taken place; in this respect, the commencement of pulmonary respiration marks the beginning of postnatal life. Even this change, however, is less sudden than it appears, for in fœtal life it has been found that regular movements of the thorax are taking place, which, although they do not of course result in the admission of air to the fœtal lungs, may yet be preparatory to the awakening of the pulmonary activity, and may become after birth the movements of respiration. Further, under quite exceptional circumstances, as in face cases and during version, especially with twins, respiration and even audible crying may take place while the child is still in the maternal passages, the condition necessary for this premature activity of the pulmonary organs being the rupture of the fœtal membranes and the admission of air. The cause of the first respiration is still matter of discussion (it has been ascribed to the action of the cold air upon the skin of the child, to the passage of blood containing carbonic acid in excess to the medulla on account of the stoppage of the gaseous interchanges in the placenta, and to the convenient but not very luminous abstraction, "a primitive law of nature"); but its effect is to usher in the adaptational changes of birth, being indeed itself the first and most important member of the series. Auscultation over the chest of the new-born infant elicits the presence of a fine crepitant râle which indicates the opening up of the pulmonary air vesicles, and is evidence that the child is beginning to do for himself what was previously done for him by the maternal lungs. For some little time the new function is not performed with that completeness and regularity to which it afterwards attains, but it immediately draws to the lungs an increased flow of blood, and so inaugurates the wonderful succession of circulatory readjustments which follow birth.

Among the increased activities supervening upon birth must be reckoned the digestive functions of the salivary glands (at least of the parotid), and stomach, and intestine, and the excretory function of the kidneys. The urinary bladder of the new-born contains a small quantity of urine, and in its intestines are about 70 grms. of the dark green bile-stained material to which the name of meconium has been given, and which consists of intestinal secretions, fat, bile, epithelial cells, some hairs, and epidermic squames. It is therefore clear that there is some digestion going on in fœtal life, and some urinary secretion, even if it be denied that there is any excretion. Gradually, all the digestive functions come into play, although it is some time before the pancreas is effective, and the submaxillary and sublingual glands do not at first take much part in buccal digestion. Another organ which must be regarded as increasing its activity greatly at birth is the brain, but it even shows an increase and not a commencement of function with the change of environment; for some parts of the great afferent tract of nerve fibres in the brain are already myelinated when birth takes place, and it is known that only fibres which have been conveying impressions show myelination.

The movements, therefore, which the fœtus has been making in utero have been sending impressions to the receptive centres in its cerebral cortex; in the new-born infant the impression-sending goes on apace, and the consequent myelination extends rapidly. It is, however, quite correct to say, that functionally some parts of the brain commence to act, are born, at birth.

An instance of the cessation of function following upon birth is found in the vessels connected with the umbilical cord, which carry blood to and from the placenta. These vessels, including the umbilical vein and arteries and the ductus venosus, soon become obliterated and functionless; and any delay in their closure may lead to dangerous consequences, as will be shown immediately. Another physiological activity which diminishes, is growth. No doubt, the new-born infant increases in weight and length with wonderful rapidity; but it is none the less true that the postnatal rate of growth is small compared with what prevailed in utero, and indeed the slackening had already begun to show itself before the infant left his uterine abode. Organ formation has practically ceased before birth, and only slight changes in the shape and relations of the viscera occur after it, although, of course, the osseous, as distinguished from the cartilaginous skeleton, is largely a postnatal formation.

Certain alterations in function, qualitative changes, take place at or soon after birth. Through the gradual closure of the foramen ovale and ductus arteriosus, the direction of the blood current in the heart is altered, and the function of that viscus as the centre of a double instead of an almost single circulation is established; no longer a mixed, but a pure, blood goes to the tissues as the result of this change. Another organ which, no doubt, to some extent, modifies its functions at birth is the liver; the portal circulation gains in importance with the commencement of more active gastric and intestinal digestion, and probably the liver takes on the function of storing up mineral poisons, a duty which there is reason to believe was previously performed by the placenta.

There are, as has already been stated, many parts of this series of readjustment and adaptation changes of birth about which little is definitely known, and about which much will yet be learned by careful investigation. How long, for instance, are the mammary glands active before birth, and how long after birth does their secretory activity continue? Do the Graafian follicles in the ovaries rupture before birth; and if so, is this period of activity followed by one of quiescence until puberty? What is the function of the thymus gland in the fœtus, and does it continue to act in the same or in a different way, or not at all, in the new-born infant? Does the thyroid gland act as a regulator of metabolism and growth before as well as after birth, or is this duty performed by the thymus? What exactly are the functions of the spleen and suprarenal capsules before birth, and are these modified by birth? These and several other questions call for an answer before the whole process of functional readjustment at birth can be

described in all its details. It may be added that the spinal cord is probably an instance of an organ whose functional activities alter little at birth, for in the fœtus it is well developed and active; and it is in the cerebral rather than in the spinal part of the nervous system that development of function goes on postnatally.

Many of these functional alterations at birth, possibly all of them, are accompanied by changes in structure which are directly related to them, or which may be only synchronous with them. For instance, there are the well-known obliterative changes in the blood vessels connected with the fœtal circulation, and the closure of the communication between the right and left auricles of the heart; there are changes in the appearances of the blood and in the composition of the urine; there is the extension of myelination to the efferent nerve fibres in the higher centres; there is the desquamation of the cuticle; and there is the disappearance of the fœtal lobulation of the kidneys. These are the anatomical readjustments of the neonatal epoch. Finally, birth is followed by an invasion of the new-born organism by a multitude of microbes, and their effects upon the developing functions must be taken into account in attempting to understand this most interesting part of the earlier period of postnatal life.

Such, then, is an outline of the physiology of birth, and of the four weeks which follow birth: there is the physiological traumatism of birth, characteristic more especially of the intranatal period; and there is the physiological readjustment at and after birth, commencing in the intranatal period, but extending into and through the strictly neonatal epoch. As will be seen immediately, when some of the individual diseases and morbid states of the new-born fall to be considered, these physiological peculiarities of the period have much to do with the peculiarities of the pathology of the period, and many things that are difficult to understand about neonatal morbid conditions become easy of explanation when regarded in the light of the physiological traumatism of birth, and the physiological readjustment at birth; but all the peculiarities are not explicable by these two factors, either acting singly or working in combination. There is a third factor which plays its part in the evolution of the special character of neonatal pathological change; it is the antenatal factor.

The Antenatal Factor in Neonatal Pathology.

Not only does the physiology of birth and the neonatal period leave its distinctive impress upon the pathology of the neonatal period, but the pathology of *antenatal* life also has its effect upon the characters of the diseases and disorders of the new-born, and serves to explain some phenomena otherwise most obscure. Birth, let it always be remembered, is not the beginning of life; it is only the beginning of a stage of an individual life. The impress of nine months' very active life, intrauterine, it is true, but none the less vital, is already on the infant at the moment of birth. Its effects,

pathological as well as physiological, are projected into neonatal life, and in many cases constitute the missing key to the explanation of the special characters of neonatal disease. Thus morbid conditions which have arisen in fœtal life, such as fœtal peritonitis, or malformations which have originated in the embyronic or germinal periods, may, by their projection into neonatal life, give an altogether peculiar character to the maladies of the new born.

Many instances might be given of the effect of the antenatal factor on the pathological manifestations of the neonatal period of life, and to several of them reference will be made in the following chapters, which deal with individual neonatal maladies; but in the meantime it will suffice if allusion be made to one. Jaundice in the new-born is a frequent condition, which occurs soon after birth. It is generally one of the results of the readjustment changes which are going on in the liver and blood on account of the circulatory modifications which follow the replacement of the placental by the pulmonary respiration; it is in these cases almost physiological in its nature. Sometimes, however, as is well known, the jaundice is of a much more persistent type, and may even prove fatal within some days or weeks of birth. Under these circumstances it has sometimes been found that its persistence and lethal character have been due to conditions developed before birth, *e.g.* congenital obliteration of the bile ducts, or antenatal hepatitis. The jaundice then indicates a truly pathological state of affairs, and is furthermore the expression of morbid states, the results of which in intrauterine life were dormant; the antenatal factor makes its influence felt immediately after birth.

CHAPTER V

Types of Neonatal Disease, illustrating the Intrusion of the Antenatal Factor: (1) Intracranial Traumatisms, Cephalhæmatoma Neonatorum, Facial Paralysis, Fractures of the Long Bones, Dislocations; (2) Intranatal Infections, Ophthalmia Neonatorum, Hæmatoma of the Sterno-Mastoid, Mastitis Neonatorum.

In this chapter and in the next is described a series of types of neonatal diseases and disorders. No attempt is made to consider all the maladies of the new-born, for that would entail the description of a very large number of diseases; but certain types are selected which serve to illustrate the manner in which the physiological traumatism of birth, the physiological readjustment at birth, and the antenatal factor, tend to give peculiar characters to the manifestations of disease at this time in life. Even the types that have been selected are not each described in all their details, but only in those which have special reference to the effect of antenatal influence, for this work is concerned primarily with Antenatal Pathology, and with Neonatal Pathology only in so far as it throws light upon antenatal morbid changes. At the same time it must not be forgotten that there exists a very close connection between the pathology of the neonatal and that of the antenatal period.

I. Intranatal Traumatisms.

Cephalhæmatoma Neonatorum.

Attention has been already drawn to the fact that the birth traumatism is the cause in the great majority of cases of a serous or sero-sanguinolent swelling upon the presenting part of the fœtal head; to this swelling the name caput succedaneum is commonly given. When labour is unduly prolonged, or when the natural traumatism of birth is reinforced by the artificial traumatism of the forceps, there may be a very considerable effusion of blood into the scalp tissues, and the caput becomes a hæmatoma. It is not, however, to this exaggerated caput or birth-bruise that the name cephalhæmatoma neonatorum has been usually given, but to a swelling which appears two or three days after birth. If any special name were given to the caput, it might be that of "intranatal cephalhæmatoma,"

for it is produced during the intranatal period of life; the term neonatal cephalhæmatoma would then be restricted to the swelling which develops, or at any rate is recognised, during the first few days of neonatal life (Fig. 5).

This cephalhæmatoma varies in size from a hazel-nut to an apple; is more or less rounded; is situated usually near the postero-superior angle of the right parietal bone, but may be found on the opposite side, or more rarely, on the occipital, temporal, or frontal bones; and is generally covered by normal scalp. It is tense and fluctuating, is usually unilateral, but is occasionally bilateral, and may even be multiple; and is limited exactly by the sutures and fontanelles, not crossing from one bone to another. Pressure upon it does not affect its size or cause convulsions or coma. From its first appearance it has a well-defined margin, and later there is a distinct hard rim surrounding its base; it may on this account be mistaken for a cranial perforation, with herniation of brain substance, or for a circular depressed fracture, but the absence of pulsation, and the detection on deep palpation of the underlying cranial bone, ought to prevent this error being made. Its existence may be masked for the first few days of life by the caput succedaneum, which usually occupies the same region of the head; it slowly diminishes in size by absorption, save in the cases where suppuration occurs, but it may be several months before all traces of it disappear. In its pathology it consists of an effusion of blood between the pericranium and the cranial bone underlying, and the hard rim is a bony ring which forms round its base at the point where the pericranium is still attached to the bone. The effused blood may be found in various stages of absorption. A fracture of the underlying bone, with hæmorrhage between the dura mater and the skull, may occur as a complication. It does not usually endanger the life of the infant, save when pus forms; and the method of treatment which has hitherto given the best results has been expectancy, but it is questionable whether the safety conferred by aseptic surgery ought not to cause us to reconsider the whole matter, and possibly to adopt more radical measures.

In attempting to explain the pathogenesis of the subpericranial cephalhæmatoma, authors have had recourse to the intranatal factor (birth-traumatism), to the physiological readjustment at birth, and to the antenatal factor. It is a rare condition, occurring only once in two hundred or two hundred and fifty labours, therefore it cannot be due to an ordinary circumstance or set of circumstances. It is more common with male than with female infants, and in primiparous rather than in multiparous mothers. It has therefore been confidently ascribed to pressure on the head in labour, to the same causes as are effective in producing the caput; but it has been found in cases in which the head did not present, and even in cases, such as that reported by me in 1893 (158), where the labour was easy, rapid, and non-instrumental. The intranatal or traumatic factor cannot then be the only or the constant cause of the hæmatoma, and the same objection applies to traumatism apart from labour. The

cause has been looked for in the circulatory conditions which exist immediately after birth, and which are the result of the change to an extrauterine environment; and the brittleness of the blood vessels, and the ease with which the pericranium can be separated from the underlying bone in the new-born infant, have been brought forward as at least predisposing causes. These explanations, however, all fail to account for the rarity of its occurrence, and it is found necessary to look to antenatal conditions. Several have been suggested; but reference need only be made to that with which Féré's name has been associated (*Rev. mens. de méd. et de chir.*, iv. 112, 1880). He found that at the site of predilection of the cephalhæmatoma, the postero-superior angle of the right parietal bone, there were occasionally seen fissures running in the bone in a radiate manner, one towards the sagittal suture, another towards the lambdoidal. The sagittal fissure sometimes united with a similar one on the opposite side to form the fontanelle of Gerdy. To this arrest of development, as shown by defective ossification in this region (*obelion*), Féré looked for an explanation of the pathogenesis of subpericranial cephalhæmatoma. Even slight pressure on the part of the head which shows this anomaly will cause extension of these fissures, and rupture of the small blood vessels which cross them; effusion of blood will quickly take place under the pericranium, which is at this point easily separable from the underlying bone. In this instance, therefore, the traumatism of birth is not in itself sufficient to account for the neonatal morbid condition, neither does the physiological readjustment at birth form a complete explanation; the antenatal factor has to be invoked, and is found in arrested development or delayed ossification of the region *obelion*.

Facial Paralysis of the New-Born.

It is not uncommon to find infants who have been extracted by means of the forceps showing a transitory form of facial hemiplegia, or "facial paralysis of the new-born." When the child cries, or when it is at the breast, the unilateral deformity of the face, due to the paralysis of one of the facial or seventh nerves, becomes very noticeable: the lines on the paralysed side are obliterated and the eye cannot be closed (Fig. 5), the angle of the mouth is drawn to the opposite or sound side, and the lines are there deepened. The infant is suffering from the peripheral form of facial paralysis, due in the great majority of cases to pressure of one of the blades of the forceps upon the seventh nerve at the point where it emerges from the stylo-mastoid foramen, or where it breaks up into its branches in front of the ear; the nerve is specially liable to injury, on account of the absence of the mastoid apophysis, and the small degree of development of the auditory meatus at this time of life. In most cases the paralysis gradually passes off, from two days to six weeks being the time necessary for its complete disappearance. Generally, there is the distinct history of forceps application to account for the paralysis;

but in a few instances it would seem that the pressure upon the nerve has been caused by a projection in the maternal pelvis (promontory of sacrum or ischial spine), or by a tumour. Sometimes, as in a case about which I was consulted by Dr. Dickson, of Lochgelly, in 1899, the long persistence of the paralytic condition throws doubt upon the peripheral nature and traumatic origin of the palsy. Under these circumstances, it is reasonable to turn from an intranatal to an antenatal mode of origin of the nerve lesion. It may then be due to a lesion in the facial nuclei in the pons, or in the fibres connecting them with the cortical centres; but, of course, even this central or cerebral form may be of intranatal origin, although it is unlikely. The instance of unilateral facial paralysis reported by M. Bernhardt

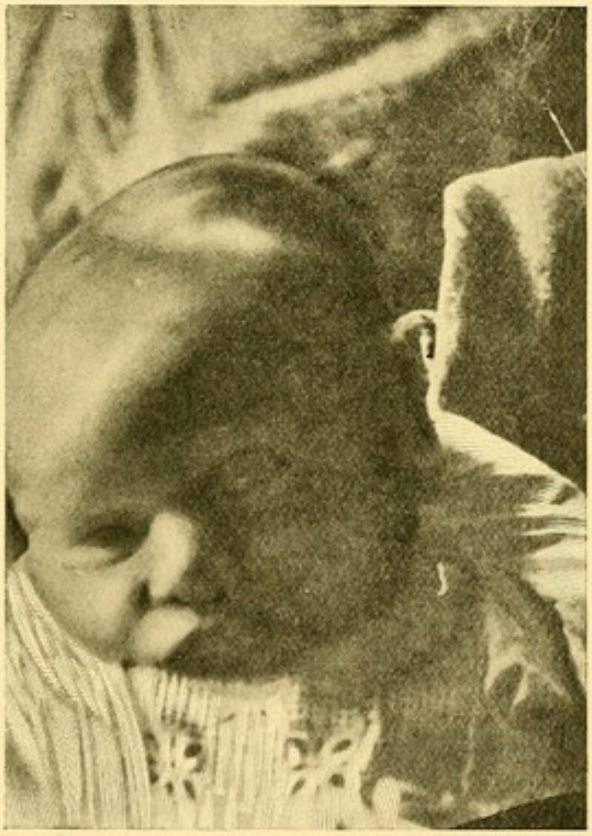


FIG. 5.

(*Neurol. Centralbl.*, xiii. 1, 1894), in a man of 24 years of age, was probably of this central type; it had been first noticed when the patient was a fortnight old, and the birth had been non-instrumental. Another instance of persisting paralysis of congenital origin in a man of 40 has been recorded by Mr. Jonathan Hutchinson (*Arch. Surg.*, xi. 20, 1900). In the central type the paralysis is seldom so complete as in the peripheral, and there usually is, for example, power to close the eye; by this means it may be possible to diagnose between the cases of peripheral and intranatal paralysis and those of the central and probably antenatal type—a matter of very considerable importance, when it is borne in mind that the former have a good prognosis, while the latter are usually incurable. But facial paralysis of the new-born may be both peripheral and antenatal, and it is then due to some

malformation or defective development of the muscles supplied by the seventh nerve. This seems to have been the cause of the paralysis in the two brothers described by H. M. Thomas (*Journ. Nerv. and Ment. Dis.*, xxv. 571, 1898); in this, an instance of the family type, there was antenatal absence of some of the facial muscles. It ought to be added that the nature of the antenatal lesion in the central form of facial paralysis of the new-born has not yet been determined; but Geyl (*Centrlbl. f. Gynäk.*, xx. 634, 1896) has described a case of the peripheral form of antenatal origin in which he suggests that pressure upon the cheek by an amniotic band was the active cause of the defective development of the seventh nerve. The relation of facial paralysis of the new-born to the intranatal (traumatic) and antenatal factors may thus be summarised: the peripheral form, usually complete, is nearly always due to intranatal pressure from the forceps or maternal pelvic walls, and it is then quickly recovered from; but it is occasionally due to antenatal causes, one of which may be amniotic pressure, and is then much less amenable to treatment; the less complete central form, on the other hand, is probably rarely due to traumatism acting upon the head in labour, and most often to obscure antenatal changes in the cerebrum or pons, and it has always a more unfavourable prognosis.

Fractures of the Long Bones of the New-Born.

The common cause of the fractures of the long bones which may be met with at birth is the traumatism of an abnormal labour, and more especially of a confinement which is terminated artificially by version. Further, the new-born infant, like the child or adult, may suffer from fractures which are the result of direct and considerable violence. In both cases, the incompletely developed state of the skeleton will predispose to the occurrence of separation of the epiphysis of the long bones rather than to actual solution of continuity of the diaphysis. Such fractures and separations usually heal quickly, if recognised and treated at the time of their occurrence. There are, however, other cases, in which, either at birth or soon thereafter, fractures occur either subsequent to very little traumatism, or without the history of any injury at all. In such instances it becomes necessary to postulate the existence of antenatal fragility of the bones. The extraction of the child from the maternal passages or some slight handling of it afterwards may still be the determining cause of the fracture, but it is quite evident that the predisposing factor lies in defective ossification. Especially is this clear when the break occurs one or two days after birth, and without any evident cause. Such a case was brought under my notice in May 1899, by Dr. J. S. Fowler. The child was apparently quite healthy when born; it was an ordinary head presentation, and no interference was required. Four days later it began to cry, and cried all night, and in the morning a great swelling of the left thigh was noticed. There was a distinct fracture in the middle of the femur, not near the epiphysis. The break mended

well, but with a large amount of callus. There was no history of any injury; there was no enlargement of any of the epiphyses; the limbs were well formed; and the child showed no signs of prematurity. It was significant, however, that the cranial bones exhibited very defective ossification; although there was no increase in the size of the head, nor any sign of abnormally high intracranial pressure, yet the state of the bones was exactly like that met with in hydrocephalus. Antenatal fragility seems the only possible explanation of the fracture in this case. It is not unlikely that it may have been an instance, although not a very marked one, of osteogenesis imperfecta, or osteopsathyrosis (8); in such cases, a striking example of which has been recorded by J. P. Crozer Griffith (*Am. J. Med. Sc.*, cxiii. 426, 1897), fractures of the long bones begin to occur a few hours or days after birth, without evident and sufficient cause; they continue to occur at intervals during infancy (Griffith's patient developed seventeen of them in his first two years), and even during childhood and adult life, and they usually unite very quickly. Syphilis, nervous diseases, and rickets can generally be excluded from the list of possible causes; and there is much doubt as to the osteomalacic nature of the fractures. One remarkable fact has been clearly proved: the tendency to be affected with numerous fractures is often transmitted by direct heredity; and even when this is not the case, family predisposition can be distinctly recognised—a fact which certainly points to an antenatal mode of origin. It may therefore be regarded as certain that all the fractures that are met with during the neonatal period of life are not the result of birth-traumatism, or of injury received after birth, even when the skeleton has been weakened by syphilis; some are due to an antenatal fragility, so great in degree that trifling causes lead to solution of osseous continuity.

Dislocations in the New-Born Infant.

That dislocations of various joints may occur as the result of the traumatism of birth, and more particularly of artificially aided birth, is an obstetric commonplace; possibly, however, it is an ill-founded commonplace. Certain it is that by far the most common congenital dislocation is that of the hip; equally certain is it that in the great majority of the recorded cases the child suffering from this dislocation has been born after a labour, non-instrumental in character, not even abnormally prolonged, in which also the head has presented, and in which, consequently, neither blunt hook nor obstetrician's fingers can have been dragging traumatically upon the infant's hips. Furthermore, can it be doubted that if the dislocation were of this intranatal kind, that it would be easily possible to correct it? Yet within recent years there is probably no subject in orthopedic surgery about the treatment of which more has been written of a controversial kind than congenital dislocation of the hip-joint. Manifestly, such a difference of opinion as to the best method of surgically correcting this distortion

betokens that no way yet devised is supremely good; herein lies the suggestion that the luxation is no simple displacement of perfectly adapted articular surfaces, due to the tractions and contractions of labour. The dislocation itself is much more common in girls than in boys; it may be bilateral or unilateral; it is commonly not noticed immediately after birth, but only later, when walking is begun; and it is noteworthy that in about 25 per cent. of the cases there is heredity, usually on the mother's side. These facts do not support the idea of obstetric origin. Indeed, the theory that the dislocation is entirely due to intranatal traumatism may be said at the present time to be abandoned. Of the theories that remain, all look to an antenatal morbid state as the primary cause. According to one view, the dislocation is due to external violence, applied to the mother's abdomen during her pregnancy; according to another, it is the prolonged but less active pressure of the amnion that is the pathogenic factor. An intrauterine destruction of the tissues of the joint is the leading feature in a third hypothesis; yet another regards all the changes as due to a primary alteration of the fœtal nervous system, causing either retraction or paralysis of the peri-articular muscles. These are theories based upon fœtal pathology; but embryonic morbid changes have also been invoked, and several forms of arrested development of the acetabulum and surrounding parts have been adduced in explanation. In their diversity these theories have it in common that they look to a time before the birth-traumatism for the causal factor; in this at least they agree. Not less diverse have been the recommendations for treatment. According to one suggestion, which has at least the merit of age, the dislocation is to be treated by traction, by fixation, by protection—"for eight or ten hours out of the twenty-four the children lie in an apparatus, holding the leg extended, abducted, and rotated outwards"—and this is to be carried on for years; truly a weary prospect, even when it is added that for the rest of the twenty-four hours of each day "they move about freely." Corsets, also, "with perineal bands," to press down upon the trochanters, are said to be "much in favour in Germany." If, however, the patient be older than three or four years, little benefit can be expected from the mechanical plan, and, consequently, recourse has been had to forcible reposition of the head of the femur into the acetabulum—under anæsthesia, with much rotating and abducting and flexing and extending of the limb. This method, first advocated by Paci, lately modified and elaborated by Lorenz, requires for its complete success the existence of a normal acetabulum and a normal femoral head; but Antenatal Pathology has revealed that these are precisely the conditions which do not exist. Therefore, at best, we are to hope for a pseudo-arthrosis; that, too, only after prolonged fixation, following the forcible reduction. Need it be wondered at that Hoffa has advocated operative measures, and that Lorenz has been led to the same, or a modified plan of procedure. Their methods have, at any rate, this in their favour, that they seriously attempt to deal with the difficulties—Hoffa by cutting into the acetabulum, enlarging

it, for it is generally very rudimentary, with the sharp spoon, and replacing the head of the femur in it; Lorenz by directing his attention also to the capsular ligament. But with these operative procedures comes, of course, the risk of death; at the same time, it is to be noted that in good hands the risk is small. When all this is taken into account, is it surprising that a recent writer (R. W. Lovett, "Keating's Cyclopædia of the Diseases of Children," Supplementary Vol., p. 988, 1899) warns his readers that "it is a time of transition and general distrust." Antenatal Pathology may yet do much to remove this distrust and throw light upon operative measures. Let it, in the meantime, be borne in mind that congenital dislocation of the hip has an antenatal origin, even when the actual separation of the articular surfaces takes place in the stress of the labour-traumatism; that it is to be looked upon as a malformation rather than as a dislocation; that it occurs at a time when the hip-joint is not fully formed and solidified (the relation of the depth of the cavity to the diameter of the head of the femur at birth is one to three, at 5 years one to two); that it ought to be diagnosed far earlier in life than it commonly is (a matter which involves the establishment of the diagnostic signs of it prior to the commencement of walking); and that in these days of surgical safety it is well worth considering the propriety of advising immediate opening of the defective joint rather than the prolonged methods of traction and fixation, and the like.

II. Intranatal Infections.

In the neonatal morbid conditions to which reference has been made (viz. cephalhæmatoma, facial paralysis, fractures, dislocations), it has been shown that the antenatal exists alongside of the birth-traumatism factor, replaces it even in some cases, so that it is now recognised that an intranatal cause is not of so much etiologic importance as an antenatal one; these morbid conditions arise not always from the traumatism, physiological or pathological, of labour; but sometimes, at least, from states originating before birth. There are, however, diseases of the new-born which are not so evidently predisposed to antenatally: such are, for instance, some of the intranatal infections. Some reference may be made here to ophthalmia neonatorum, mastitis neonatorum, and hæmatoma of the sterno-mastoid muscle.

Ophthalmia Neonatorum.

Ophthalmia neonatorum, or blennorrhœa neonatorum, once the great, or one of the great, scourges of the Lying-in Hospitals —occurring as it did in 10, 12, even in 15 per cent. of the babies born in Maternities—is now but a shadow, mercifully, of its former malignant self. It is known, and has for some twenty years been known, to be due to the entrance of the gonococcus into the con-

junctival sac of the new-born. The gonococcus was lurking in the maternal vagina, the mother having suffered from gonorrhœa, at any rate from a "discharge" of some kind in pregnancy; and the infant's head, having been detained in the canal, *e.g.* on the perineum, for perhaps some minutes, had come in contact with the gonorrhœal secretion containing the gonococcus; the result was infection of the mouth or nose or eyes of the child, unless, as even in pre-antiseptic days sometimes happened, great care were taken to wash away all discharge from the infant's face. A great scourge once upon a time. For it led on to blindness, through such intermediate stages as conjunctivitis, recognisable on the third day of life, becoming purulent a day or two later, corneal ulceration, corneal perforation, dislocation perhaps (of the lens), pyramidal cataract, adherent leucoma, anterior staphyloma, panophthalmitis, and atrophy of the bulb. There were many morbid possibilities; but the end was too often the same—blindness for the individual, and economic loss to the State. Primarily an intranatal infection, it did not, unfortunately, remain so, for, secondarily, it became a neonatal one; the discharge from the one eye trickled over the bridge of the nose and infected the other, or was carried by the midwife to the eyes of another child, or got into the eyes of the nurse or doctor treating the case. The first woman graduate in medicine lost the sight of one eye through infection from a new-born infant suffering from ophthalmia, whose eyes she was syringing (130). Now this disease is happily in process of abolition, "almost expelled from our Maternities"; almost, but not entirely, as the following case shows. A young woman, pregnant for the first time, and at about the eighth month, was admitted to the Edinburgh Maternity in August 1900, suffering from unilateral Bartholinitis, gonorrhœal in origin; was operated on with all care; and soon thereafter was discharged till labour supervened. She returned for her confinement in September, when she was seen by me; during her labour all the approved prophylactic measures (to be immediately referred to) were adopted; nevertheless, two or three days after birth, the infant developed signs of gonorrhœal conjunctivitis in the right eye. Under treatment the inflammation ran a comparatively mild course, and the left eye was scarcely affected at all. There was no other case in the Hospital. The treatment necessary to prevent such cases has passed through three stages, if we regard it from the standpoint of the time when it is applied. It was first neonatal, when obstetricians took pains to cleanse the face and eyes of the new-born. Afterwards it became intranatal, when Credé, and those who adopted his methods, began to apply to the eyes of the infant, before the section of the cord, a drop or two of a 2 per cent. solution of nitrate of silver, and to use corrosive sublimate vaginal injections during labour, for the purpose of disinfecting the maternal passages. It has now to some extent become antenatal, for it is beginning to be recognised to be desirable to commence the vaginal disinfection before the supervention of parturition. It is no longer thought to be necessary

to use nitrate of silver solution as a prophylactic, for it has been found that insufflation of iodoform powder into the new-born's eyes does as well; even a few drops of boiled water, say some teachers, will serve. It is to be concluded, therefore, that during all the years when prophylaxis was not yet thought of in the management of this disease, thousands of infants suffered from ophthalmia, and became, in many cases, blind and burdensome to the community, through the absence of a few drops of a 2 per cent. solution of nitrate of silver, or of pure water, applied to the right place, at the right time. But, and herein lies the antenatal factor in this apparently entirely intranatal matter, in some instances there is evidence to show that the eyes have been infected before the passage of the child through the vagina, for the eyes may show at, or a few hours after birth, changes which point to the second stage of the ophthalmia. This, however, is a subject to which reference will again be made in dealing with intrauterine infection. Let it be understood that it is not always necessary that it be gonococcic infection that produces conjunctivitis neonatorum; neither is it the conjunctival membrane alone that is affected; for Bond (*Virginia Med. Semi-Monthly*, xxi., 1074, 1895) has reported a case in which the eyes, umbilicus, vulva, and skin glands of a new-born infant all seem to have been infected by septic matter from an old lacerated cervix uteri during labour.

Hæmatoma of the Sterno-Mastoid Muscle in the New-Born.

The occurrence of an extravasation of blood into the substance of the sterno-mastoid muscle has an importance which is projected beyond the neonatal period of life; for it is currently, and it may be correctly, regarded as one of the causes of congenital torticollis: and that unfortunate condition is often projected onward for many years, as, it is said, Alexander the Great found, who was well able to conquer the world, but had a wry neck. Occasionally one notes after birth a swelling ("size of a pigeon's egg," "shape of a pencil") in one or other, rarely in both sterno-mastoids. This is due to an effusion of blood into the substance of the muscle, and in time this gives place to a fibrous thickening of it following upon a myositis of a parenchymatous kind. It is easy also to believe that in delayed or instrumental labours, especially in those in which the breech is born first, traction on the neck or the pressure of a blade of the forceps will lead to such lesions in the cervical muscles, and more particularly in the sterno-cleido-mastoid. But then, some of the labours have been spontaneous and easy! Under these circumstances, ingenuity has alleged that attempts at respiration have been made prematurely while the infant's neck was still grasped in the maternal passages, and that these muscles, being thus put on the stretch, have been ruptured. This notion seems at any rate to be accepted by Bronislaw Kader (*Przeglad. Chir.*, iv. 93, 1898), in

an elaborate contribution on the subject of torticollis of muscular origin, how valuable one is not quite able to say, for it appears in the Polish language, with but a short summary in a tongue more generally understood in Western Europe, but evidently a lengthy and learned paper. To explain some difficulties, it has been suggested that the myositis which follows the injury and leads to the contraction which brings about the torticollis, is of infective origin, and Kader (in the French summary of his article) is reported as believing that the infection is *viâ* the blood from the alimentary canal. But, in tracing this connection between the birth-traumatism and hæmatoma of the sterno-mastoid, and again between it and muscular torticollis, there are other difficulties; for it is not at all certain that a hæmorrhage into a muscle will lead to a shortening of that muscle, either with or without rupture and myositis. Further, there is the associated cranial asymmetry to be accounted for. It seems at any rate as reasonable to look for an antenatal as for an intranatal or neonatal origin. No doubt hæmatoma of the sterno-mastoid occurs as the result of a labour in which the breech has presented; but there is a doubt whether it leads on to muscular torticollis, and it is certainly a possibility that the latter may be due to intrauterine causes, such as pressure (amniotic or other), which distort the head and neck of the fœtus. One matter, however, we need be in no manner of doubt about: that it is wise to inspect with care the state of the sterno-mastoids in infants born as breech presentations, or after instrumental deliveries. If the hæmatoma be there, then let there be massage and inunction; it will be well to relieve somewhat the torticollis, for, after all, that is of more importance than the proving or disproving of a theory.

Mastitis Neonatorum.

Not a few medical men are surprised once in a while to observe that the breasts of a new-born infant are distended with a milky fluid; sometimes some of them send to a convenient medical journal, which has a column of replies to correspondents, a startled inquiry as to the meaning of this curious phenomenon, adding occasionally, to make it more curious, that it was a male and not a female infant that showed this remarkable mammary activity. And, look at it as we like, and even after familiarity with it has lessened its strangeness, it is a curious phenomenon!—worthy to be put alongside the occasional discharge of a red sanguinolent fluid from the vagina during the first days of life, "menstruation of the new-born." Both have a meaning, doubtless, but a meaning yet to be found out; and only to be found out after we have discovered all the details of that marvellous series of changes known as the "physiological readjustment at birth." Some things are known, or at least guessed at: during fœtal life the sebaceous glands are active, secreting freely, and helping thus to make up the vernix caseosa, "cheesy varnish," of the infant's skin; it is thought that the mammary glands have been

evolved from sebaceous glands, for in the secretion of both there is much fat; but other embryologists are of opinion that they are modified sweat glands, an opinion which Minot regards as resting "upon strong evidence"; the neonatal mammary secretion is undoubtedly lacteal, chemical analyses all agree about this. Chemically milk then, but something queer about it, *Hexenmilch* the Germans call it. The human new-born is not peculiar in this lactescent character, but shares it with some of the young of the other mammals—the witches, presumably, not restricting their attentions to him alone (!) Is it possible, it may be hazarded, that as the fœtus from its semi-parasitism shares so intimately in the bio-chemical changes of the mother, changes which terminate for her in the establishment of lactation, so even after birth the character of the chemistry of the body goes on at first along similar lines, and causes activity of the mammary glands in the infant also? Whether this be so or not, there need be no hesitation in taking measures to prevent meddlesome midwives or mothers squeezing the breasts of the new-born, with the notion (most erroneous) that they are in this way doing the infant a service—"breaking the breast-strings," they say, perhaps in justification. Truly the most malicious of the witches could wish for nothing else than this squeezing of the secreting mammary glands of the new-born to "break the breast-strings," leading, as it not uncommonly does, to mastitis neonatorum, mammary abscess, cicatricial contraction, and years afterwards, when the infant, if a girl, has become a mother, to lactational ineptitude. It is said that some medical men even believe in this squeezing as a prophylactic against mastitis neonatorum, a belief which provokes from Dr. J. Comby ("Traité des maladies de l'enfance," v. 258, 1898) the indignant protest, "C'est à cette opinion que je m'attaque." Surely it is to be expected that glands in a state of physiological activity, if subjected to pressure, amounting generally to traumatic pressure, and at the same time not kept aseptic, will readily pass on into inflammation, abscess formation, and cicatrisation. Evidently, then, mastitis neonatorum is a clearly established neonatal condition. Possibly, however, both the traumatism and the infection may in some instances be intranatal, as in a delayed labour in a vaginal canal infected with gonococci. More than this, there is some evidence in support of the idea that antenatal predisposing factors may be at work in some instances. Two cases, occurring in my practice about seven and six years ago, contain to my mind suggestions of some such antenatal predisposition. In one, the infant, a first child and a female, had when born a skin as absolutely free from any trace of vernix caseosa as it is possible to imagine; so striking was it, that both my attention and that of the nurse were drawn to it at once. During the first month of life, that infant had a very severe and widespread attack of eczema neonatorum, for which no apparent cause could be found; the crusts were very marked. Little more than a year afterwards, the brother of this infant was born; he exhibited the same remarkable absence of the vernix, although in not so striking a way; he

also developed troublesome eczema and intertrigo; and, further, one of his breasts became greatly enlarged and inflamed, but fortunately did not go on to pus formation. It is reasonable to ask whether in these two infants, born of the same mother, the absence of the vernix caseosa at birth had any relation to the after-development of the eczema and the mastitis neonatorum. The circumstances are at any rate suggestive.

CHAPTER VI

Types of Neonatal Disease, illustrating the Intrusion of the Antenatal Factor (*contd.*): (3) Neonatal Infections, Tetanus Neonatorum, Erysipelas Neonatorum, Sepsis Neonatorum, Hæmoglobinuria Neonatorum, Omphalorrhagia Neonatorum; (4) Disturbed Neonatal Readjustments, Icterus Neonatorum, Melæna Neonatorum, Keratolysis Neonatorum, Pemphigus Neonatorum, Sclerema Neonatorum, Asphyxia Neonatorum, Neonatal Heart Disease; Summary.

THE new-born is liable not only to morbid conditions arising from the traumatism of labour, and from infection during labour (intranatal traumatism and infection), but also to maladies which originate in infection after birth, and in disturbances or arrests of the physiological readjustment which occurs at this transitional time (neonatal infection and disturbed readjustment). Into these neonatal morbid entities, just as into those described in the previous chapter, the antenatal factor occasionally, perhaps frequently, intrudes itself. It may be profitable to note the manner of the intrusion.

III. Neonatal Infection.

TETANUS NEONATORUM.

The "Scourge of St. Kilda" is happily no longer so to be called, for tetanus neonatorum, once so fatal to the new-born St. Kildans as to justify that appellation, has been shown to be preventible, and is accordingly now prevented, in St. Kilda, at least, and soon it will be everywhere else, let us hope. Truly a scourge indeed, once upon a time, not long ago either, in that most western of the Western Hebrides, lying "fully forty miles west of North Uist," called "Isle of Feathers," also for many birds thereon and few human beings (population in 1841, 105, but much less now). Up to the year 1894 it seemed likely that there would be fewer men and women and more birds as the years went on, for the babies born on the island, although all "proper bairns" up to the age of two or three days, generally gave up sucking on the fourth or fifth day, on the seventh "clenched their gums together, so that it was impossible to get anything down their throats," were seized with convulsive fits, and, "after struggling against excessive torments till their strength was exhausted, died," most often on the eighth day, the disease thereby

getting the name of the "eight-day sickness." Many things about this sickness of St. Kilda have been recently told to the medical world by Dr. G. A. Turner (*Glasgow Med. Journ.*, xliii. 161, 1895), to whom and to Dr. W. L. Reid, as well as to the Rev. Angus Fiddes, the islanders are much beholden, for through their efforts a mortality of at one time nearly 80 per cent. of new-born infants ("the disease proved fatal to eight out of every ten children born alive") has been reduced to nothing or nearly so. Various were the alleged causes of this terrible malady. There are many birds in the island, one a "particularly oleaginous bird," the fulmar by name, found in no other place in the United Kingdom, and greatly used by the inhabitants for food; possibly its oil, some said, getting into the milk of the mother, proved too strong for the new-born infant. Others have found causes in deficient ventilation of the huts, in exposure of the infants to sudden alternations of heat and cold, and in the zinc roofs of the newer houses, which did not protect the inmates. Some suggested mismanagement of the umbilical cord, although others, and among them Sir Arthur Mitchell, were satisfied that there was "nothing exceptional in the mode of dressing the umbilical cord to account for the results." An antenatal cause was looked for in race deterioration, through the intermarriages which have of necessity been common in so sparsely populated an island; and this view was advanced to combat the theories founded upon defective hygiene, and careless dressing of the cord. Nevertheless, it is now abundantly demonstrated that the management of the cord had at any rate much to do with the etiology of the disease; for since the midwifery nurse has secured surgical cleanliness of the umbilical region by cutting the cord with a pair of clean scissors, dusting the stump with iodoform powder, and dressing it with iodoform gauze and sublimate wool, the infants of St. Kilda have been practically free from tetanus. The tetanus bacillus ("pin-headed, bristle-shaped" in sporulation), although doubtless still present on the island, does not any longer make his way through the umbilical wound into the bodies of the new-borns. *Nascentes morimur* ("being born we die") is not now applicable to the infants of St Kilda; not the infant but the epitaph is for ever buried, not to be resuscitated! Along with freedom from the daily newspaper and the post, and almost complete freedom from the tourist, St. Kilda enjoys immunity, after long years, from tetanus neonatorum. In other parts of the world, however, the disease still lingers, and sporadic cases occasionally occur both in cities and in country places; the aseptic treatment of the cord and navel is necessary to eradicate these few remaining cases. The disease is tetanus, but tetanus modified by the neonatal state, the chief modification being that the bacilli gain access through the umbilical wound. It may be that some infants are antenatally predisposed to this invasion on account of congenital weakness, and consequent imperfect closure of the umbilical avenue of entrance at the time when the cord drops off; but the antenatal factor is not prominent

in this neonatal disease, nor likely to be unless consanguinous marriages can be shown to be of etiological importance.

Erysipelas Neonatorum.

Trousseau, in his remarkable "Clinique médicale de l'Hotel-Dieu de Paris" (tome i. p. 174, 1865) has a fine chapter on erysipelas neonatorum, a chapter which leaves us wishing, after its perusal, that the author had given us more from his pen upon this and other diseases of the new-born. In it he describes, with wonderful insight, the malady, nearly constantly fatal, "presque fatalement mortel," which is still known as erysipelas neonatorum, "érysipèle des nouveau-nés." He had been struck by the fact that when puerperal fever prevailed at the Maternité, many of the new-born infants suffered from erysipelas, ophthalmia, and peritonitis, and he had called all these morbid manifestations "puerperal," regarding them as essentially the same. This opinion he had freely expressed twelve or fifteen years before (in 1850 or 1853), but the view had not got outside the hospital walls, had not at any rate been made widely known, had at the most been gliding ghost-like through the pages of some medical journals ("se glissant silencieusement dans les colonnes de quelques journaux de médecine"). P. Lorain had, however, brought the matter prominently forward in his *thesis*, "Sur la fièvre puerpérale chez la femme, le fœtus, et le nouveau-né" (Paris, 1855). He had absolutely demonstrated, with facts really incontrovertible, the association of septic conditions of mother and infant—thirty infants dying from peritonitis, simple, or with erysipelas, ten of the mothers had died with the same lesions as the infants; fifty women whose infants had died from peritonitis had themselves puerperal affections, but had recovered. Solidarity in pathology had thus been established between mother and infant. "Il est impossible de ne pas accepter en pathologie la solidarité qui unit entre les mères et les enfants, le tronc et la branche qui en émane." But Trousseau and Lorain did more for the elucidation of erysipelas neonatorum: they pointed out the peculiarities of its symptomatology and the gravity of its prognosis in a way that left little for later writers to add. The infant's umbilicus is the common, almost constant, avenue of entrance for infection; it is a wounded surface like the interior of the mother's uterus; the infant then takes erysipelas by the umbilicus. But the first signs of the erysipelatous change are to be seen, not immediately round the navel, but near the symphysis, the infection having travelled thither along the vessels (hypogastric arteries). Slowly the disease passes to the scrotum (or vulva), then to the thighs, gluteal regions, and legs, and finally to other parts. There is bright redness of the skin, with hardness of the subjacent tissues, there is sometimes œdema also, and bullæ containing yellowish serum. The swelling of the parts may be very great, and may be followed by desquamation of the cuticle. There is fever, with a rapid, small pulse; the breast is refused; collapse follows, and death, often unexpected, closes the scene.

Uncommon complications are gangrene of the abdominal walls and elsewhere, phlebitis of the umbilical vein, with hepatitis and jaundice, peritonitis, pleurisy, etc. Trousseau pointed out that when abscesses formed in the subcutaneous tissue, recovery sometimes occurred, which very seldom, if ever, happened under other circumstances. The explanation of this fact has been furnished lately by P. J. Achalme (*Thesis*, Paris, 1892). He found that the streptococci (the bacterial cause of erysipelas) were present in great numbers in the connective tissue separating the lobules of fat in the subcutaneous tissue. They were also very numerous in the walls of the lymphatics. Nowhere was there any trace of a multiplication of leucocytes; nowhere was there any evidence of the phagocytic defence, of the leucocytic reaction. Herein lies the explanation of the extraordinary gravity of erysipelas neonatorum; it may not be the only explanation, neither need it be all the explanation, but it is a working hypothesis to found an explanation upon. When, however, abscesses form in the subcutaneous tissue, there is evidence of the phagocytic reaction, albeit of a tardy or delayed kind ("réaction phagocytaire tardive"); and under these exceptional circumstances the patient may recover.

Generally, it cannot be doubted, the streptococcic invasion takes place at or soon after birth, and the disease is to be reckoned as a true neonatal infection; sometimes, however, it may be supposed to have occurred in labour (intranatal), and rarely it has been intrauterine (antenatal). Of the antenatal cases more must be said in another chapter. There is, however, another antenatal aspect to the question, for causes existing before birth may have contributed to weaken the tissues of the umbilicus and its vessels, and so to hinder the separation of the cord and the closure of the arteries and vein, and thus to predispose to the onslaughts of the streptococci. At any rate, the proper treatment of erysipelas neonatorum, as of tetanus neonatorum, is prevention; and that, in a word, is to be obtained by aseptic treatment of the umbilical cord. When the separation of the cord leaves a surface from which a catarrhal discharge ("umbilical lochia" of Lorain) is coming, or from which there is actual suppuration, then the time for prevention is past, and an active treatment with nitrate of silver solution is indicated. If erysipelas neonatorum have declared itself, then moist antiseptic applications may be made, the anti-streptococcic serum tried, and possibly saline injections used. A healthy antenatal life, terminating not prematurely, along with the aseptic management of the cord, at and after birth, these constitute the best treatment of erysipelas neonatorum—a "wise prophylaxis."

Sepsis Neonatorum.

In certain cases, when the umbilical cord separates, the umbilicus does not look unhealthy, but stains of blood, and even of pus, are seen on the dressings, and, on separating the edges of the cicatrix, one can see a small ulcer; this may be regarded as the mildest

form of sepsis, and requires washing with boric lotion, and dusting with iodoform powder. In other cases the ulcer has led on to the formation of a small rounded mass or granulation (granuloma) in the position of the umbilical cicatrix; myxomatous in its pathology, pale red in its colour, of the size of a pinhead or a pea, bleeding when handled, throwing off a constant watery or purulent secretion, with or without excoriation of the surrounding parts; the little mass calls for antiseptic treatment, for it indicates that septic germs are at work in the umbilical cicatrix, and are preventing normal union of surfaces. There is no clear line of demarcation between such cases and those in which the skin margin surrounding the navel has become involved; in this condition of periumbilical lymphangitis, the inflammation tends to be superficial, and is attended by some pain and redness, but is not productive of much systemic disturbance. When the periumbilical cellular tissue is also involved, another stage of septic invasion has been reached, and omphalitis is present; the local symptoms are more marked, and systemic disturbance is now to be observed; pus forms, and there may be abscesses in the umbilical region, with resolution after rupture or after surgical evacuation. There is again no line of demarcation between omphalitis and erysipelas neonatorum (*viâ* the umbilicus) such as has just been described; both are due to an invasion of the tissues with the streptococcus through the umbilical wound. With or without the appearance of erysipelatous changes, the septic series of umbilical manifestations may progress still further, and widespread ulceration, and even gangrene of the tissues, may result, manifestations which fortunately are rare nowadays. There are yet other possibilities of neonatal sepsis through the umbilical avenue of entrance: the arteries or vein may become the special seat of infection, the streptococci or staphylococci setting up thrombo-arteritis, or periarteritis, or thrombo-phlebitis, and from these foci the germs may be carried to distant parts of the body. In such cases the umbilicus and the tissues in its immediate neighbourhood may remain apparently quite healthy; at any rate, a case reported by L. P. Audion (*Bull. et mém. Soc. anat. de Paris*, 6. s. ii. 241, 1900) and two others by Pierre Audion (*ibid.*, p. 291) suggest this conclusion. In one of these, the infant of an albuminuric mother, born fifteen days before term, showed nothing abnormal at the fall of the cord stump (no discharge or secondary hæmorrhage) on the fifth day of life. The umbilicus was apparently healthy and cicatrising, yet death occurred on the seventh day, the infant having lost 350 grms. in weight, and having had convulsions prior to his decease. The autopsy revealed an apparently healthy umbilicus; but a probe could be passed in easily and deeply in the direction of the umbilical vein, which was wide, smooth, white, and surrounded by some vascularity; there was no unhealthy appearance of the neighbouring peritoneum; the probe passed on easily by the ductus venosus into the vena cava. There was also a persistence of permeability of the umbilical arteries, from defect of retraction. The cause of death was suppurative cerebral meningitis,

affecting the right temporal, parietal, and occipital lobes, with superficial œdema over the frontal. Streptococci were found in the pus. In the umbilical vein was a small clot, slightly adherent to the interior. In the other two cases the conditions were somewhat different, but pointed to the same mechanism of microbic invasion. It is probable that in these cases, and in others like them, there is also an antenatal factor at work as well as the neonatal; the prematurity of the infants (they were all under weight) may predispose to an arrest in the process of closure of the vessels of the umbilicus, and so permit invasion of the organism by germs passing along the distinctively fœtal route. It will thus be seen that there is a series of cases of sepsis neonatorum, varying in degree and in locality, but agreeing in the mode of entrance of the infection. They may be grouped, as Finkelstein (*Jahrb. f. Kinderhlk.*, S. 3. Bd. l. 560, 1900) proposes, in three divisions, with subdivisions, thus:—

1. Local inflammation of umbilical wound.
   - (*a*) Surface infection = pyorrhœa; with infection of the adjoining arterial thrombi = blenorrhœa umbilici.
   - (*b*) Ulcerative process = ulcus umbilici.
2. Local umbilical disease, with infection of the umbilical ring and adjoining abdominal wall = omphalitis simplex, abscedens, gangrænosa, ulcerosa.
3. Progressive umbilical diseases.
   - (*a*) Thrombo-phlebitis and periphlebitis umbilicalis.
   - (*b*) Thrombo-arteritis = suppuration of the thrombus in the whole length of the arteries.
   - (*c*) Periarteritis = lymphangitis umbilicalis.
     - (*a*) Primary process.
     - (*b*) Secondary to omphalitis or ulcus.
   - (*d*) Phlegmone umbilicalis interna s. præperitonealis.

In the preceding paragraph the umbilicus alone has been considered as the route by which septic infection takes place in the new-born infant; but although it is a very characteristic route, it is not the only one. Abrasions of the cuticle, or actual wounds of the skin, may occur in labour, or after birth, and through this cutaneous avenue of entrance streptococci and staphylococci may pass. The infant may, during his progress through the pelvic canals, make premature efforts at respiration, and draw septic vaginal discharge, or even liquor amnii, into his lungs or stomach, and so lead to infection of these organs. The conjunctival membranes may also be inoculated with septic germs, although, as has been already noted, it is more commonly the gonococcus than the streptococcus that gains a lodgment there, and the same remark applies to the genito-urinary mucous membrane. The conditions produced by septic invasion along these different routes are all to be regarded as forms of neonatal sepsis; they arise, some of them, in the intranatal, and some of them in the neonatal, and some of them even in the antenatal period of life, but they exhibit their characteristic

phenomena just after birth. These phenomena may, according to the route of invasion, take the form of erythematous, pemphigoid, and hæmorrhagic cutaneous manifestations; of bronchitis, pneumonia, or pleurisy; of stomatitis, gastro-enteritis, or cholera infantum; of ophthalmia, or of vulvitis, urethritis, and vaginitis. In this way there occur in the new-born such affections as septic diarrhœa, and septic pneumonia; but the true nature of these conditions has only been appreciated within recent years. It seems probable, also, that in this group of the septic neonatal infections must be placed certain little understood morbid processes, to which the names of Ritter's disease, Winckel's disease, Buhl's disease, and the hæmophilia of the new-born have been applied. In doing so, however, it is necessary to widen greatly the definition which used to be accepted of the germs which are to be regarded as septic; it must include, not only the streptococcus, and the staphylococcus, but also the *Bacterium coli commune*, a bacillus analogous to the *Bacillus pneumoniæ* of Friedländer, the *B. enteriditis*, etc. Some words of description will be given to the diseases which are thus admitted within the scope of "sepsis neonatorum," but, in the first place, it will be well to complete the reference which is being made to neonatal sepsis in its more restricted sense. All the septic conditions of the new-born have this in common, that they are very liable to prove fatal. This lethal character may be due in part to the weakness of the phagocytic or leucocytic reaction at this time of life, and this in its turn may be a persistence of a fœtal peculiarity, for in intrauterine life (life normally in sterile surroundings) there can be little need for such a reaction. It may be also associated with the small degree of development of the lymphatic glands and the spleen. There can be no doubt that congenital debility, premature birth, the presence of malformations (such as hare-lip, cleft palate, umbilical hernia), and the coincidence of an antenatal disease (*e.g.* syphilis), will increase the receptivity of the infant to pathogenic, and specially to pyogenic, microbes. In this way there is both an increased septic mortality and morbidity in neonatal life, and in the production of both there is the antenatal factor evidently at work. The germs are everywhere present—in clothes, in baths, in *couveuses*, in maternal secretions, in the mouth of the infant, round the umbilicus, in the folds of the skin; the new-born is prone to their attacks, by reason of the peculiarities of his neonatal physiology, and antenatal pathology, and intranatal traumatism; therefore, there is need for an enlightened prophylaxis, which shall not only endeavour to prevent the entrance of microbes along the avenues which have been referred to, but shall also attempt to strengthen all the defences of the organism against their onslaughts when they have entered.

Hæmoglobinuria Neonatorum.

A plurality of names and an obscurity of pathology often go together, the former being bred of the latter; so, at any rate, it is

with regard to the malady of the new-born called hæmoglobinuria neonatorum. Many names, truly. "Winckel's disease" (might, with equal appropriateness, be "Pollak's" disease, or "Bigelow's" disease, or "Laroyenne's," or "Charrin's" disease), "bronzed hæmatic disease," "renal tubal hæmatia" (Parrot), "pernicious icteric cyanosis" (Winckel's own name for it), and "bronzed hæmaturic disease of the new-born." There is one value, at least, in the plurality of names: a suggestion is contained therein of the outstanding features of the malady. It is rare, but when it occurs it is usually in an epidemic form, and in a Maternity Hospital. The victims (nineteen perished out of twenty-three attacked in one epidemic) are healthy and strong at birth; two or three days after birth they begin to be ill, very ill in fact, dying in thirty-two hours, and even in a shorter time in some cases. They have a cyanotic-icteric colour of their skin, each one appearing like a "little mulatto," a peculiar bronzed colour, almost violet on the palms of the hands and the soles of the feet, the conjunctiva sub-icteric. There are fits of crying, alternating with somnolent states. The blood is black as ink, or has a chocolate colour. The stools are black-green, and leave on the napkins a stain with a sanguinolent areola. The urine is sanguinolent also, very markedly so, drawing the attention of the clinician at once. There is no fever, but a rapid pulse. There are head symptoms also, such as convulsions and squinting. As already hinted, death usually follows. The autopsy reveals to a very considerable extent the changes which the symptomatology has led one to expect; there are hæmorrhages in many situations, the lungs are black, the cerebro-spinal fluid and that from the pericardial sac are sanguinolent, the bladder contains sanguinolent urine, the liver and spleen have a brownish black colour, the kidneys are marone-coloured, and the pelvis and calyces are filled with a black-grained clot. There is no disease of the umbilical vessels; about this point all observers seem agreed. The microscopical examination of the tissues throws a faint flicker of light into the pathological darkness of the malady. In the urine are to be found epithelial cells from the bladder, epithelial masses from the calyces, granular cylinders of blood corpuscles, and micrococci in great numbers; there are hæmoglobinuric infarcts at the level of the papillæ in the kidneys. Thus Winckel. The renal change is described more minutely by Bar: there is a blood effusion into the convoluted tubules at the papillæ, and the effusion has acted upon the renal epithelium by compression; the straight tubes show similar changes, especially marked at the level of the "pyramids of Ferrein"; in the latter he found elongated bacteria, and in the former micrococci in large numbers, arranged in chains or clusters. A micrococcus also is to be observed in the blood, according to Hirst, and in the liver, spleen, and lungs; rapid diminution in the red blood cells, 5,700,000 one day, 3,400,000 three days later; ratio of white to red, 1: 13·5, hæmoglobin, 89 per cent.

It was and is an obscure disease. Resembling in some details the malady known as Buhl's disease, or acute fatty degeneration of

the new-born, for in both there are hæmorrhages and fatty degeneration of the internal organs, but differing in others. Obscure as to its etiology, when it occurred in an epidemic form (Max Runge (*Die Krankheiten der ersten Lebenstage*, p. 175, 1893) says: "Die Ætiologie dieser Epidemie blieb demnach dunkel"), it was also obscure when it was met with sporadically ("auch blieb die Ætiologie unklar," *Runge*). One or two things alone seem certain: it is an infection; it does not, primarily at any rate, affect the umbilicus; it is hæmorrhagic; and it specially attacks the tubules of the kidney and the blood. Buhl's disease has been referred to. In it the fatty degeneration of several of the internal organs is a marked feature; something similar has been described in the new-born of other mammals, namely, the "Læhme" ("foot-halt") of lambs. In "Buhl'sche Krankheit," there are infarcts, bleeding from the bowel and stomach, and jaundice. In some details the disease differs from hæmoglobinuria neonatorum: hæmorrhage from the umbilicus is common, and the subject has often been in an asphyxiated condition at birth. Sepsis may be expected yet to be clearly demonstrated in both, although it is difficult to understand by what avenue of entrance micro-organisms have invaded the body; but with such cases as those of Audion (*loc. cit.*) in the mind, it is quite conceivable that germs may have passed in through unclosed umbilical vessels, without there being any signs of disease in the umbilicus itself (persistence of antenatal permeability?). "Bleibt die Ætiologie unklar!"

Omphalorrhagia Neonatorum.

Hæmorrhage from the umbilicus is "not a disease but a symptom of different morbid states" ("keine Krankheit, sondern ein Symptom verschiedener krankhafter Zustände," *Runge*); this, at any rate, is the modern view taken of the idiopathic, or secondary, or spontaneous form of omphalorrhagia in the new-born. With primary bleeding from the stump of the umbilical cord from slipping of the ligature, abdominal constriction from the binder, etc., we are not here concerned. Idiopathic omphalorrhagia begins after the fall of the cord; often in insidious fashion, bleeding having begun and for some time continued before it has been observed, perhaps when the infant is being undressed, and the gravity of the case then for the first time recognised. The time of commencement, then, may be fixed as between the fifth and seventh days of life. The sex more often affected is the male (males, 65¾ per cent.; females, 34¼ per cent.); but the disease is rare (once in 5000 new-born infants, *Winckel*); is very fatal when it does occur (mortality, 83 per cent., *Grandidier*); and runs its course in a short time as a general rule (a few hours, at most a few days). The umbilicus, when inspected, shows rather a steady and general oozing or sweating of blood than a distinct hæmorrhage from any vessel or vessels; some clots may be found in the neighbourhood of the umbilicus, but commonly the blood shows no tendency to coagulate. There may or may not have been premonitory, at any

rate precedent signs, such as vomiting, somnolence, jaundice, colic, and purpuric spots.

It is inevitable that such a hæmorrhage should be regarded as of the nature of the hereditary malady hæmophilia, but then omphalorrhagia is rare in families with this hereditary tendency (I know of but one); and it does not clear up matters to suggest that it represents a sort of "transitory hæmorrhagic diathesis" due to the transition from the fœtal to the neonatal mode of respiration ("natürlich ist dies keine Erklärung, sondern nur eine Umschreibung der Thatsachen," *Runge*). It would seem that it is sometimes the result of congenital syphilis, although it must be freely confessed that all evidence of the presence of parental syphilis is often absent. It may, as has already been noted, be associated with Buhl's disease, an association which does not help us much in our search for its causation, the etiology of Buhl'sche Krankheit itself being "unklar" up to this time. Sepsis neonatorum has also been regarded as the cause of omphalorrhagia with some increasing degree of probability, for various microbes have been found in such cases (streptococcus, staphylococcus albus, staphylococcus aureus, special diplo-bacillus). Finally, the antenatal factor has been invoked, and the condition has been ascribed to malformations of the heart and blood vessels. Whether there is any degree of truth in this opinion or not, is not easily decided, but there can be no doubt that two and even more cases of omphalorrhagia may occur in the same family; further, I have notes of a family history in which the first infant died of umbilical hæmorrhage, and the second was dead-born with grave malformations of the intestine and urinary bladder. Some evidence, therefore, exists to prove that the antenatal factor is not to be neglected in endeavouring to distribute the etiological blame aright. In presence of such a grave condition as omphalorrhagia, mild remedial measures are commonly of little use, and only occupy valuable time. The application of various styptics and the filling of the umbilical fossa with plaster have been tried; but it is generally necessary to resort to compression of the umbilicus or to mass ligature of it with the aid of hare-lip pins. The umbilical vessels may be sought for and ligatured separately, but there is no strong evidence that the bleeding is specially from the vessels. The abdominal cavity has been opened in one or two cases, and the vessels tied on the inside, but with no good effect. Constitutional treatment (*e.g.* anti-syphilitic) has not been forgotten; but all means too often fail. Of this disease, as of some others which affect the new-born, it may be sadly said, "presque fatalement mortel."

IV. Disturbed Neonatal Readjustments.

It is impossible to separate off the maladies which are due to neonatal infection from those in which the chief morbid factor seems to be a disturbance of the physiological readjustment which follows birth. There can be no doubt that to some extent they overlap, both factors being present. What I am trying to do is to group together

those in which the infection-factor seems to be the more important, and those in which the disturbed readjustment plays the greater part. The classification, however, is not insisted upon, for the object of the chapter is to show the intrusion of the antenatal factor into all, or nearly all, the diseases of the new-born.

Icterus Neonatorum.

Surely there is no question in neonatal prognosis more difficult to settle than the significance of jaundice of the new-born in any given case. Certainly there is no problem in neonatal pathogenesis farther from solution. So common and generally so benign as to have gained for itself the name "physiological," jaundice of the new-born may yet be due sometimes to one of the rarest of malformations, and may have a mortality that is appalling. Hypotheses there are in plenty; but of solid, incontrovertible facts few are to be found, although sought for with care. One fact among the few is worth remembering, even if much else be forgotten: jaundice of the new-born is, like omphalorrhagia neonatorum (but even more), to be regarded as a symptom rather than a morbid entity or separate disease. Another fact is its frequency, and the evident deduction (but not a fact!) would seem to be that it must therefore depend upon a frequent condition or group of conditions; it is safer, however, to conclude that it *generally* depends upon a frequent conjunction of circumstances, and *rarely* may be due to quite exceptional states. There is certainly one group of cases in which the jaundice is slight and transient, and so often met with that one is justified in regarding it as a symptom of a physiological state of affairs, the outward sign and manifestation of the inner processes of functional readjustment and adaptation which take place at and soon after birth; in this group, the jaundice is by some termed *idiopathic* or *spurious* icterus, or icterus neonatorum in the narrower sense. It is equally certain that there is another group of cases in which the jaundice is again a symptom, but now a symptom of a pathological condition — nay rather of several pathological conditions of various degrees of gravity: *symptomatic* icterus, then, may be its name. It is possible, but there is no great strength of possibility about it, that in such a disease as hæmoglobinuria neonatorum it is the jaundice that is *the* pathological condition that constitutes the disease itself. Thus, to summarise, there are, *or may be*, three groups:—

1. Idiopathic icterus—the symptom of a physiological process or processes — a sign of neonatal readjustment in progress.
2. Symptomatic icterus—the symptom of a pathological process or processes—a sign of neonatal pathology in action.
3. Essential icterus—not a symptom but the disease itself—a doubtful entity and class—possibly will turn out to be a form of symptomatic icterus, variety septic.

In endeavouring to find a suitable pathogenesis for *idiopathic* jaundice, the pathologist has run riot, and what with his hepatogenous theories and his hæmatogenous ones, there is confusion in the minds of not a few writers and readers both. Here are some of the hepatogenous theories: desquamation of the epithelium in the bile-ducts leading to blocking; slowing of the portal circulation due to the circulatory changes resulting from birth and the ligature of the cord; stasis in the bile-ducts from their compression by the œdema of Glisson's capsule due to the phenomena following birth; persistence of permeability of the ductus venosus; retention of the meconium; and late ligature of the umbilical cord. With respect to most, if not all, of these, Runge's remark (*op. cit.*, p. 228) holds true, "Keine einzige dieser Anschauungen ist anatomisch begründet, sie sind sämmtlich hypothetscher Natur." They agree, let it be noted, in one thing, that they all look for a cause of the jaundice in one or other of the phenomena which follow birth as a result of the rearrangement of functions made necessary by the marked change in environment then taking place; they regard the icterus as due in some way to disturbance of an absolutely perfect performance of the neonatal readjustment. Then, again, there have been the hæmatogenous theories which seem to have been widely held in France; the hepatogenous apparently being popular in Germany. Destruction of red blood corpuscles after birth, setting free of much pigment in the blood, changes in the blood plasma leading to the breaking down of blood corpuscles; these and other changes in the blood have been advanced, but not of late with any great boldness, the demonstration of bile acids in the pericardial fluid having given apparently a deadly blow to the hæmatogenous theories. This much, however, it is worth while remembering: that the hæmatogenous, in common with the hepatogenous theories, look to the readjustment phenomena in the new-born, or to a slight disturbance of them, as the causes of the blood or liver changes which produce the jaundice. Some investigators carry the inquiry further back, and ask what cause or causes contribute to the slight disarrangement of the physiological readjustment of birth: some find an explanation in errors of feeding during the first days of life; while others conclude that delay in labour, or undue interference with its mechanism, has been the disturbing condition; and yet others are compelled to look for the antenatal factor, and find it in congenital weakness or prematurity. Thus, idiopathic icterus neonatorum is due, according to the opinion of most, to a disturbance of the physiological readjustment of birth, and this disturbance is caused by a neonatal, an intranatal, or an antenatal factor, by one of these, or perhaps by all. At any rate, and to the physician this is a matter of moment, the condition usually disappears quickly and leaves no evil effects behind it; it is an almost harmless disorder, albeit having "a well-marked clinical individuality" ("une individualité clinique bien marquée").

A different group of circumstances and conditions goes to make up the malady known as *symptomatic* icterus neonatorum. Its causes are not unknown, are in fact well known, but they are numerous and not

easily to be differentiated from each other during the life of the infant affected therewith. It is in some instances due to hepatic lesions, neonatal or antenatal. In this group must be placed the jaundice which follows umbilical infection with sepsis; that which is caused by syphilitic hepatitis of the congenital type; and that produced by interstitial hepatitis, the syphilitic nature of which cannot be proved. It is in other instances due to obstacles to the flow of the bile, obstacles which have arisen in the neonatal period or in the antenatal. Thus it may originate in a catarrhal blocking of the common bile-duct, at the point where it passes through the wall of the duodenum; or it may arise in that interesting malformation, or result of antenatal disease, known as congenital obliteration of the bile-ducts, and it may then be justly termed "malignant icterus," for it is always fatal sooner or later; or it may be caused by the impaction of a small gall-stone in the ductus communis choledochus or in the cystic duct, it being necessary in such a case to believe that the calculus was formed in intrauterine life (antenatal); or it may, finally, be the result of an over-production of bile leading to obstruction in the ducts. In this multitude of causes it is to be noted again that the antenatal factor occupies a not unimportant place, and when it is present in any given case it largely increases the difficulty of treating the jaundice, and makes the prognosis correspondingly worse. The hope of the physician, in one sense, lies in the confirmation of the diagnosis of catarrhal blocking or of syphilitic hepatitis, for castor-oil in the one case and mercury in the other may, and does, work wonders; the diagnosis of congenital obliteration of bile-ducts or impaction of an antenatally formed gall-stone, a diagnosis made largely as a matter of exclusion, raises little therapeutic expectation.

Melæna Neonatorum.

In cases of gastro-intestinal hæmorrhage in the new-born, the bleeding is generally from the bowel (melæna), and rarely from the mouth (hæmatemesis); it has therefore become customary to apply the name "melæna neonatorum" to the disease. That it is to be regarded as a disease is, however, more than doubtful; it is, in fact, no more a disease than icterus; it is, like icterus, a symptom of several different morbid states. Generally a symptom among other symptoms, it may in some rare instances stand alone as the only symptom; then, and then only, is it justifiable to call it a disease—a morbid entity. Unlike jaundice of the new-born, it is a very rare condition, occurring but once in 500 or 700 new-born infants; there is no great resemblance either in the matter of prognosis, for melæna neonatorum is very often fatal, mortality being from 35 per cent. to 50 per cent., even from 50 per cent. to 60 per cent. according to Runge. In one thing the two conditions fully and entirely agree: in the multitude of theories which pathologists and physicians have brought forward to explain their pathogenesis. Many of the theories are not founded upon even the slightest stratum of anatomical fact, there being no trace of solid bed-rock in the shifting sand. Some of the theories condemn

themselves to the thinking mind at once; those, namely, in which a very common occurrence, such as early or late ligature of the umbilical cord, is blamed for the production of melæna neonatorum, admittedly a very rare condition. Surely it must be conceded at once that a rare morbid state demands for its causation a condition which is also rare, or at least a rare conjunction of common conditions. As it is, the pathogenetic theories of melæna neonatorum are in a state of hopeless, bewildering confusion. There is, perhaps, little service to be got out of an attempt to arrange them; but there is for our present purpose some interest in so far as it gives a demonstration of the way in which the four great factors, traumatism, infection, disturbed neonatal re-adjustment, and the antenatal factor, are all in turn invoked and combined in various ways, and shuffled like a pack of cards in the hope that here or there, in this circumstance or that, a feasible explanation may be forthcoming. A little simplification is possible: there are some cases, at any rate, in which the melæna is evidently the result of blood swallowed, *e.g.* from a hare-lip or cleft palate, or from the nose or lungs; more, the blood may not even belong to the infant, but come from the maternal nipple; certainly there is justification in separating off these cases and giving them a special name, with a warning that they are not to intrude any more into the etiology of melæna neonatorum. Separated off, therefore, they have been, and have been called "melæna spuria." With the remainder, what is to be done? Let us see how they arrange themselves under the four great etiologic factors. Perchance this method of regarding them may be of some small service.

First, then, there is traumatism, intranatal or neonatal. Compression of the trunk of the infant in birth, violent procedures adopted to restore the half asphyxiated child, swinging movements, for instance, after birth, have been suggested. Two difficulties immediately suggest themselves: such traumatic occurrences are common, while melæna is rare; cases of melæna rarely follow such traumatic occurrences. Traumatic factor, however, is not to be driven out of the field so easily; according to F. von Preuschen (*Centrlbl. f. Gynäk.*, xviii. 201, 1894), the traumatic part of the process is to be looked for in the cranium, where hæmorrhages have destroyed some portion of the central nervous system—a theory founded upon the experiments of Schiff and others upon the production of gastric hæmorrhage in dogs, and supported to some extent by Schütze's case, in which there was a small hæmorrhage under the tentorium cerebelli (*ibid.*, p. 207). Intracranial hæmorrhages, it must be borne in mind, are not so rare as supposed, and are certainly many times present when melæna is absent.

Second, there is infection, intranatal or neonatal. The theories founded upon some sort of infection are wonderfully popular at the present time. The special form which the infection takes may be septic, and it is not doubted that gastro-intestinal hæmorrhages occur in sepsis neonatorum; it may also take the form of Buhl's disease, and be caused by the microbe peculiar to it; or, it may be due to a bacillus peculiar altogether, as F. Gärtner (*Arch. f. Gynäk.* xlv.

272, 1893) and those who have followed his lead have maintained. It is unfortunate for the acceptance of this theory, that so many microbes have been discovered: streptococcus alone or with the diplococcus of pneumonia, bacillus pyocyaneus alone or with the staphylococcus, bacillus lactis aerogenes, a bacillus like Friedländer's, a bacillus like Kolb's found in purpura hæmorrhagica, Gärtner's bacillus above referred to, and a micro-organism suggesting, but not to be identified, with the diplococcus of pneumonia. A bacteriological "embarras des richesses" is thus created, which, as has been pointed out by Kilham and Mercelis (*Arch. Pediat.*, xvi. 161, 1899), adds to the confusion, and does not increase the probability of the existence of any specific microbe.

Third, there is disturbed neonatal readjustment. A large number of pathogenetic theories is associated with this factor. Further, most of the theories look to a disturbance in one part of the readjustment phenomenon, in that, namely, which has to do with the circulation. Of course it is at once apparent that any irregularity in the complicated series of changes (physiological and anatomical) which marks the transition from the fœtal to the neonatal circulation, will be likely to produce congestive conditions in one part of the vascular system and anæmic conditions in another. It is in this way that early or late ligature of the cord, thrombosis in the umbilical vein from delayed establishment of the pulmonary circulation, and other frequently occurring irregularities, have been invoked as pathogenetic factors. The fact that it is common to find at the autopsies of infants who have died from melæna erosions, defects, and even ulcers in the mucous membrane of the duodenum, stomach, and œsophagus, is not regarded as weakening this theory. For it is ingeniously argued: there has been slackening of the circulation in the umbilical vein with formation of a thrombus, and later from that thrombus pieces have separated and have been carried as emboli into the small arteries in the gastric or intestinal walls, where they have produced local death of the tissues, and partial digestion of the mucous membrane has taken place, with exposure of the vessels and hæmorrhage. These little defects or ulcers are, it is said, found in 45 per cent. of the cases. It is an ingenious theory, but still a theory only. Another purely theoretic view is that the hæmorrhage is due to the closure of the ductus arteriosus at a relatively slower rate than the foramen ovale, causing increased pressure in the abdominal arteries. Other theories are retention of the meconium and the exposure of the infant to cold. That in many of the cases of melæna neonatorum the bleeding is concerned in some way with disarrangement of the readjustment processes, and more especially with the vascular part of the adaptation, must, I think, be admitted as exceedingly probable; but here again the pathologist is brought face to face with the objection that such vascular disturbances must be very common, while melæna is very rare. Consequently many observers have welcomed the idea of an antenatal cause or predisposition.

Fourth, the idea that an antenatal factor must be looked for in melæna neonatorum is not new. Further, it has taken many forms;

and it has either stood by itself or has been regarded as accessory to other factors. In one of its simplest forms it is the recognition of melæna as a manifestation of hæmophilia; and the obvious objection that there is no hereditary history of that disease, nor indeed any other sign of it, then or later, is explained away by regarding it as a temporary hæmorrhagic diathesis in the new-born. Nevertheless, in some cases, it is probably a correct explanation; for in women hæmophilia may show itself only as post-partum hæmorrhage, and possibly the new-born may under certain circumstances show it only as melæna. Another view is that the disease is congenital purpura, and has been transmitted from the mother; Diehl (*Ztschr. f. Geburtsh. u. Gynäk.*, xli. 218, 1899) has reported a case in which this transmission seems to have taken place, but it is exceedingly rare. Malformation of the heart or great vessels is another form the antenatal factor has taken, and congenital syphilis of the hæmorrhagic type is another.

Such, then, are the etiological theories of melæna neonatorum. Their enumeration has at least demonstrated the presence of the antenatal factor; it has possibly done nothing else of any value. Let it be added to the foregoing, that in some cases of melæna no pathological changes at all have been found, and the reader will be impelled to say with Demelin (Comby's *Traité des mal de l'enf.*, ii. 143, 1897), "la pathogénie est loin d'être simple." And as to treatment? That, likewise, is "far from simple," save in the cases where it is just nothing at all; in such it has a simplicity truly, but not one of the right kind. Doubtless prevention is better in melæna neonatorum than any attempt to cure; but a wise prophylaxis depends upon a knowledge of the pathogenesis and etiology, and that is still wanting. Theoretically, it may be said that we ought to endeavour to favour the readjustment of functions at birth; but, practically, this is not easy to do unless we know wherein and how the readjustment is failing. In the presence of a well-marked case of melæna, it will generally be wise to keep the body of the infant warm (for the application of cold, *e.g.* ice, to the abdomen has met with no conspicuous success), and to give some styptic internally. Possibly it may be found that the injection of a solution of gelatin (5 per cent. to 10 per cent.) into the bowel will give good results.

Keratolysis Neonatorum.

Under this name, or under its synonyms (Dermatitis exfoliativa neonatorum, Ritter's disease, Dermatitis erysipelatosa) is known an affection of the new-born, whose most prominent symptom is an exaggerated cuticular desquamation. I say "exaggerated," for there is a physiological furfuraceous or finely lamellar exfoliation of the epidermis which occurs in all new-born infants. It is one of the outward manifestations of the readjustment changes which follow birth; but there is some degree of mystery as to its causation, possibly it may be produced simply by the drying of the epidermis in the absence of the liquor amnii, possibly there is a deeper seated and more recondite cause than that. At any rate, a clearing up

of our knowledge of the physiological desquamation of the new-born could not but prove of value in elucidating the pathogenesis of Ritter's disease. In Figs. 6 and 7 are high and low power micro-photographs of the appearances of the skin in a new-born infant, with perhaps an excessive degree of desquamation, certainly with a well marked degree of it. The looseness of attachment of the layers of the stratum corneum is in these clearly displayed, and there can be no doubt that in the new-born the normal in this respect very easily may pass over into the pathological. In Ritter's disease, however, there are other signs than epidermic desquamation. There are, according to Ritter himself (1) a prodromal stage, in which there is a dry scaly condition of the epidermis; (2) a stage of erythema and exudation; (3) one of exfoliation and drying, the desquamation following progressively the march of the redness; (4) one of reintegration of the epidermis, accompanied by a fading of the erythema; and (5) a stage of sequelæ, such as boils, abscesses, and eczema. Often the whole process, prior to the sequelæ, is completed without severe constitutional symptoms; but there may in some cases be diarrhœa and pneumonia. I have met with a case of keratolysis neonatorum in which the symptoms were torpidity, rejection of food from the mouth, unless it were put far back on the tongue, highly coloured stools, and swelling of the parotid glands; at ten days after birth the cord had not separated; the child died when a fortnight old; it had been born after a dry labour, and the desquamation was going on at birth.

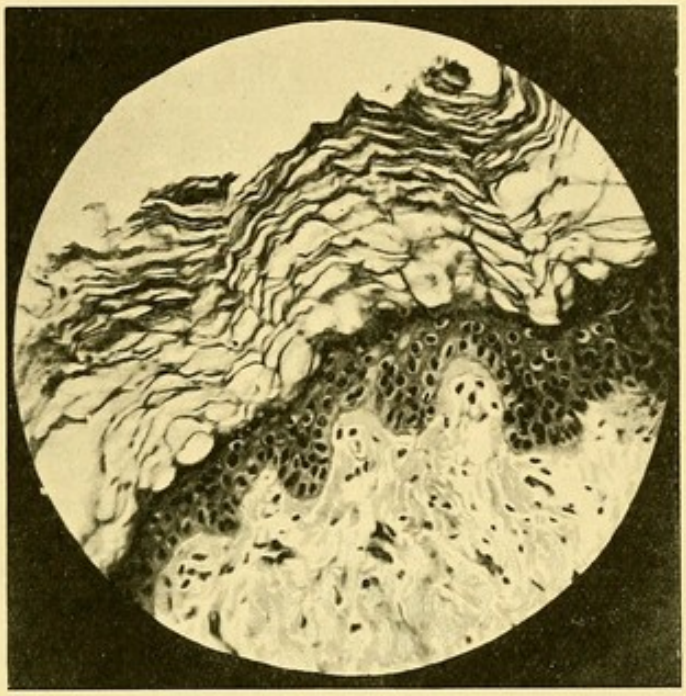


Fig. 6.

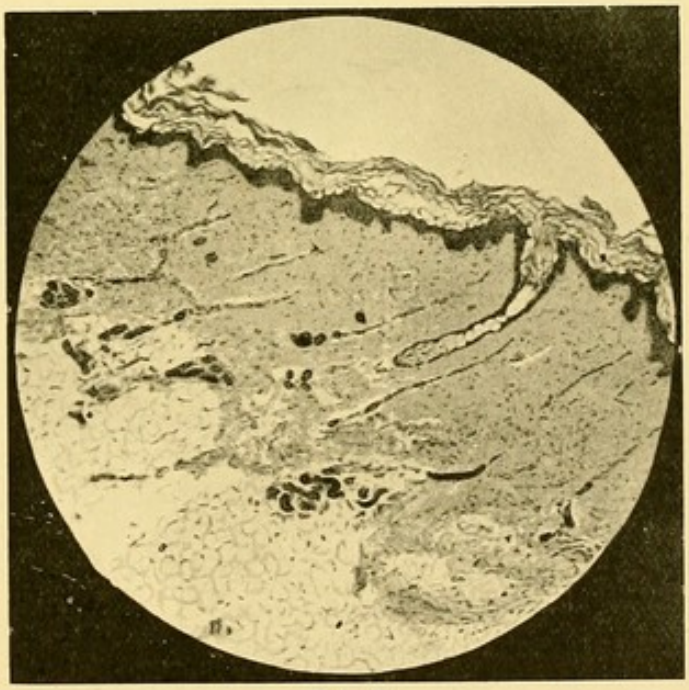


Fig. 7.

A most puzzling malady this has proved to the physicians who

have met with it, a character which it has in common with many other neonatal diseases. Possibly it is to be regarded, like several other morbid states of the new-born, as a symptom rather than a disease by itself. It may, for instance, be a symptom of sepsis, in which case we invoke the factor of neonatal infection; it may be the result of an exaggeration of the physiological exfoliation of the cuticle, in which case the readjustment factor is brought into the etiology; or it may be the consequence or accompaniment of an intrauterine disease, such as fœtal measles, scarlet fever, or erysipelas, in which case it is the antenatal factor that is being advanced. We must, it is to be feared, leave it where Caspary (*Vierteljahrschr. f. Derm. u. Syph.*, xi. 122, 1884) left it sixteen years ago—"an epidermolysis of unknown nature, with secondary hyperæmia of the cutis."

Pemphigus Neonatorum.

Another disease (or symptom of disease) of the new-born, which is probably connected with a disturbance of the readjustment process, in so far as it affects the skin, is pemphigus neonatorum. A great deal has been done within recent years to elucidate the bullous conditions of the skin of the new-born, and there has been an attempt to get rid of the term "pemphigus," and to put in its place such names as "congenital bullous dermatitis," "epidermolysis bullosa," "congenital dermatitis herpetiformis." Reference will be made to it in another part of this work; in the meantime, it may be said that for its explanation it has been found necessary not only to invoke the readjustment and infection factors, but also the antenatal, in so far as most authorities have been led to ascribe the malady to a congenital and often hereditary vulnerability of the skin, even when there have been no lesions present at birth.

Sclerema Neonatorum.

Sclerema of the new-born is a grave disease, characterised by induration of the subcutaneous cellular tissue, and a lowering of the body temperature; and more widely different and even conflicting theories have been advanced to explain its origin than have been brought forward in connection with any other neonatal morbid condition. Truly a plurality of theories is present, with not a little of the "guesser's darkening of knowledge"; a bad omen for the emergence of truth. It can, at any rate, generally be separated from "œdema neonatorum," which is almost certainly a symptom rather than a disease *per se*. The readjustment factor has been sought for and found in the condition of the subcutaneous fat at and about the time of birth; it is more easily solidified by a fall in temperature, and the new-born infant which is not kept warm becomes scleremic. But it may very fairly be asked, why, then, is sclerema neonatorum comparatively so rare, for certainly many infants are allowed to become chilled? Further, in a case which I saw some years ago (35), the microscopical appearances

of the subcutaneous tissue suggested something very different from simple solidification of the adipose layer; they showed an invasion of the layer by bands of connective tissue, and an atrophy of the fat cells (Fig. 8). Another origin for the disease was found in the cardio-vascular readjustments at birth, or in the disturbance of them. Some writers identified sclerema with morbus cœruleus; others grouped it with the infections, and saw in it an unusual form of erysipelas neonatorum. The antenatal factor (a convenient one in these cases, about which our ignorance is the densest) has of course been long in the field, and has ranged from fœtal syphilis and myocarditis, to anomalies of the lymphatics and antenatal lesions of the thermic nervous centres. What I wrote in 1895 (4, p. 53) I may with safety place again here: "It would seem as if nothing

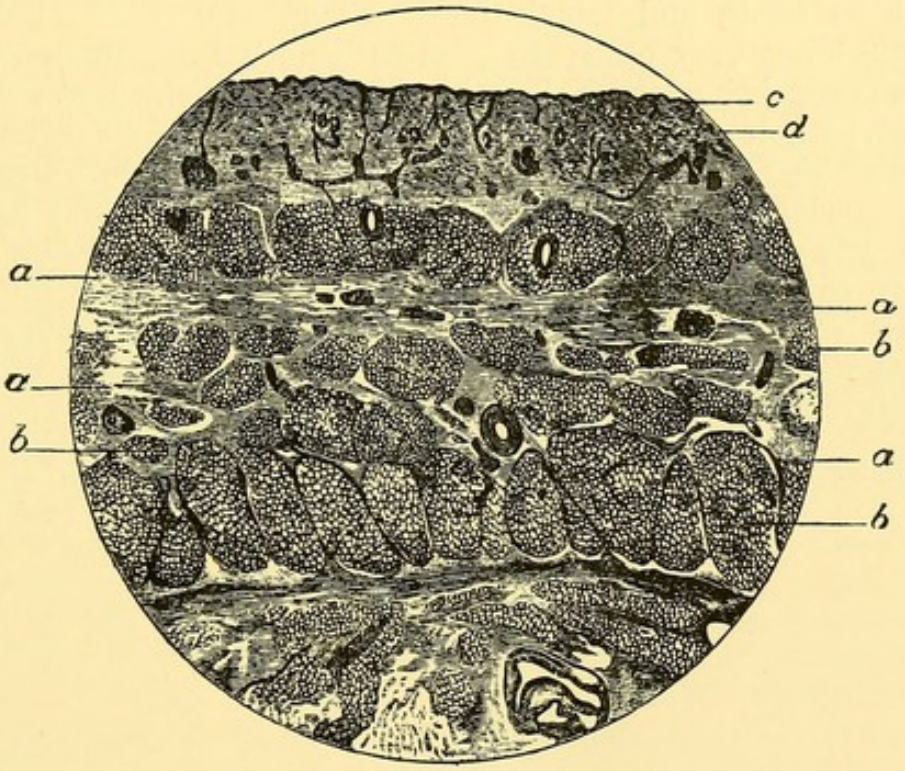


Fig. 8.

less than the labours of an international committee of investigation might succeed in clearing up the confusion, and in undoing the results of the erroneous generalisations of the past century." *Spes incerta!* At any rate, the malady affords another instance of the intrusion of the antenatal factor into the pathology of the new-born, and to illustrate this intrusion has been the chief object of this and of the preceding chapter.

There are yet other morbid states of the new-born, such as asphyxia neonatorum, and neonatal heart disease, in which a disturbance, or rather a complete arrestment of the physiological readjustment at birth, is very evidently present. In them, also, it is not difficult to recognise the antenatal factor in the background of the etiology.

Summary.

From the facts which have been enumerated, it is clearly evident that if the characters of the diseases of the new-born infant are to be understood, it is essential that account be taken not only of the circumstances that the infant's organism has just passed through a period of traumatism, and is passing through one of readjustment to meet new requirements in a new environment in which microbes are plentiful, but also that during the nine months of intrauterine life which precede birth, it may have been the sphere of morbid processes which have left their impress upon it. It may come into its extrauterine surroundings already diseased, or malformed, or predisposed to some pathological development. Like pregnancy, neonatal life is an epoch which has a physiology in many respects peculiar to itself, and which borders very closely on the pathological, tending very easily to pass over into it. Further, just as every woman brings with her into her pregnancy the results of her past pathological history, so the new-born infant brings with him, out of his antenatal life into his neonatal existence, the effects of any morbid processes which may have attacked him in utero. In this way the pathology of pregnancy and the maladies of the new-born infant are both invested with peculiarities; in the former there is, among other things, the pathology of pre-reproductive maternal life; and in the latter there is, among other factors, the pathology of antenatal fœtal and embryonic life.

BOOK II

THE PATHOLOGY AND HYGIENE OF THE FŒTUS

CHAPTER VII

Diseases of the Fœtus; General Characters of Fœtal Life; Contrast between Embryonic and Fœtal Life; The Neofœtal Period; Anatomy and Physiology of the Neofœtal Period; External, Internal, and Environmental Changes in the Neofœtal Epoch; Fœtal Growth and Development at the successive Months of Intrauterine Life; Summary.

In this chapter a beginning is made. In previous chapters the general relations of Antenatal Pathology to Postnatal and Neonatal Pathology were considered; in this chapter, and in those that follow till the end of the volume is reached, it is Antenatal Pathology itself in all its wonderful variety of phenomena that is the subject of study. A beginning, then, is made with Antenatal Pathology; but it is not purposed to begin at the beginning of Antenatal Pathology. To do so would be to begin with the most obscure and most difficult part of it, namely, Germinal Pathology. It is better, in every way, to commence with Fœtal Pathology. When that has been mastered, it will be easier to deal with Embryonic Pathology; and, thereafter, even Germinal Pathology will have its darkness to some degree illumined. For the fœtal period of antenatal life is that lying nearest to postnatal, and in this case proximity means some degree of similarity. Fœtal Pathology has, indeed, much in common with Neonatal and Postnatal Pathology, has certainly much more in common with them than Embryonic Pathology, which at first sight seems to have nothing at all in common, to be entirely foreign to them. This, however, is not quite true, and the study of Fœtal Pathology will show it. It is, then, convenient and reasonable to begin Antenatal Pathology with the part which in its manifestations most closely resembles the morbid processes of later life. What we know of Postnatal Pathology is thus made to throw light upon the darkness of Fœtal Pathology, and by and by what we shall find out about Fœtal Pathology will carry the light onward, not intensifying it in transmission, into the thick darkness of Embryonic and Germinal Pathology. *Natura in operationibus suis non facit saltum;* let us try to imitate nature by endeavouring *progressively* to find out the secrets of these operations with which she astonishes and humbles us.

General Characters of Fœtal Life.

As it is necessary to be acquainted with the physiology and anatomy of the new-born infant in order to understand the peculiarities of neonatal diseases, so a knowledge of the physiology and anatomy of the fœtus throws much light upon fœtal pathology. There are many, many problems connected with these subjects still awaiting solution; but enough is known of intrauterine life and health to help materially in elucidating the causes of intrauterine death and disease. Let us try to form a general conception of the characters of fœtal life.

The chief feature of intrauterine life is its parasitism or semi-parasitism. The fœtus spends the whole of its existence, which lasts, roughly speaking, about seven and a half calendar or eight lunar months, in the interior of the uterus. It is immediately surrounded by the liquor amnii, which, serving as a natural water-cushion, protects it from sudden shocks and jars; the uterine walls, by their growth and distensibility, allow increase in size and freedom of movement to the fœtus, while they shield it from harm, and maintain by their vascularity that constant temperature so needful for healthy development; and, external to the uterus, are the partly osseous, partly muscular pelvic and abdominal walls, which serve still further to secure the safety of the tender organism. In its protected position the fœtus makes little call upon several of its organs; its lungs are absolutely quiescent; its stomach, intestine, kidneys, lymphatic glands, and skin are largely in a resting state. The heart and liver, however, are active; and the thymus, thyroid, suprarenal glands and sympathetic system play a very considerable part in the physiology of intrauterine life. The brain and spinal cord, more especially the cord, are quite capable of replying to all the demands which are made upon them, their activity being chiefly of the reflex type during this period of existence.

The most important and the most active of the fœtal organs has not yet been referred to; it is doubtless extra-corporeal, and the fœtus is only part possessor in it; nevertheless it is the dominating influence in fœtal life, and is absolutely essential to the unborn infant. Without the placenta, intrauterine existence in the fœtal period is impossible; with it, in a healthy condition, almost all the other organs can be dispensed with. Fœtal vitality, although not structural integrity, may be maintained by the aid of the placenta alone. The brain and the spinal cord may be absent; the intestines may be occluded at several places or reduced to a few coils; the mouth and anus and nares and pharynx may be imperforate; the lungs, kidneys, liver, and spleen may be wanting; and the heart may be little more than a dilatation upon the chief blood vessels; yet so long as the placenta is available, fœtal life can go on. Nay more, the headless, and limbless, and almost trunkless fœtus known as an allantoido-angiopagous twin of the anidean type, does not require even a heart in order to continue in life, so long as he can maintain a

connection with a corner of his twin-brother's placenta. The placenta, then, is physiologically necessary to the fœtus, and the fœtal economy is complete only when it includes the umbilical cord, the placenta, and the membranes. The important facts in fœtal physiology, therefore, are—(1) The preponderating influence of the placenta, which is really lungs, kidneys, stomach, and perhaps even liver to the unborn infant; and (2) the characters of the intrauterine environment, which may be described, in a phrase, as life in a fluid medium of high and practically constant temperature, in the dark, and with almost complete protection from external violence. Fœtal life, in short, is semi-parasitism upon the mother through the placenta.

Contrast between Embryonic and Fœtal Life.

The chief result of the physiological activity of the fœtus is growth, growth of a remarkable kind and taking place at a remarkable rate, but growth alone; there are no striking alterations in the relation of the various parts of the organism to one another, no fusions, no separations of parts; and in the head, and the limbs, and the liver, and the intestine of a full time fœtus we can recognise with no difficulty these structures as they occurred in the fœtus of three months, only they were then much smaller in size. In this respect, the result of fœtal physiological activity contrasts very sharply with that of embryonic vital processes. From the apparent chaos of the germinal globe comes the orderly arrangement of the embryonic world. Not simple increase but evolution is the great accomplishment of the life of the embryo. Not at once either is the evolution manifest and complete, but after a time of arrangement, of re-arrangement, and of remodelling, and through a series of changes kaleidoscopic in their variety and in the rapidity of their transposition. The fœtus of nine or ten months is, although greatly enlarged, evidently the same organism as the fœtus of three or four months. Put a magnifying glass over the latter, and you may quite well imagine that you are looking at the former. Quite otherwise is it with the embryo. What dissimilarity there is between the embryo of forty and the embryo of fourteen days! In appearance, what resemblance can be seen between the embryo of fourteen days and the blastodermic vesicle? Truly, there is a deep-seated, a fundamental difference between the results of vital activities in the fœtus and in the embryo. At the same time, there is no sharp line of division between the two periods; there is no special day, far less minute, when it can be said the embryo has now become a fœtus, the time of modelling is past and that of growth begun. On the contrary, some traces of the peculiar activities of the embryo continue to appear throughout the whole fœtal epoch; and growth is not, of course, absent in the embryonic period. Indeed, there is a sort of transition time, the neofœtal, and to that it will be well to direct attention, for it has a very evident importance, as in fact all transition times have.

The Neofœtal Period.

Just as postnatal life begins with a period of transition or readjustment to suit new environmental conditions, a period named the neonatal; so the passage from embryonic to fœtal life is marked by a transition time of adaptation (*Natura non facit saltus*—Nature makes no leaps) which we may call the neofœtal, during which, among other notable phenomena, the placental economy is being established. The neofœtal period coincides roughly (there are no sharp limits, Nature, as has been said, making no leaps) with the second half of second (lunar) month of intrauterine life. Its commencement is on or about the fortieth day (end of sixth week), when the new organism takes on a form which can be recognised as distinctly human; this somewhat indefinite change Minot regards as marking the end of the embryonic epoch (*Human Embryology*, p. 391, 1892) and the beginning of the fœtal. It is, however, better to regard it as marking the beginning of a period which is neither embryonic nor fœtal, but a transition between or combination of the two—the organism is putting off its distinctively embryonic and putting on its fœtal characters, is becoming *human*, *i.e.* recognisably similar to child or adult. The "transition" form is seen in His' embryo xxxiv. (Dr.), the estimated age of which was thirty-eight days, and the length of which from neck-bend to coccygeal bend was 1·5 cm. (Fig. 9). "Transition organism," we may call it, yet it is probably more correct to regard organisms of all ages between six weeks and two months as transition forms, the transition itself being not sudden, but gradual, requiring two weeks at least. For, during the seventh and eighth weeks (neofœtal period), several changes take place in the appearance of the organism; and some of these can be recognised by comparing the His embryo (Fig. 9) with a fœtus (Fig. 10) in my collection, measuring 2·5 cms. in length (cephalo-coccygeal length), and of an estimated age of fifty-six days (end of neofœtal period).

Fig. 9.

Fig. 10.

Anatomy and Physiology of Neofœtal Period.

The changes which occur in the neofœtal period are external and internal; they are less marked than those which have occurred in the embryo, but they are much more marked than those that are to occur in the fœtus.

With regard, in the first place, to *external* appearances, the following may be emphasised as noteworthy. The greater part of the head of the

six weeks' embryo is sharply flexed at right angles to the back part of the head and neck, so that the eye lies in front of the ear and below its level. The point where the back part of the head is continuous with the trunk is marked by a concavity, called the *Nackengrube*. In the fœtus eight weeks old, elevation of the greater part of the head has taken place, so that now the mid-brain lies above instead of anterior to the hind brain, the eye lies in front of the ear, but more nearly at the same level, and the *Nackengrube* is almost obliterated. In the six weeks' embryo there are no traces of eyelids, the external ear is scarcely recognisable, and the maxillary processes have little more than united in the median line anteriorly; in the eight weeks' fœtus the eyelids are present, although not fully formed, the concha is quite distinguishable, the anterior fusion of the maxillary processes is complete, and the face has taken on the human appearance (eyes, nose, mouth, chin). In the six weeks' embryo the upper limbs (in profile views) reach beyond the level of the heart, show the tripartite division, but are still strikingly bud-like; in the eight weeks' fœtus they reach beyond the anterior margin of the chest (in profile views), show clearly their three segments and five separate digits, and are flexed at the elbows and bent upwards towards the face. Similar but less marked changes take place in the lower limbs. The anterior contour of the trunk in the six weeks' embryo shows very evident bulging, due to the presence of the heart and liver; this character is not so noticeable in the eight weeks' fœtus, although in it also the liver is of "relatively enormous dimensions," and reaches well into the hypogastric region. The epidermis at the end of the first month consists of two layers, and this two-layered stage lasts till the end of the neofœtal period; probably the outer layer of cells represents the epitrichium. The dermis is not yet differentiated into corium and subdermal layer; but the *anlage* of the mammary gland can be seen at the eighth week. The caudal projection (true tail), which attains its maximum about the thirty-fifth day (end of fifth week), becomes less and less marked during the neofœtal period, and has disappeared as a free appendage at the end of it (attainment of "human" form). During this eventful period, also, the protrusion of intestine into the umbilical cord increases to reach its maximum in about seven and a half weeks; the genital tubercle, which at first lies anterior to or within the orifice of the cloaca, becomes more prominent, although it cannot yet be distinguished as penis or clitoris. Such are the external changes taking place in the organism during this transition time of neofœtal life, those most noteworthy being the elevation of the head, the disappearance of the tail, and the specialisation of the face and limbs.

The *internal* changes are no less wonderful and epoch-making. They are also numerous, and call for some kind of classification. They may be conveniently subdivided into—(1) the more marked or more typically embryonic changes, and (2) the less marked and more specially fœtal changes. In the former group I place the changes which occur in the skeleton, in the cranium and its contents, and in the pelvis and lower part of the abdomen and their viscera. In the latter group may be ranged the changes, slight in character, which take place in the organs of the thorax and upper part of the abdomen.

1. *The skeletal changes.*—The changes which occur in the skeleton are chiefly of the nature of commencing ossification. Ossification begins in the neofœtal epoch, to end far on in post-natal life—a developmental change late of appearance, late also of completion. At the seventh week ossific nuclei appear in the clavicle (first bone, then, to become bone); in

the shaft of femur and of tibia; in the frontal, parietal, interparietal, and, perhaps, in the squamosal and palatine bones; in the bodies of the vertebræ, at any rate in the dorsal region; and in the ribs (in this week or the next). In the eighth week the number of ossific nuclei is increased by the appearance of those for the shafts of the humerus, radius, and fibula; for the nasals, lachrymals, vomer, superior maxillaries, and malars; for most of the vertebræ; and possibly also for the metatarsals and metacarpals. Ossification then has made a commencement at the end of the second month of intrauterine life. The rest of the skeleton, though not ossified, is already definitely mapped out in cartilage or membrane, *e.g.* the skeletal pieces of the limbs. It is noteworthy that the sternum consists of two cartilaginous lateral halves, still separate; and that the neural arches have not yet met on the dorsal side of the spinal cord. The condition of the spinal cord may be referred to here. It equals in length the vertebral column, the lumbar and cervical enlargements are indicated, the central canal begins to contract towards the close of the neofœtal period, and the anterior fissure begins to appear and the grey matter rapidly to increase. The notochord has begun to disappear.

2. *The cephalic changes.*—In the region of the face during the neofœtal period there are noteworthy changes. The nasal processes grow to form the external nose; the *anlage* of the lachrymal duct is present at the sixth week as a solid ridge; the development of the teeth begins with the formation of the dental groove and ridge at the seventh week, and the budding of the enamel organs at the eighth week. The *anlage* of the submaxillary gland is present at the beginning of neofœtal life, that of the sublingual appear soon after, and that of the parotid at the eighth week; about the same time chondrification of the larynx begins. Of all the internal changes in the head-end of the fœtus at this time, those of the brain are of most importance. The unequal growth of the various parts of the brain, which has already led to the production of mid-brain flexure and neck-bend, continues; the wonderful expansion of the cerebral hemispheres makes a commencement, and at the end of the period these structures have expanded to the edge of the mid-brain; the Sylvian fissure or fossa was evident at the fifth week, marking off the frontal from the temporal lobe, and in addition there can now be seen the *Bogenfurche* or callosal fissure, these two being total grooves or true folds of the brain; and the base of the olfactory lobe is carried forward by this same cerebral hemispherical expansion. The axes of the eyes become parallel; and there is fusion of some of the tubercles which go to form the external ear. There are already indications of all the cranial nerves, but at this time the cavity which exists in the optic stalk begins to close.

3. *The pelvic changes.*—At the opposite or pelvic end of the fœtus important changes are also taking place. The Wolffian body reaches its maximum of development at the seventh week, and at the eighth begins to resorb; the kidney, which measures barely 2 mms. in length at the sixth week, is 2·5 mms. at the end of the neofœtal period, shows commencing lobulation, and in it Malphigian corpuscles begin to form. It is stated that a dilatation of the allantois to constitute the urinary bladder takes place, but the details of the development of this part of the urino-genital apparatus have not been yet ascertained. The testis is histologically distinguishable from the ovary at the sixth week by the smaller number of *Ureier* (primitive ova or ovic cells) in it. The fusion of the Müllerian ducts has begun at the eighth week. Sex, therefore, is already recognisable in the neofœtal period, albeit the distinguishing character is microscopical.

4. *The thoraco-abdominal changes.*—It is a remarkable fact that after the sixth week of intrauterine life the organs of the thorax and upper part of the abdomen may be said to have completed their development; during the remaining thirty-four weeks they grow indeed, but show no changes in their construction till birth forces new functions upon them; some of them do not change even then. This is specially true of the heart and great vessels, for they change little, if at all, between the beginning of the neofœtal and the end of the fœtal period. In the circulating blood red cells (nucleated) are the most numerous, but the red plastids (non-nucleated) have begun to appear. The liver also is well developed, and grows enormously in size in the second month, and the gall-bladder is present. The spleen is quite recognisable. There is a slight change in the pancreas, but in its position only; it lies at first parallel to the long axis of the body, and later comes to be directed transversely. The asymmetry of the lungs is seen even at six weeks, and the lobes are marked off as branches. The typical form of the stomach is indicated at the fifth week, before, therefore, the beginning of the neofœtal epoch; and the villi and glands of the intestine have begun to develop at the second month, although the intestinal coils continue to elongate during fœtal life, and may not have taken up their permanent position and relations even at the time of birth. The development of the thymus gland from the entoderm of the third gill-cleft has begun. The two lateral *anlages* of the thyroid gland have united with the single median *anlage* at the seventh week; the ductus thyreoglossus may remain open till the eighth week; and at the same time the formation of hollow acini has commenced. In one detail, however, development in this region is incomplete: the separation between the pleural and abdominal cavities has not taken place in a two months' fœtus.

Not only are there changes, external and internal, in the embryo-fœtus during the neofœtal period, but there are also alterations in the fœtal appendages of very considerable importance. The organism lies in the sac formed by the decidual membranes, the reflexa being still distinct from the vera; the chorion is villous all over, but the villi in the region where the placenta is soon to form are larger than the others, and are already vascularised to a greater degree by the allantoic or umbilical vessels; the decidual membranes and chorion weigh together from 11 to 15 grms.; the liquor amnii is present in the amniotic cavity to the amount of 10 to 13 grms.; the umbilical vesicle has atrophied, but is still to be seen attached to the abdomen of the neofœtus by a thin cord, and doubtless there is still some circulation going on in the vitelline or omphalo-mesenteric vessels. As has been already stated, the projection of intestine into the umbilical cord is increased during the first week of the neofœtal period. The great changes seen in the environment of the fœtus at this epoch are the replacement of the vitelline by the allantoic or umbilical circulation, and the progressive growth in importance of the placental over the general chorionic circulation.

The end of the neofœtal period therefore coincides with the beginning of the placental connections. There is thus a sort of birth before birth, a transition not so sharp as that which occurs at the tenth month of intrauterine life, but nevertheless definite enough and of great importance. Further, just as there are many traces of the fœtus to be seen in the new-born infant, so in the neofœtus there are not a few indications of the embryo; there are in it still some

signs of typical embryonic or developmental activity, as the preceding paragraphs abundantly have demonstrated. By the end of the third month, as will be seen, the new-born fœtus is fairly established under the placental régime, its yolk-sac (vitelline) connections can be dispensed with and all its circulatory activities can be concentrated in the allantoidal union with the decidua serotina. The transition thus accomplished is not without its element of danger; and just as the neonatal period is commonly one of danger to the new-born infant, so the neofœtal is full of risk to the "new-born fœtus." It is, at any rate, a fact well known that intrauterine life is often brought to an untimely end by abortion at the third month. The incidence of abortion so immediately after the neofœtal period suggests want of complete adaptation to the new condition of life, in other words, a defective establishment of the placental connections.

Fœtal Growth and Development.

Such being the characters of the neofœtus, it remains for us to trace the stages through which the organism passes in order to become a neonatus; in other words, it is necessary for us to possess some knowledge of the changes which occur month by month in the growth and development of the fœtus from the eighth to the fortieth week of intrauterine life. It is essential that we have some idea of the body, the diseases of which we are preparing to study; that is, if we wish in any measure to make progress in our knowledge. Dry details, doubtless, but peculiarly essential. Details which the reader skimming lightly over the surface of the subject will pass by. Let them be put in small type to warn off such readers; let them also be compressed within reasonable limits. Perchance a reader here and there will read, and remember, and even form visual images of the fœtus at the different months. Unfortunately for him and for Antenatal Pathology, only glimpses of antenatal life are yet possible; it is not practicable, through imperfect knowledge, to give a cinematographic procession of fœtal forms at different stages and of different ages.

Third Month.

The third month of intrauterine life is, let it be borne in mind, the first month of typically fœtal life. In it, as in all the months that follow it, there are changes to be recorded; changes which may be grouped into external, internal, and environmental. These may be taken in order.

The fœtus by the end of the month measures from 7 to 9 cms. in length, and weighs 30 grms. (460 grs.). The protruding abdomen has receded. At the ninth week two lines are very evident on the face, one from the eye to the angle of the mouth, the other passing down alongside of the nose; the external nares are closed with a plug of epithelium, which disappears later (at the fifth month). The eyes are now protected by eyelids, and the mouth is closed by lips; if the mouth be opened it can be seen that the shutting off of the buccal from the nasal cavity has begun in this month and is finished at the end of it, when also the uvula has appeared. In the external ear the upper and posterior part of the concha bends forward so as to

cover the anthelix: this stage of anteversion of the ear has a short duration of possibly a fortnight. The toes as well as the fingers are now separate. In this month there is the first indication of nails, as thickenings of the epitrichium over the end of the digits; but the primary terminal position of the thickened epitrichium ("eponychium," Unna) is quite transitory, and soon "the ungual area migrates to the dorsal side of the digit" (Minot, *op. cit.*, p. 554), through growth and expansion of the palmar side. The epidermis at this age has reached the "several-layered stage"; there is a basal layer of cuboidal cells, then two or three rows of irregular large cells, and an outer epitrichial layer of distinctive "dome" cells. On parts which are to be hairy the epitrichium does not advance beyond this stage, but on hairless parts it persists as several layers. Later, it is probable that the epitrichium undergoes cornification, becoming the stratum corneum or horny layer, while the stratum lucidum has become differentiated and is continuous at the ends of the digits with the nails. The dermis shows two layers at the third month: (1) A true dermal layer or corium, and (2) a subdermal stratum. Hair *anlages* appear at this time over the forehead and eyebrows. At the pelvic end of the ten weeks' fœtus the genital tubercle is prominent, and on each side of it is a "genital labium"; later (in the fourth month), the genital labia unite to form the scrotum in the male, or remain separate to constitute the labia majora of the female. It is hardly possible at the end of the third month to tell the sex of the fœtus from the inspection of the external genitals, but sometimes in the male the urethral groove in the genital tubercle has closed, and then it can be said that the distinctive stage of the penis as compared with the clitoris has been attained. Finally, with regard to these external characters and changes, it has to be noted that by a mechanism, the nature of which is at present unknown, the loop of intestine in the root of the umbilical cord is retracted within the abdomen.

The internal changes during the third month are, like those in the neofœtal period, of very considerable importance. In respect, in the first place, to the skeleton, it is to be noted that the neural arches have met posteriorly in the dorsal, but not yet in the lumbar and sacral regions of the spine. In addition to the ossific nuclei which have already appeared, deposits of bone have to be recorded in the ulna, phalanges, præmaxillaries, tympanals, ilium, ischium, occipital and sphenoidal regions of the cranium, in the mandible, and also in the lower end of Meckel's cartilage which is incorporated in the mandible. By the end of the third month the joints of the limbs are true articulating surfaces, having passed at this early date out of the synarthrodial stage; the articulating surfaces are therefore shaped before any free motion can begin. In the spinal cord the contraction of the central canal continues till, at the tenth week, the walls have met everywhere except at the dorsal part; the cords of Burdach have arisen, the anterior and posterior horns of grey matter are of equal size and of the same shape, and are connected by a broad band; the cord itself is still as long as the spine, and its cervical and lumbar enlargements are quite well developed. In the brain the *anlages* of the cerebellar hemispheres and vermis are recognisable, and the characteristic transverse fibres of the pons Varolii have appeared as a narrow, thin band; the mid-brain, which has had a precocious expansion, continues to grow, but at a much slower rate, and at the third month the cerebral peduncles are just recognisable; in the fore-brain, the *anlages* of the septum lucidum, corpus callosum, fornix, and anterior commissure are well seen; the cerebral hemispheres continue their remarkable expansion, and now cover fully one-half of the mid-brain (the stage

of development which is permanent in reptiles); the Sylvian fossa begins to deepen into a fissure, and the *Bogenfurche* is now well marked; and a differentiation and forward bending of the olfactory lobe takes place. In the eye, atrophy of the arteria centralis and of its branches begins, folds appear on the retina due to its rapid growth, and the lachrymal gland can be recognised in a solid state. The tympanic cavity is very small. Further development takes place in connection with the dental germs of the milk teeth, and the follicular wall appears.

There are changes at the pelvic end of the fœtus during the third month. The testis can now be distinguished from the ovary by its external form; its descent begins about the tenth week, and is due in the first instance, at any rate, to atrophy of the part of the uro-genital ridge lying tailward of the sexual gland. The resorption of the Wolffian body continues, but traces of the glomeruli can usually be made out till the end of the month. The fusion of the Müllerian ducts to form the uterus is generally complete at this time, so that the sex can now be determined by the presence or absence of that structure.

The thoraco-abdominal changes are comparatively unimportant. The heart shows little alteration; but the blood is now mainly made up of red plastids (non-nucleated), and nucleated red cells form a small minority. The lumen of the *anlage* of the thymus is obliterated about the twelfth week; in the thyroid the formation of hollow acini is continued. The changes in the stomach consist in the development of the peptic and mucous glands, and in the appearance of prominences between the gland openings, which have been called villi, but are not truly so. In the liver (which is very large, extending into the hypogastric region) the vascular territories of the portal and hepatic veins are distinguishable; and islands of tissue appear, each of which is the *anlage* of a group of lobules; the portal system cuts into these islands and so forms the lobules. The suprarenal glands assume the cap-shape at this time, and clusters of cells (sympathetic part?) can be recognised in them, but only during the third month. Both the kidneys and the suprarenals show rapid growth, with the result that they are brought into contact, the adrenal resting upon the kidney. The diaphragmatic separation of pleural from the peritoneal cavity has now completely taken place.—(*Mall* in *Booker's* article, *Arch. Pediat.*, xiv. 649, 1897.)

The fœtal environment has altered little at this month. The decidua reflexa diminishes in thickness and shows marked degenerative changes—presence of a hyaline substance, fibrin so called, and vagueness of the cellular outlines. The chorionic villi are limited to the part in connection with the decidua serotina, where, now, the small placenta (weight, 23½ grms.) is quite distinct. The whole decidual sac with its ovular contents is about the size of "a goose's egg"; more exactly, its length is from 9·5 to 11 cms. The umbilical cord is from 7 to 12 cms. long, shows some degree of torsion, and has the umbilical vesicle attached to it at its placental end by the yolk-stalk; the rest of the yolk-stalk is embedded in the cord. The amount of liquor amnii is about 42 grms.

Fourth Month.

During the fourth month of intrauterine or the second month of fœtal life (13 to 16 weeks) the fœtus has a length of from 10 to 17 cms., and a weight of about 55 grms. (850 grs.). Some hairs are to be seen on the scalp, and over the body the fine down (lanugo) is beginning to sprout forth.

Microscopic sections of the skin show ridges on the under side of the epidermis, and the appearance of fat cells in the subdermal tissue (14 weeks). Slight changes take place in the external ear; the tuberculum anterior encroaches upon the fossa angularis, and reduces the lower part of it to a fissure, and so the tuberculum itself comes almost into contact with the anthelix and the anti-tragus; through the growth of a ridge the upper part of the fossa is separated from the lower, and the latter becomes the opening of the meatus; and later (in the fifth month) the lobule is marked off as the tænia lobularis. The eyelids are now fully united. An inspection of the posterior end of the fœtus is at this month sufficient to determine the sex of the offspring, as the scrotum in the male is evident.

The internal changes which occur in the fourth month are important, although not so extensive as those of the third. With respect, in the first place, to the development of the skeleton, the scapula is one-half ossified at this age; ossification has begun in the pterygoids, although these do not unite with the alisphenoids till the fifth or even the sixth month; the centres for the body and odontoid process of the axis vertebra appear in this or in the next month; a point of ossification can be seen in the ascending ramus of the pubis; the neural arches have closed throughout the whole length of the spinal column; and, according to Professor Arthur Thomson (*Journ. Anat. and Physiol.*, xxxiii. 359, 1899) the sexual differences of the pelvis are already indicated. The ossification of the cranial bones is proceeding, but the spaces between them are still widely open. In the brain it is to be noted that there is a rapid increase of the pons Varolii, that transverse grooves appear upon the cerebellum, that a rapid growth of the choroid plexus takes place which quite fills the lateral ventricle, and that the corpora albicantia can be seen on the floor of the third ventricle. The cerebral hemispheres cover nearly the whole of the mid-brain. The Sylvian fissure becomes deeper, and at the posterior end of the *Bogenfurche* appear the *anlages* of the parieto-occipital and calcarine fissures, diverging to form the future cuneate lobe. In this month, also, the cartilage of the Eustachian tube can be recognised; the enamel organ of the milk teeth is fully differentiated about the fifteenth week; and a commencement is made with the development of the tonsils in the shallow pouch representing the second gill-cleft behind the arcus palato-glossus (Gulland, *Laborat. Rep. R. C. Phys. Edin.*, iii. 163, 1891). The trachea shows the high cylinder epithelium which remains throughout life. At the pelvic end of the fœtus the division of the cloaca into uro-genital and anal openings has taken place (14 weeks); the evagination which is to form the prostate and that which is to give rise to Bartholin's gland can be recognised; and the testis has its permanent form, but the sexual cords in it remain solid throughout fœtal life. The conversion of the hind remnant of the genital fold into the gubernaculum is going on, but is not completed during the fourth month. In the female, the lumen of the vagina is closed. The kidneys show well-marked Henle's loops. The musculature of the stomach is clearly evident at this time in intrauterine life.

With regard to the fœtal environment, it is to be noted that the decidua reflexa is in contact with the vera, and exhibits still further signs of coagulation-necrosis antecedent to its disintegration and removal, for it is probable that Minot (*op. cit.*, p. 20) is right in thinking that there is no fusion but a complete disappearance of the reflexa. The meaning of the phenomenon is not clear; "as to the purpose or advantage of the sacrifices of maternal tissue we are in the dark," says Minot (*op. cit.*, p. 21); in the

dark, truly, about these and many other things in antenatal life, but beginning to see a pin-point of light here and there. The placenta has increased in size in the fourth month, and weighs from 30 to 50 grms.; the liquor amnii weighs 60 grms.; so that the fœtus now weighs a little more than the placenta, and a little less than the liquor amnii. The umbilical cord shows a certain amount of twisting; in it the cœlom is nearly or quite obliterated; the vitelline duct remains till the sixth month; and the now solidified allantoic duct may persist till the full term. The external covering of the cord exhibits a double layer of ectodermic cells, the outer stratum of which may possibly be the representative of the epitrichium, at any rate, some of its cells are dome-shaped. The length of the cord will be about 19 cms. (Hecker). The fœtus, if expelled from the uterus at this month, may live for some hours; and at this time its limbs may show vital tremblings and twitchings.

The chief changes found in the fœtus at the fourth month are still situated at its two extremities (cephalic and pelvic) and in the skeleton. The developmental or embryonic changes are fewer now than previously, and affect particularly the external ear, the brain, and the genital organs. Ossification is actively proceeding. Fœtal growth in size and weight is wonderfully rapid.

Fifth Month.

In the fifth month (third of fœtal life) the same rapid growth is continued; the fœtus measures from 18 to 27 cms. in length, and weighs about 273 grms. (8 oz.). The face and body of the fœtus have a wrinkled appearance, "senile" look, a character to be ascribed to the small quantity of subcutaneous adipose tissue which is as yet present. At the same time, the subdermal fat is increasing, and can be seen in little whitish islands in sections of the skin. The cells of the epitrichium are very large, much larger than those of the subjacent layers. Near the beginning of the fifth month hairs have appeared over the whole head, and by the end of the month (twentieth week) practically all the hair areas have been mapped out all over the body. The nails are becoming more horizontal and less oblique in relation to the dermis. Sebaceous glands begin to appear on the head at this time, and by the end of the month they are plentiful there and elsewhere, with the result that traces of the vernix caseosa are to be seen. Sudoriparous glands also make their first appearance, but have as yet no lumen, and consequently no secretion. The eyelids begin to show signs of separation. Wax glands are developed in connection with the external auditory meatus. The hymen is differentiated.

The internal changes consist, in the first place, in the extension of the process of ossification, thus the osseous centres of the vertebral bodies reach the surface of the cartilage during this month, and several of the bones of the cranium take on their more permanent form. In the second place, the brain shows further developmental changes: the cerebral hemispheres now cover not only the thalamencephalon and mesencephalon, but also the cerebellum and medulla; the fissure of Sylvius has become deeper and more oblique, but still leaves the island of Reil exposed to view; the fissure of Rolando is sometimes found during this month, and the colloso-marginal or splenial fissure is generally recognisable, marking off the gyrus fornicatus; and the corpora quadrigemina on the dorsal wall of the mid-brain are marked off by oblique grooves. At this time in intrauterine life the spinal cord has greatly grown; but the central canal is now relatively small, for it

is stationary. In the cerebellum the cells of Purkinje are recognisable; the cerebral peduncles begin markedly to enlarge, an enlargement due in great part to their penetration by the pyramids of the medulla oblongata. In the third place, further changes occur in the developing teeth in the jaw; in the case of the milk teeth the follicle closes above the germ, the neck of the enamel organ is resorbed, and dentine appears; while the enamel buds of the permanent teeth can be recognised (the enamel bud of the first molar, it may be noted, was seen earlier, at the fifteenth week). In the fourth place, some minor changes occur in the abdominal and thoracic viscera; the development of the vagina (in the female) continues; the pancreas loses the mesentery which it has till this time possessed, and with it its movability; in the omentum the *anlages* of lymphatics and fat cells are recognisable; and in the heart the chordæ tendineæ appear.

The fœtal environment now shows more than ever the predominance of the placenta (Fig. 13), which weighs from 125 to 300 grms. (178 grms., Hecker). The umbilical cord measures about 31 cms. in length; and the weight of the liquor amnii generally exceeds that of the fœtus at this date. The fœtus is now capable of making movements which can be easily recognised by the mother as indications of the life of her unborn child, "quickening" as the phenomenon is called. If born alive, the infant may make some respiratory efforts, and may even survive for some hours.

Sixth Month.

During this month there is a further slackening in developmental changes, but the extraordinarily rapid growth in size and weight continues, so that now the fœtus measures from 28 to 34 cms. in length (Fig. 11), and weighs 676 grms. (23½ oz.). The length in the preceding month was, as will be remembered, 18 to 27 cms., and the weight 273 grms. or 8 oz. (Fig. 12). There is more hair on the head, and eyebrows and eyelashes can be recognised; the lanugo ("that ancestral simian characteristic") is still present in large amount, and doubtless in this, as in other later months, much hair is shed into the liquor amnii. The skin is still somewhat wrinkled ("senile"), but a greater amount of fat is being deposited in the subcutaneous tissue. The free margin of the nails still projects from the underlying skin (persistence of ungual obliquity). The vernix caseosa, consisting of sebaceous secretion, hairs, and epidermic cells, is now conspicuously present. In the case of the skin of the hands and feet, the papillæ of the dermis are well marked.

There are in this month internal changes which are again, as in previous months, largely located in the skeleton, in the brain, and in the pelvic end of the fœtus. Ossific nuclei now appear in the os calcis, in the presternum, and in the first piece of the meso-sternum (Paterson, *Journ. Anat. and Physiol.*, xxxv. 21, 1900). The marking-off of the cerebral convolutions continues: there can, at this time, be quite well seen the fissure of Rolando; the præcentral fissure of the frontal lobe; the intra-parietal of the parietal lobe; the superior, inferior, and occipito-temporal fissures of the temporal lobe; and the post-central fissure of the island of Reil. An angular notch is noticeable in the anterior margin of the fissure of Sylvius. At this age the arteria centralis of the eye and most of its branches have aborted; and the development of the definite form of the internal ear is complete.

At the posterior end of the fœtus the chief change is found in the

descent of the testicle. At the end of the month the male sexual gland lies opposite the internal inguinal ring. This descent is the last great alteration in the relation of organs to occur in antenatal life, and it occurs only in the male, although there is a less marked downward movement of the ovary in the female fœtus. About the exact mechanism of the *descensus testiculorum* conflicting statements have been made and much mystery has existed. It has to be borne in mind, however, that most of the relation-changes which occur in intrauterine life are due to differences in growth or development of contiguous parts; one organ or part grows in size, that next to it diminishes or atrophies; or one organ grows or atrophies at a faster rate than its neighbour; and so one organ may pass by or overlap or take the place of another in the kaleidoscopic life of the unborn infant. Some process such as this brings the testis from its first position down to the level of the internal inguinal ring. As will be remembered, the descent has already begun at the second month with the nearly complete disappearance of the urogenital fold lying tailward of the testis; the remnant of this fold is converted into the gubernaculum, a change occupying from the fourth to the sixth month; at first the growth of the gubernaculum causes the testicle to move forward, and, afterwards, its atrophy accounts for the passage of the gland along the wall of the processus vaginalis (which is due to an evagination of the peritoneum at the inguinal ring). This stage in testicular descent is that which is permanent in some rodents and other mammals; the further descent (into the scrotum) is late of occurrence in the human fœtus, late also of occurrence in the zoological series, being high up in the Mammalia.

In the abdominal cavity the liver is still disproportionately large compared with the other organs; but these other viscera are now beginning to overtake the liver, the growth of which is slackening. The appendix vermiformis of the intestine is long, slender, and relatively better developed than in the adult; four well-marked ridges of mucous membrane can be recognised in the œsophagus; and in the trachea the glands and cartilages are clearly developed.

The placenta weighs from 225 to 455 grms. (273 grms., Hecker), and the cord measures 37 cms. in length. Life after birth at the sixth month may be carried on for several days, and possibly for longer, if sufficient care be taken to imitate the intrauterine environment in the matters of temperature and protection from injury.

Seventh Month.

The seventh month (fifth of fœtal life) has many characters in common with the sixth. In it, again, there is rapid growth in length and weight; at its termination, the fœtus measures 38 cms., and weighs 1170 grms. or 41 oz. Lanugo covers the whole body except on the palmar and plantar surfaces of the hands and feet respectively; and the vernix caseosa is plentiful, although it is to be borne in mind that in some fœtuses the vernix is never present in great amount. In the eye the portion of the tunica vasculosa which lies in front of the lens (*membrana pupillaris*) is very marked, but begins to atrophy before the end of the month. If sections be made of the skin at this age, elastic fibres will be seen in it, and the sweat glands will be found with the excretory ducts extending through the epidermis. There is branching of the glands which compose the mammæ, but these do not yet show a lumen.

Ossific nuclei appear in the second and third pieces of the meso-sternum, in the ethmoidal region (although the ethmoid itself does not ossify till after birth), and in the astragalus. In the brain the fissure of Sylvius is deeper and narrower, and its margins are approaching each other to hide from view the island of Reil; and the retro-central fissure of the parietal lobe is marked off. The dentine increases in amount on the germs of the temporary teeth, it is to be recognised in the first molars; and the other permanent teeth have the enamel organ fully differentiated. In the male the descent of the testicle is continued, for it is now drawn into the mouth of the sac of the tunica vaginalis behind the processus vaginalis; and it may, before the end of the month, lie in the scrotum. Meconium is found in most of the large intestine.

The placenta weighs from 210 to 250 grms. (374 grms., Hecker), and the umbilical cord measures 42 cms. in length. The fœtus, if born alive at this month, may quite well survive its birth, and continue to live if well cared for, but it is specially susceptible to changes of temperature and to the onslaughts of pathogenic microbes.

Eighth Month.

The eighth month of intrauterine and the sixth of fœtal life (29 to 32 weeks) is marked by comparatively trifling changes, the truly epoch-making periods of antenatal existence having now all passed. The length of the fœtus is from 39 to 41 cms., and the weight has increased to 1571 grms. or 3½ lbs. There is more hair on the scalp and less lanugo on the body than in the earlier months, much of the lanugo having been shed into the liquor amnii. The nails are now quite horizontal as regards the underlying skin, but they do not project beyond the finger-tips. The testicles of the male fœtus will be found in the scrotum.

The placenta weighs about 451 grms. (one-third of the weight of the fœtus, *circa*) and the umbilical cord measures 46 cms. in length. Birth at this month ought not to be followed by early death, although, of course, such an infant is less likely to survive than one born at the full time.

Ninth Month.

The ninth month is comparatively featureless save for continued rapid growth; the length is now from 42 to 44 cms. (15·25 to 16 inches) and the weight 1942 grms. (4½ and later 5½ lbs.). There is a marked amount of adipose tissue beneath the skin, and there are often miliaria about the tip of the nose. The vernix caseosa is very evident. Towards the close of this month the ossific nucleus in the lower epiphysis of the femur may occasionally be made out as "a more or less circular blood-red spot in the midst of milk-white cartilage"; but more commonly it is not visible till the middle of the tenth (lunar) month. The placenta weighs about 461 grms. (one-fourth of the weight of the fœtus), and the umbilical cord measures 47 cms. in length.

Tenth Month.

The tenth (lunar) month of intrauterine life, or the eighth month of truly fœtal life, culminates in the attainment of the maturity or ripeness of the fœtus—further developments of the organism will take place in its extra-uterine environment, but the end of profitable intrauterine life has been

reached. In these last four weeks (thirty-seven to forty) there is still great activity of growth, and by the end of the month a weight of 7½ lbs. or thereby has been attained, and a length of 51 cms. (20 in.) reached. The skin is now of a paler pink and may be almost white; and the lanugo has all, or nearly all, disappeared. The eyelids are quite separate, the eyebrows and eyelashes are well developed, and the cartilages of the nose and ears are firm. The nasal miliaria are scanty as compared with the ninth month. The vernix caseosa is evident, and the nails project beyond the finger-tips. Further, the infant has a general appearance of maturity, which is difficult to express in words, but which is known to the expert; there is also a certain immovability of the cranial bones; and the umbilicus is near the centre of the body. Ossification shows further progress: an ossific nucleus is now to be found in the cuboid and one in the hyoid bone, while "the circular blood-red spot in the midst of the milk-white cartilage" of the lower epiphysis of the femur is now recognisable, and measures from two to three lines in diameter. There is an indication of a similar but smaller "blood-red spot" in the upper end of the tibia. During this month accessory cerebral fissures appear, and the margins of the fissure of Sylvius approximate and completely hide from view the island of Reil. In the convolutions there is a certain amount of myelination, as well as in the spinal cord, medulla, pons, corpora quadrigemina, and optic thalamus; and the myelination is situated round the primary fissures (Sylvian, Rolandic, calcarine) and in areas which are the end-stations of the afferent projection systems (F. W. Mott, *Brit. Med. Journ.*, vol. i. for 1900, p. 1517). The meconium is found in the rectum, at least in the sigmoid flexure, at the end of the tenth month; and there is often some urine in the bladder.

The environmental changes are preparatory to the separation of the fœtus from its maternal connections. The umbilical cord is about 51 cms. in length. The placenta has increased but little in weight—it now weighs about 481 grms.—and, since the weight of the fœtus is about 3400 grms., it follows that the placenta is only a seventh, instead of a fourth, of the fœtal weight. At the time when the fœtus is increasing by so many pounds a month, the placenta is only adding a few grammes. It is evident that the time of placental activity is nearly over; and vascular changes in the structure of that organ have been taking place during the tenth month, which facilitate the separation of parts soon to occur. The full-time infant, when born alive, soon breathes freely, cries loudly, makes active movements of the limbs, and takes the breast.

Summary.

Such are the changes which take place during the life of the fœtus as measured by months. Wonderful changes they are, yielding in wonderfulness only to the changes of the embryonic period. They are worthy of careful study by the student of Antenatal Pathology; they must, in very truth, be studied by him with assiduity if he is to make any progress at all in clearing away the dust and rubbish which have been cast all over the subject. The dust and rubbish of mistaken views of fœtal growth and development and function have in the past done much to almost crush the life out of our subject and to bury it deep. Yet a subject with wonderful vitality! For it has not

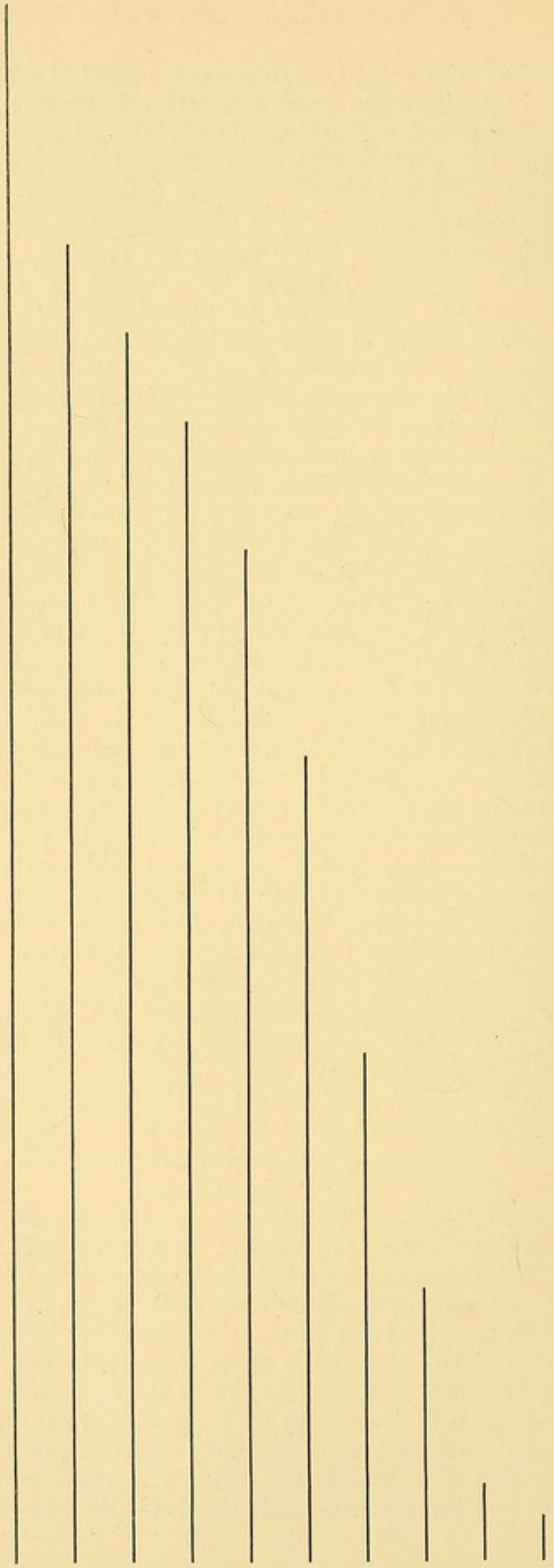
been crushed and stifled, no, not even by all the erroneous notions and theories which have been cast upon it by those who believe in "maternal impressions," and would explain all antenatal phenomena by them. Let us therefore take heart of courage, and proceed—more slowly, doubtless; more really, it is confidently anticipated.

The changes characteristic of or occurring in fœtal life may be all arranged in two groups: those which are typically fœtal in one, and those which are embryonic or reminiscent of the embryonic in another. In the former must be placed the growth in weight and the increase in length of the fœtus during the eight lunar months of fœtal existence. The schemes (Figs. 11 and 12) are of service in giving a graphic and diagrammatic representation of these two outstanding phenomena of fœtal life. If the neofœtal period be included, the increase in weight is from one-ninth of an ounce at six weeks to seven and a half pounds at full term, while that in length is from 1·5 cms. at six weeks to 51 cms. at the full term. The increase in weight will serve best for forming an estimate of vital activity, for there is a fallacy in the calculation of the length. It will be seen that the period of most active growth in weight is between the fourth and fifth months (from the sixteenth to the twentieth week), when the weight quadruples; during the next month it nearly trebles; during the next it does not double; and thereafter its monthly gain is about a half. The period of most active growth in weight therefore corresponds to the time just following the full establishment of the placental economy. If, now, the weight of the placenta at the various months of fœtal life be inquired into, it will be found that its period of most active increase in weight coincides with that of the fœtus; in other words, is the fourth month, the sixteenth to the twentieth week. In the scheme of placental growth in weight (Fig. 13) this is brought out. The placenta more than quadruples its weight between the fourth and fifth months; in the next month, it does not even double, only about a half being added; in the next, less than a half is added; in the next, about a sixth is the increment; in the next, less than a fifteenth; and in the last month, less than a sixteenth. Both the fœtus and the placenta have their maximum rate of growth at the same time in intrauterine life; but the latter much sooner shows signs of lessening growth-rate, having a much shorter life-history, so to say, and is already ready to perish when expulsion from the uterus occurs.

The second group of changes, those which are reminiscent of embryonic life, contains phenomena of development in contradistinction to the alterations in size and weight which characterise the purely fœtal changes. The embryonic changes are much more marked in the early than in the later months; in fact, in the ninth and tenth months they have to be closely looked for, being then almost insignificant. Further, even in the early months they do not affect equally all the organs or all the regions of the body. Speaking broadly, the central part of the body and the viscera of the thorax and upper part of the abdomen therein contained show little or no changes of any importance, while the cephalic and caudal ends with

SCHEME OF FŒTAL GROWTH IN LENGTH.

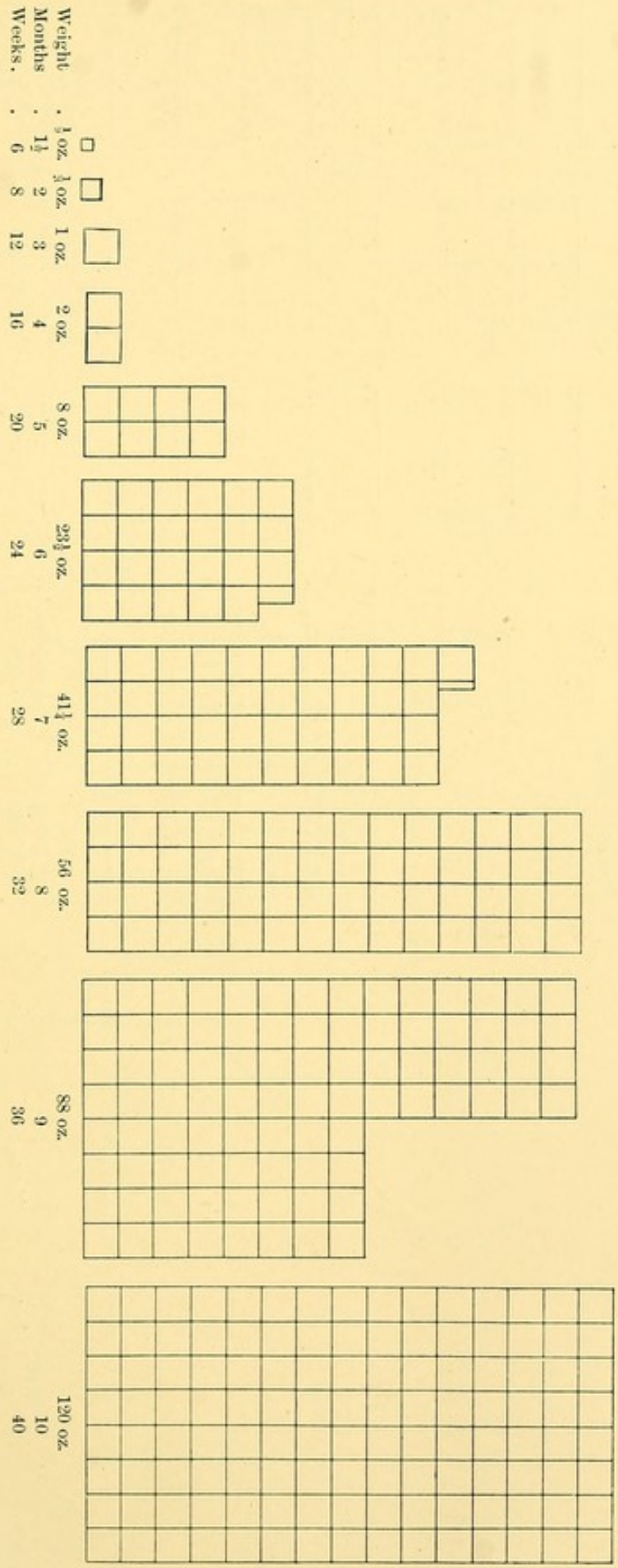
Fig. 11.



Length in cms.	51	44	41	38	34	27	17	9	2·5	1·5
Months . .	10	9	8	7	6	5	4	3	2	1½
Weeks .	40	36	32	28	24	20	16	12	8	6

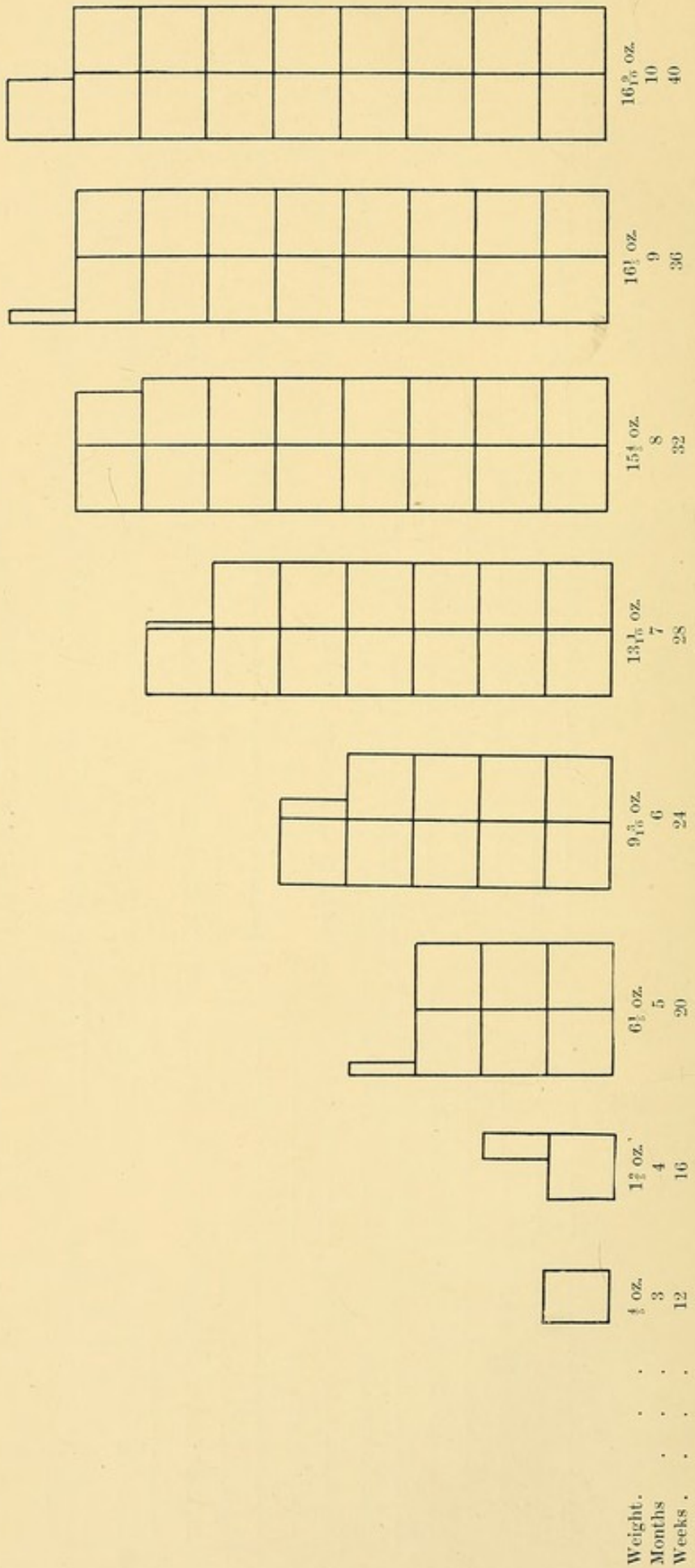
SCHEME OF FŒTAL GROWTH IN WEIGHT.

FIG. 12.



SCHEME OF PLACENTAL GROWTH IN WEIGHT.

FIG. 13.



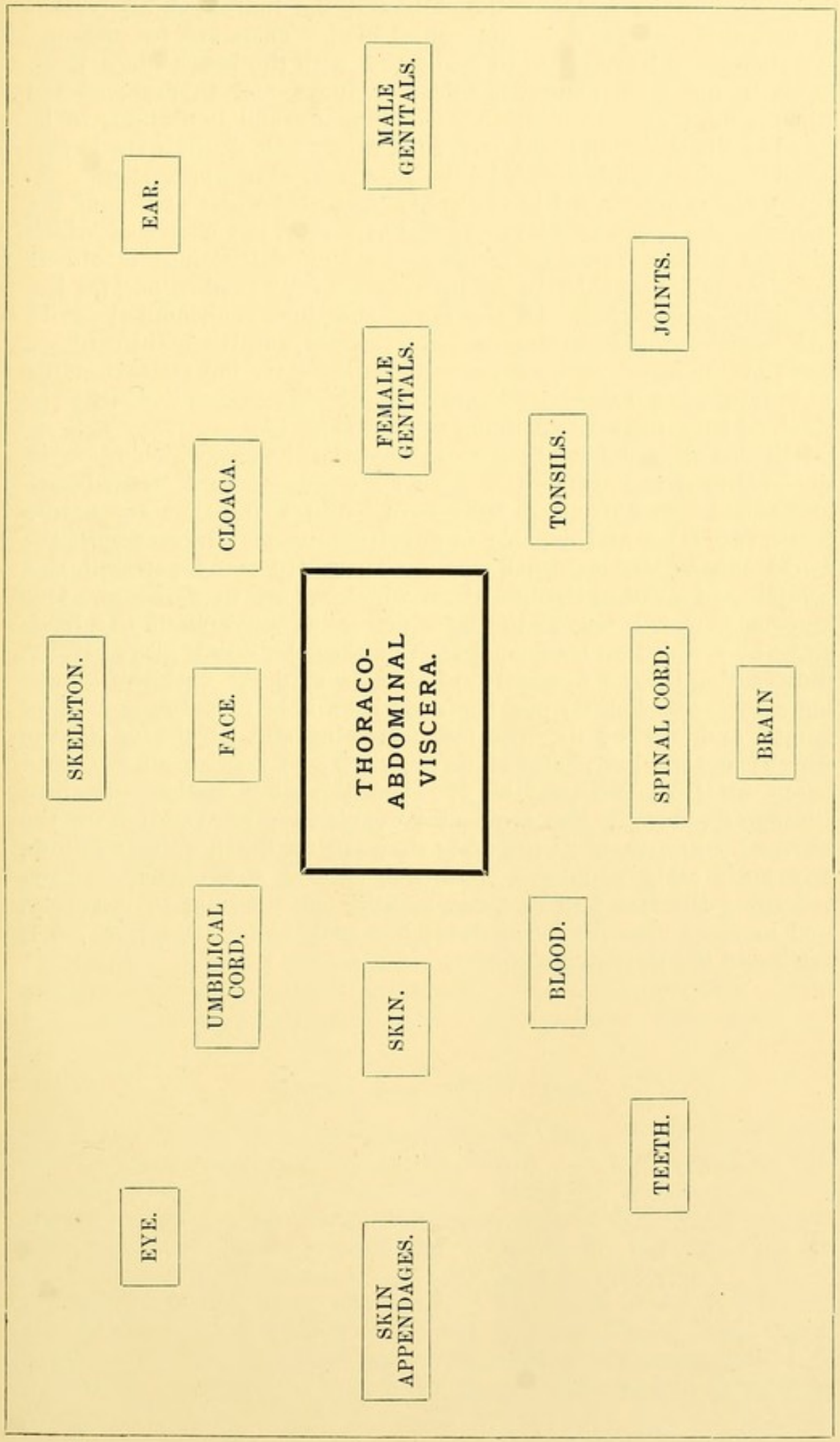

SKELETON.
EAR.
EYE.
FACE.
CLOACA.
UMBILICAL CORD.
THORACO-ABDOMINAL VISCERA.
SKIN.
SKIN APPENDAGES.
MALE GENITALS.
FEMALE GENITALS.
TONSILS.
BLOOD.
JOINTS.
SPINAL CORD.
TEETH.
BRAIN

FIG. 14.

their viscera, the skeleton, the skin, and the limbs, exhibit certain evident alterations of a developmental kind. There are, for instance, few changes to be recorded in connection with the heart, lungs, liver, stomach, intestine, pancreas, spleen, kidneys, and thymus; on the other hand, there are alterations, both many and important, to be noted in the skeleton, brain, face, ears, eyes, teeth, genitals (male and female), spinal cord, blood, joints, skin, and skin appendages. To revert to a comparison I have already instituted when writing of the embryo—the fœtus may be compared to a city, the centre of which with its main avenues of traffic and its chief buildings is almost complete, while its suburbs are scarcely yet fully marked out, far less definitely constructed. In the fœtus the thoraco-abdominal cavity and contents constitute the centre of the city, and the brain, genitals, many of the bones, skin, etc., are the rudimentary but fast-extending and developing suburbs. Some idea of this conception may be obtained from the accompanying scheme (Fig. 14).

In this chapter have been considered the changes which occur in the organism and convert it from an embryo into a "new-born" fœtus, and again from a "new-born" into a full-time or mature fœtus, ready for and capable of surviving its transference into the world outside the maternal womb. There are many parts of this complicated series of changes about which we are in darkness. Our knowledge of it is similar to that which we at night obtain of a landscape over which an occasional flash of sheet-lightning plays fitfully, illuminating it for a moment and then leaving the darkness almost more intense. For no one has ever been able to watch month by month and day by day the fœtus growing and developing in the womb; and our knowledge of its growth and development has been made up from glimpses of it—sheet-lightning flashes—obtained through its more or less accidental expulsion prematurely from the uterus. Glimpses of its life truly they are, for death quickly follows any such early expulsion from the natural environment. Even regarding the last two or three months our information is scanty, and in some measure incomplete; but such as it is we now set it forth—in the following chapters.

CHAPTER VIII

Anatomy of the Mature Fœtus. Anatomy of the region of the Head, Spine, Neck, Thorax, Abdomen, Pelvis, and Limbs. Anatomy of the Umbilical Cord, Placenta, and Membranes.

In this chapter and in the two that follow an attempt is made to state what is known regarding the anatomy and physiology of the full-time or nearly full-time fœtus. To be more exact, the attempt is made to state wherein the anatomy and physiology of the fœtus differ from the anatomy and physiology of the child and adult. With regard to fœtal anatomy we are on fairly sure ground, for it is, alas! a too common circumstance that a fœtus comes into the world dead and of use only for dissection; by such dissections and sections a knowledge of the structural peculiarities of the unborn infant has been built up. By a sad hap it sometimes comes about that a mother dies with her infant undelivered in her womb; from the examination of such cases certain details of fœtal anatomy have been more accurately ascertained. With fœtal physiology there is no such certainty of information; there is much speculation and there are many theories, and the investigator has not always "avoided the guesser's darkening of knowledge." The defects in our acquaintance with the peculiarities of fœtal physiology are responsible for our ignorance of many of the phenomena of fœtal pathology; as a matter of fact, we have had to deduce several of our conclusions regarding the physiology of intra-uterine life from the study of the disturbances of fœtal function, *i.e.* from the diseases of the fœtus. There is accordingly much uncertainty and an appalling paucity of facts—facts, therefore, in this subject are of more than usual value. May their number increase!

Anatomy of the Fœtus.

Within recent years our knowledge of the anatomy of the full-time fœtus has been added to and confirmed by the sectional method of study. In 1891 I published the results of the investigation of a number of fœtuses by means of frozen sections (1, 37, 38, 39, 42, 47); and since then have appeared the works of H. Mettenheimer (in Schwalbe's *Morphol. Arbeiten*, Bd. iii., Hft. 2, 1893), of F. Merkel (*Menschliche Embryonen*, Göttingen, 1894), and of J. H. Chievitz (*Topographical Anatomy of Full-term Human Fœtus*, Copenhagen, 1899). Merkel has endeavoured to extend the investigation to fœtuses of different ages from three months onwards, and O. Schäffer

(in F. von Winkel's *Berichte und Studien in München*, pp. 136–205, 478–654, Leipzig, 1892) has made many accurate measurements; but the number of specimens yet dealt with is too small to permit of the safe formation of general conclusions with regard to any but full-time fœtuses. I do not pretend here to discuss all the anatomical characters of even the full-time fœtus (for such full discussion the reader is referred to my work, *An Introduction to the Diseases of Infancy*, or to the other books above mentioned), but will deal only with the more prominent peculiarities. The details will be taken up according to the regional method of anatomical study.

The Head of the Fœtus.

The head of the fœtus is relatively large, if we regard the adult proportion as the normal; and the younger the fœtus the greater is the relative largeness. Of the two parts of the head—cranium and face—the former is relatively larger than the latter. The cranium, which is composed of eight bones, is divided into two parts, vault and base; the cranial arch (distance from the root of the nose round to the back of the foramen magnum) in the fœtus is to the cranial base approximately as 3 to 1; this is the highest proportionate length which it attains, and in the adult it is as 2·7 or 2·8 to 1. The bones which make up the vault of the fœtal cranium are loosely joined together by membrane at the sutures and fontanelles; every student of Obstetrics knows the sutures and fontanelles, for they are the parts which are to be felt during the progress of labour. It is presumed that the reader, too, is well acquainted with them. The base of the cranium is made up of the basiocciput, the sphenoid, the ethmoid, and the petrous-temporals; these bones, unlike those of the vault, do not change their relative position as the result of pressure brought to bear upon them; there is no moulding of the basis cranii during labour, and it is fortunate for the fœtus that there is not.

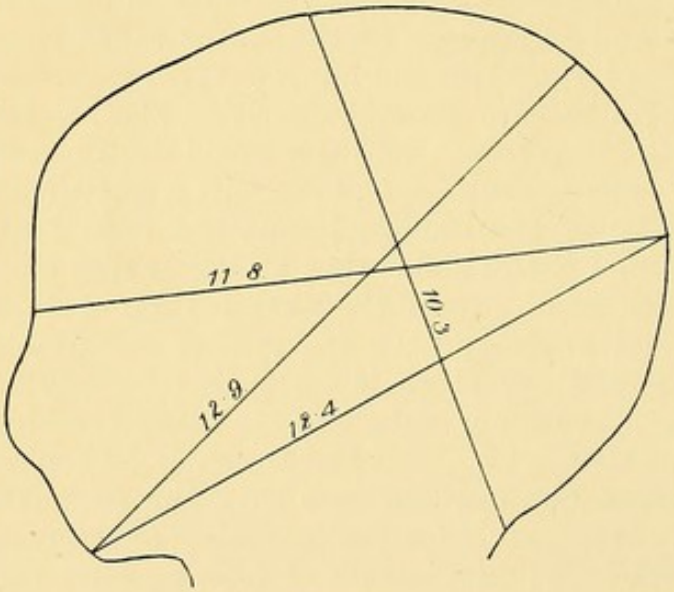


Fig. 15.

The form and diameters of the head of the full-time fœtus (Fig. 15) are not those of the new-born infant (Fig. 16). Only a few hours may separate the fœtal from the neonatal state, but in those few hours happens birth, and in birth the unmoulded head of the fœtus becomes the moulded head of the new-born infant. The form of the

unmoulded or normal head is expressed by the relative lengths of its antero-posterior and lateral diameters. For a full-time fœtus, measuring from 48 to 51 cms. (19 to 20 inches) in length the diameters will be approximately as follow: Maximum antero-posterior, 13 cms.; occipito-mental, 12·5 cms.; occipito-frontal, 11·5 cms.; sub-occipito-bregmatic, 10·3 cms.; bi-parietal, 10 cms.; and bi-temporal, 8·7 cms. During labour the maximum diameter greatly increases and most of the others diminish, the form of the head becoming obliquely sugar-loaf-shaped from before backwards and upwards. The distortion of labour usually passes off about a week afterwards, but it may be to a greater or less extent permanent. In the meantime, let it be borne in mind that the form of the fœtal head is not the same as that of the infant during and just after birth. It is not yet known with certainty whether the fœtal head shows a primitive asymmetry; the head of the new-born infant often is distinctly asymmetrical, but, manifestly, unilateral depressions may be due to the birth-traumatism which has just taken place.

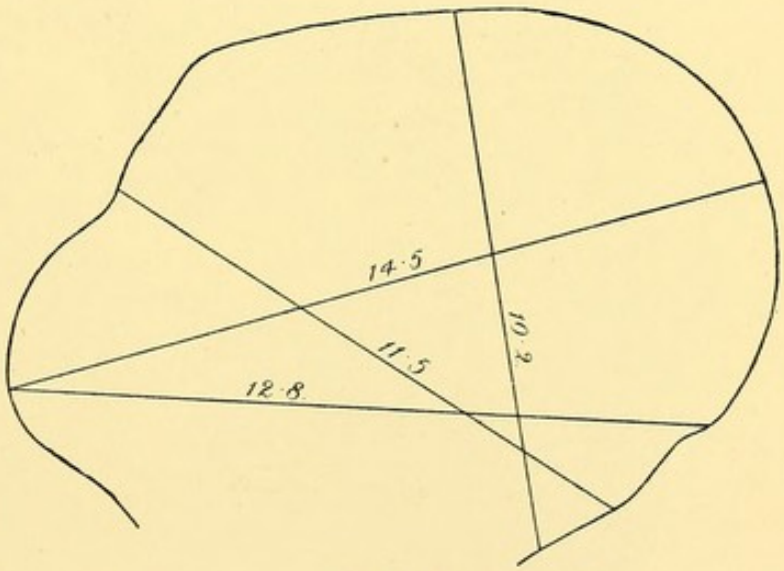


Fig. 16.

The brain, like the cranium which contains it, is relatively large in the mature fœtus—"big but inactive" is the description which has sometimes been given of it; big it certainly is. The relation of the brain landmarks to the cranial landmarks is in some details different from what it is in the adult; but the facts are difficult to get, for the topography of the brain of the unborn fœtus is practically unknown, and it is manifestly fallacious to draw conclusions from the moulded head after birth. The following statements, therefore, may require revision. The Sylvian fissure is at a higher level in the fœtus, and lies above the squamous suture instead of coinciding with it as in the adult; it has been stated that the lower end of the fissure of Rolando lies in front of the coronal suture in the fœtus, but my observations do not support this opinion, although they show that the fissure is apparently less vertical than in later life; the parieto-occipital fissure corresponds with some accuracy with the tip of the occipital bone at the posterior fontanelle, and lies behind rather than in front of the lambdoidal suture; and the calcarine fissure is situated approximately opposite the occipital protuberance. It has been said that the cerebrum overlaps the cerebellum to a less

extent in the fœtus, but my sections do not show this peculiarity (Figs. 17 and 18).

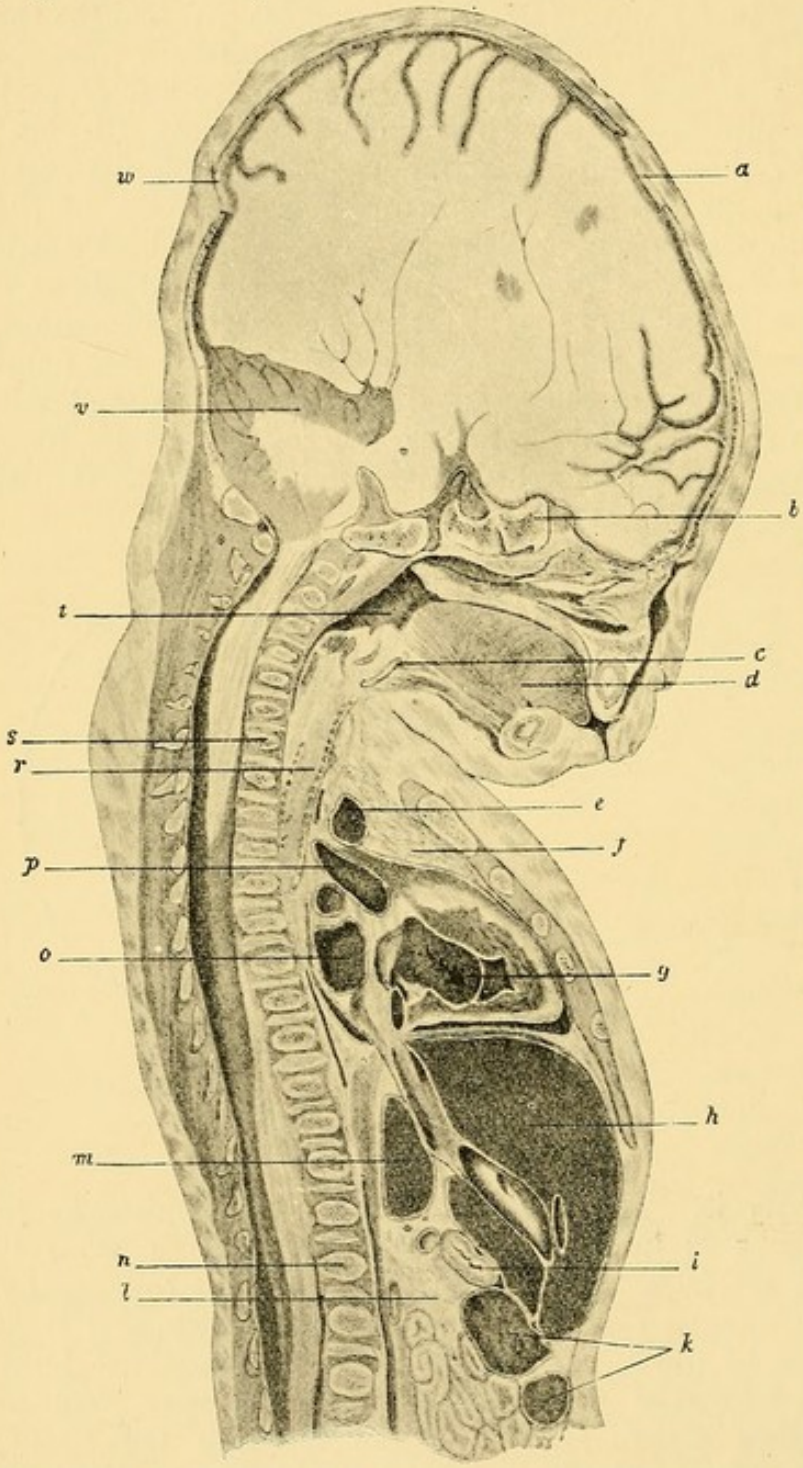


FIG. 17.—Mesial sagittal section of fœtus. In the upper part of the region of the head the section has passed slightly to the right of the middle line, leaving the falx cerebri unexposed. *a*, Anterior fontanelle; *b*, presphenoid; *c*, thyroid cartilage of larynx; *d*, tongue; *e*, left innominate vein; *f*, thymus gland; *g*, tricuspid opening in the heart; *h*, the liver; *i*, the pylorus; *k*, transverse colon; *l*, the pancreas; *m*, lobus spigelii of liver; *n*, first lumbar vertebra; *o*, left auricle; *p*, aorta; *r*, trachea; *s*, seventh cervical vertebra; *t*, the pharynx; *v*, cerebellum; *w*, posterior fontanelle.

The cerebral convolutions are less complex in the fœtus than in the adult, and the sulci are less deep. It may be that some accessory fissures are not developed till after birth, and are therefore postnatal formations, but about this matter there is little knowledge. The study of the minute anatomy of the fœtal brain has recently received a great impulse by the discovery of Flechsig that there is a correlation between the functions of systems of neurones and the myelination of their axons: in the full-time fœtus, the whole afferent tract conveying tactile, articular, muscular, and visceral sensations by the posterior columns, fillet, thalamus, and corona radiata is myelinated; and it follows, if the hypothesis of Flechsig be correct, that impressions have, during the last three or four months of intrauterine life, been passing along

these bundles of fibres to the receptive centres in the cortex, Rolandic area. From these observations much light may be expected to be thrown upon the physiology of the fœtal brain (*vide* W. W. Ireland's *Digest* of papers by Flechsig, Döllken, and Nissl, in *Journ. Ment. Sc.*, January 1899).

The small size of the face of the fœtus as compared with the cranium is partly due to the small size of the superior maxilla; the antrum of Highmore and the alveolar process of the upper jaw are both ill-developed. The inferior maxilla also is small in the fœtus; its symphysis is not fully ossified; and its angle is obtuse. In a well-nourished full-time infant the cheeks are prominent, and this prominence is partly caused by the presence of a special encapsulated mass of adipose tissue (Fig. 19); this mass of fat lies upon the buccinator and partly upon the masseter muscle, and has the risorius superficial to it; it is called the sucking-pad ("Saugpolster"). Two anatomical peculiarities of the buccal cavity in the fœtus are revealed by frozen sections: the gums are not in contact even when the jaws are tightly closed, and the lower jaw lies in a plane posterior to that of the upper jaw. The nasal cavities are relatively small; the orbits

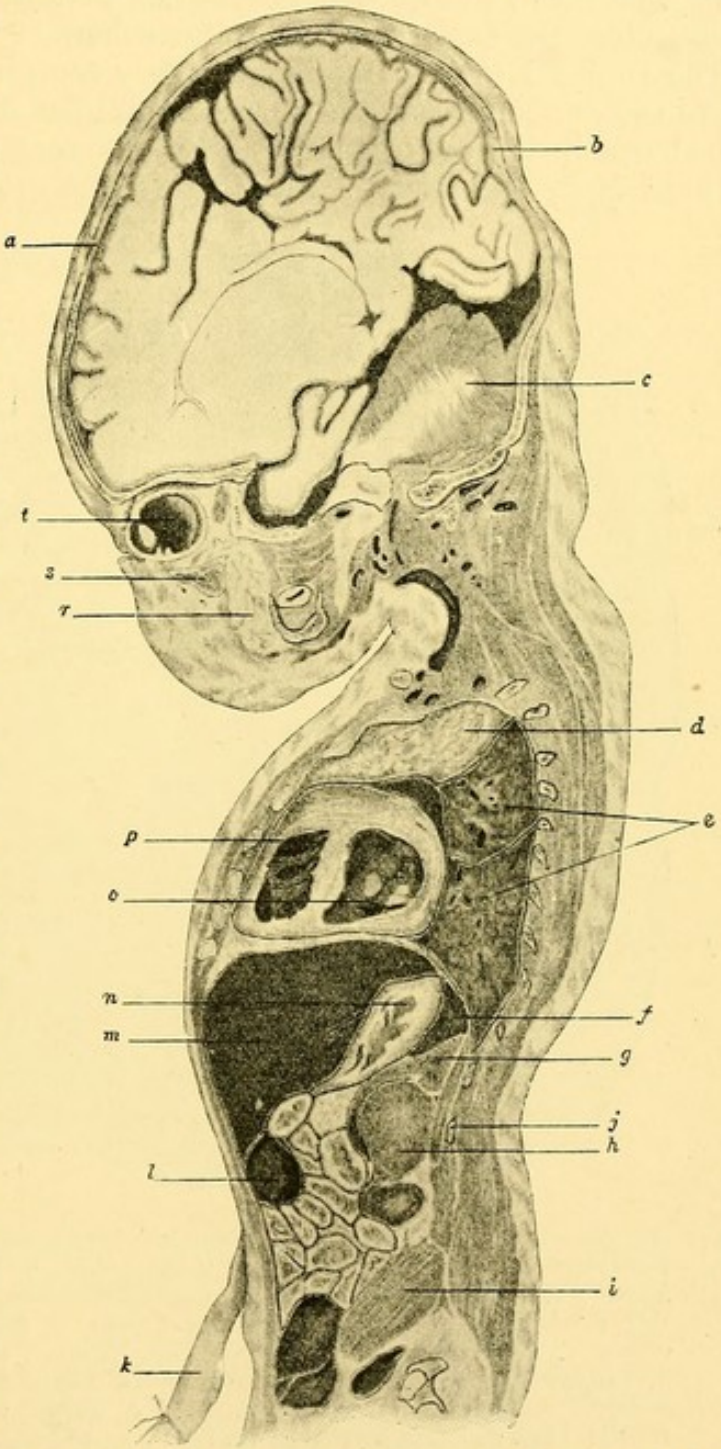


FIG. 18.—Left lateral vertical section of fœtus. Right face of section seen. *a*, anterior fontanelle; *b*, posterior fontanelle; *c*, cerebellum; *d*, thymus gland; *e*, left lung, upper and lower lobes; *f*, spleen; *g*, left supra-renal capsule; *h*, left kidney; *i*, left psoas muscle; *j*, twelfth rib; *k*, umbilical cord; *l*, transverse colon; *m*, liver, left lobe; *n*, stomach; *o*, left ventricle of heart; *p*, right ventricle of heart; *r*, left sucking-pad; *s*, left malar bone; *t*, left eye.

and their contents do not differ in their anatomy from these parts in the child or adult.

The ear of the full-time fœtus has certain characters in which it resembles the ear of the adult, and others in which it differs from it. The internal ear, for instance, is very completely developed, and so are the tympanic cavity and ossicles and the mastoid antrum. It is to be borne in mind, however, that in the roof of the tympanic cavity there is an unclosed suture, the petro-squamous (Fig. 20). The cavity is said to be filled with a gelatinous substance, embryonic connective tissue which has undergone regressive change; air enters after birth. The remaining parts of the ear, on the other hand, are far from complete development. The Eustachian tube is short, runs almost horizontal, and can hardly be said to possess an osseous part. The external auditory meatus is osseous in its inner third alone and that only in the roof, the floor being made up by the fibrous tympanic plate; the mastoid air cells are not developed; and the annulus tympanicus forms a very slight projection. The meatus with the soft parts in situ is probably of about the same relative length as in the child or adult; it has no anterior or posterior curve upon it; and its inner or tympanic end is somewhat enlarged to form the sinus. The external ear, then, is in a transition state in the fœtus; so is the skull in its neighbourhood. Anterior to the meatus is the antero-lateral fontanelle (region "pterion"), while posterior to it is the postero-lateral fontanelle (region "asterion"), and between these

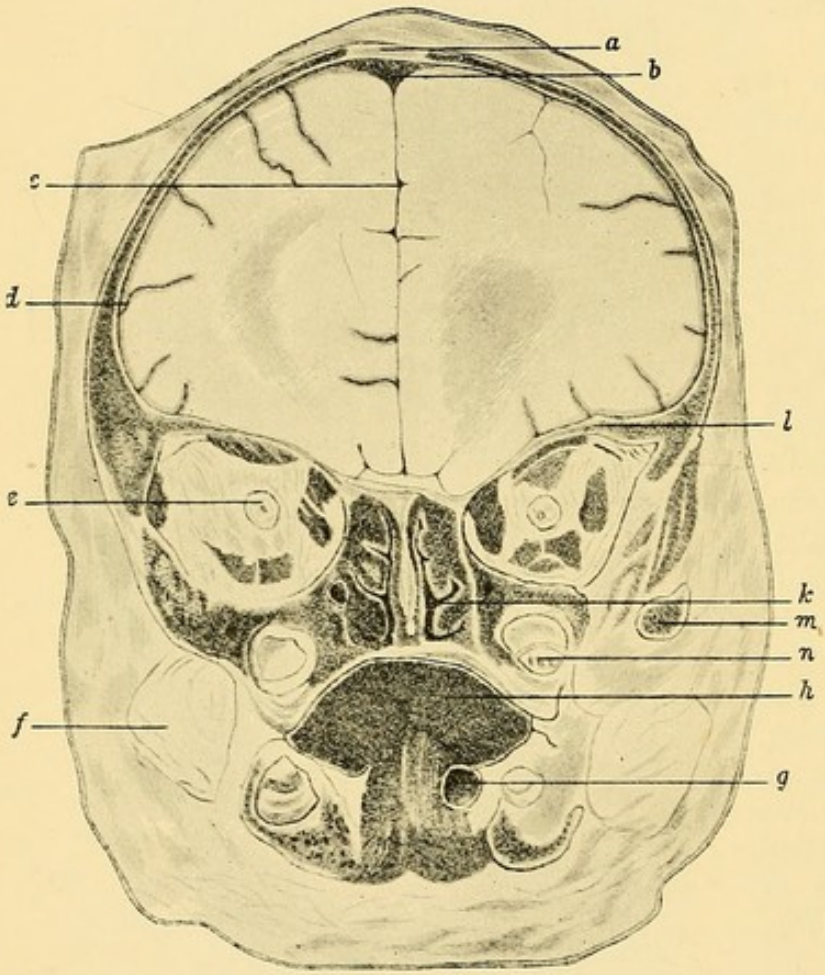


FIG. 19.—Coronal section of head of fœtus in plane posterior to the eyeballs (viewed from behind), ⅔ natural size. *a*, Frontal suture; *b*, longitudinal sinus; *c*, longitudinal fissure with falx cerebri; *d*, beginning of sylvian fissure; *e*, left optic nerve; *f*, left sucking-pad; *g*, cystic tumour below tongue; *h*, tongue cut transversely; *k*, right nasal fossa, showing superior, middle, and inferior meatuses; *l*, orbital plate of frontal bone; *m*, zygoma near its root; *n*, tooth germ in upper maxilla.

two fontanelles is a medley of small bones and cartilage islands, showing that development is not far advanced in this neighbourhood. Buntaro Adachi (*Ztschr. f. Morphol. u. Anthrop.*, ii. p. 223, 1900) has given an interesting description of the changes which occur in this neighbourhood in the fœtus and new-born infant. Post-natal development is necessary before the tympanic and squamoso-zygomatic parts

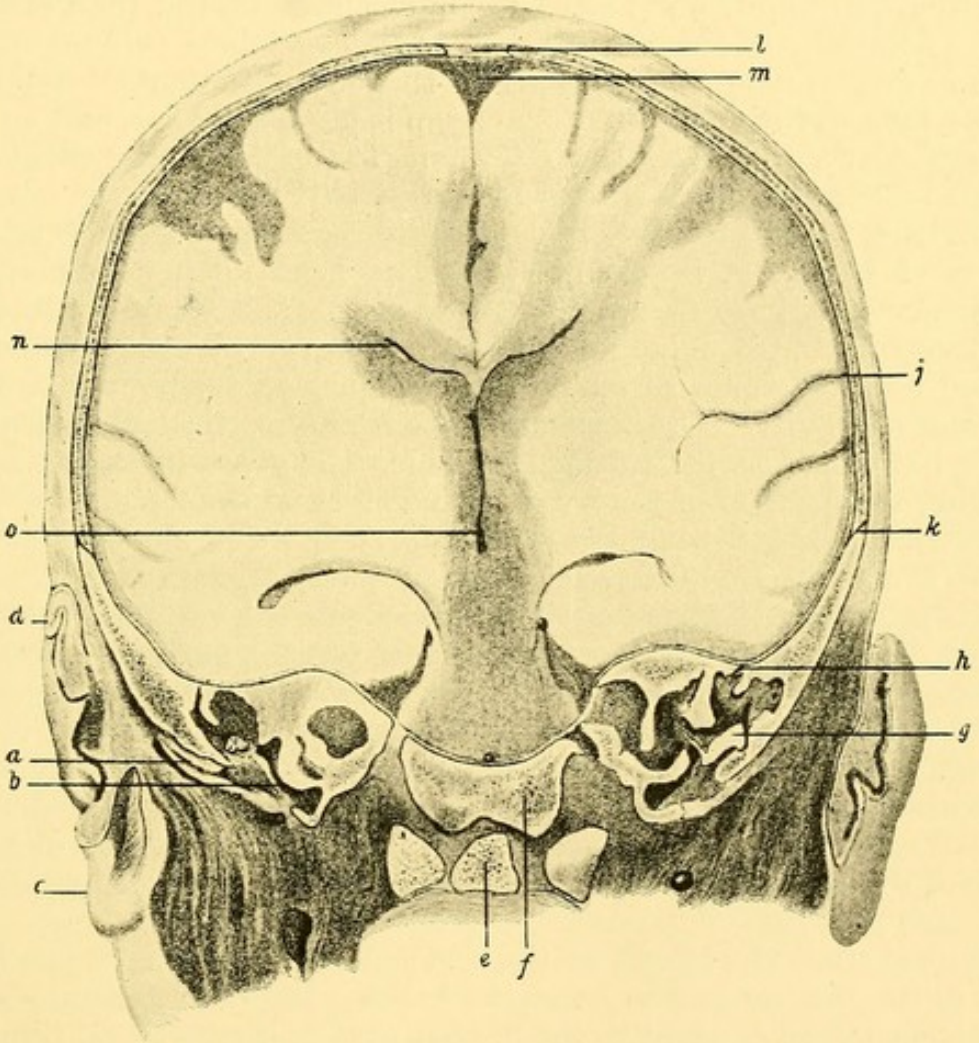


FIG. 20.—Coronal section of head of fœtus in plane of the middle ear, viewed from behind, right side slightly posterior to left, $\frac{2}{3}$ natural size. *a*, External auditory meatus (left); *b*, membrana tympani; *c*, lobule of left ear; *d*, helix of ear; *e*, odontoid process of axis vertebra; *f*, basisphenoid; *g*, incus, with stapes in fenestra ovalis; *h*, petro-squamous suture in roof of tympanic cavity; *j*, sylvian fissure; *k*, squamous suture; *l*, sagittal suture; *m*, superior longitudinal sinus; *n*, lateral ventricle; *o*, third cerebral ventricle.

of the temporal bone are fully formed. The pharyngeal tonsil is said to be poorly developed in the fœtus.

In frozen sections of the head the hypophysis cerebri can be seen in the middle line lying in the sella turcica (Fig. 17). Below it, in the sphenoid, can sometimes be seen traces of the early canalis cranio-pharyngeus; I have seen these traces in one case, a dropsical fœtus.

The Region of the Spine.

The spine of the fœtus is "a wonder of lightness and flexibility," for its ossification is incomplete (is not indeed complete till far on in postnatal life) and there is much cartilage in it. Any one who has handled a new-born infant must have been struck by the flexibility of the spine and the facile manner in which the head swung forwards and backwards and to the side; the movements of the head are due to the flexibility of the cervical part of the vertebral column rather than to great range of movement at the occipito-atlantoid articulations; indeed, the condyles of the occiput are nearly flat, and so are the articular surfaces on the lateral masses of the atlas, characters which little fit them for extensive movement.

In the fœtus in utero, lying as it does with a greater or less degree of flexion of its trunk and of its head upon its trunk, the spine shows a general anterior concavity. The single arch, with concavity forwards, is slightly broken, however, by the promontory of the sacrum, which produces two unequal secondary curves with anterior concavity. Other curves have been described as present at birth, but the truth is that any curves may be given to the spine by altering the position of the fœtus; none of them are fixed. Further, by extension of the head, the column may be made almost straight. There is a slight lateral deviation in the dorsal region.

Inspection of the back of the fœtus reveals the vertebral spines as a row of projections on a rounded surface, for the median depression does not appear till later, when it is caused by development of the spinal muscles. The spine of the seventh cervical vertebra is not specially prominent; it certainly does not yet deserve the name "prominens." On account of the forward flexion of the head upon the trunk of the fœtus in utero, the back part of the head and the back of the trunk form a continuous curve with but slight indication of a neck groove.

In the adult the length of the cervical region of the spine is to that of the lumbar as 2 to 3; in the fœtus it has been stated by some that the cervical is equal to the lumbar part of the vertebral column; it is, however, more exact to say that before birth the lumbar region is only slightly longer than the cervical. My measurements give 18 per cent. of the length of the spine for the cervical region, 40 per cent. for the dorsal, 22·5 per cent. for the lumbar, and about 19 per cent. for the sacro-coccygeal. The relation of the spinal cord to the spinal column varies at different periods in intrauterine life: at the third and fourth months the cord and the column are of practically equal length, the conus terminalis ending opposite the second coccygeal vertebra; at the full term, however, it ends opposite the first or second lumbar; at the fifth month it is opposite the fourth lumbar (Chievitz, *op. cit.*, p. 20).

In the full-time fœtus there are, as a rule, three primary centres of ossification in each vertebra—one central for the body, and two lateral for the arches and processes; but certain vertebræ offer exceptions. The atlas has its anterior arch cartilaginous; but then

its real body is doubtless the odontoid process of the axis, and in it one, sometimes two ossific centres are found. The five parts of the sacrum usually follow the general plan, and exhibit one central and two lateral primary centres in each; but the coccyx is commonly quite cartilaginous, although a single ossific nucleus may be occasionally noted its first part (Lambertz, *Die Entwicklung des menschlichen Knochengerüstes während des fötalen Lebens dargestellt an Röntgenbildern*, p. 18, Hamburg, 1900).

The Region of the Neck.

The neck of the full-time fœtus is noteworthy for its apparent shortness. This character is due in part to the high position of the sternum, in part to the abundance of subcutaneous fat in the region, and in part to the relatively large size of the head. As has been noted, the cervical part of the spine is not relatively short, but relatively long in the fœtus. In connection with this region, I may refer to the hyoid bone, the larynx, the trachea, the pharynx, and the thyroid gland. All these structures lie at a higher level in the neck than in the adult.

On account of the flexed attitude assumed by the fœtus in utero, a vertical line drawn through the hyoid bone falls in front of the manubrium sterni. The hyoid lies almost in contact with the thyroid cartilage, and opposite the lower part of the body of the third cervical vertebra; but with the head extended there is a distinct thyro-hyoid interspace, and the hyoid then lies on the level of the body of the axis vertebra. The ossification of the basi-hyal and of the great wings has begun in the full-time fœtus.

The larynx, like the hyoid, lies at a higher level in the neck in the fœtus than it does in the child and adult. With the head sharply flexed (intra-uterine attitude), the epiglottis lies opposite to the cartilage between the body and odontoid process of the axis vertebra, and the lower border of the cricoid is in the plane of the disc between the fifth and sixth cervical vertebræ. With the head erect the larynx is about a vertebra higher. The length of the larynx is approximately one-half the length of the cervical region of the spine. A finger's breadth (a *fœtal* finger's breadth) below the lower border of the cricoid is the isthmus of the thyroid gland; the thyro-hyoid and crico-thyroid membranes, also, have each the breadth of a fœtal finger. The trachea extends from the level of the body of the fifth cervical vertebra to that of the third dorsal, where it bifurcates; its level is a little higher when the head is sharply flexed; in the adult the bifurcation is one vertebra lower, *i.e.* opposite the body of the fourth dorsal. Part of the trachea is in the neck and part in the chest. Its length is about 3 cms., and its diameter from 2 to 3 mms.; in a seven months' fœtus it may be only 1 mm. in diameter. Its truly fœtal form shows an antero-posterior flattening, so that, while the antero-posterior diameter may be not more than 3 mms., the transverse may be 5 mms. (Mettenheimer, *loc. cit.*, p. 310). The pharynx has a vertical extent of about 4 cms.; the naso-pharynx

is a very small space. It becomes continuous with the œsophagus at the level of the fifth or sixth cervical vertebra posteriorly, and of the cricoid cartilage anteriorly.

The isthmus of the thyroid gland lies in front of the trachea (upper four or five rings) opposite the body of the fifth or sixth cervical vertebra (Fig. 17); with the head flexed it is in contact with the upper border of the thymus; its lateral lobes usually extend from the lower border of the thyroid cartilage to the level of the fourth or fifth tracheal ring; the weight of the gland is about 7 grammes.

The high level of the cervical structures in the full-time fœtus is an interesting anatomical fact, reminding us, as it does, of the embryonic origin of these parts from the visceral arches. The gradual descent of the organs in the neck, which takes place after birth, is in part due to the straightening of the body and head which then occurs, but in greater part it is caused by the downward growth of the tongue and lower jaw.

The Region of the Thorax.

The thorax of the full-time fœtus (Plates II. and III.) differs in certain anatomical details from that region of the body in the adult or child; it differs even from the thorax of the new-born infant, although the fœtus may be separated in age from the new-born infant by only some minutes—important minutes, however, for in them respiration has or may have begun. It will be convenient to consider, first, the thoracic framework, and, second, the thoracic contents.

The thorax as a whole is situated at a higher level *quâ* the spine in the fœtus (Fig. 17): its upper limit, the upper border of the manubrium sterni, lies opposite the body of the first dorsal vertebra (Plate II.); the central tendon of the diaphragm lies opposite the disc between the eighth and ninth dorsal vertebræ. Its high position is probably due to the non-development of the spinal curves. In the interior of the chest it is noticed that the sulcus pulmonalis on each side of the spine is shallower and less capacious than in later life.

The external transverse diameter of the thorax is not quite twice as great as the external antero-posterior, while the internal transverse diameter is fully twice as great as the internal antero-posterior; in the adult the transverse is three times as great as the antero-posterior. The mesial vertical diameter varies from 4 cms. anteriorly to 6·5 cms. posteriorly. All the diameters are increased when respiration has been established, but the antero-posterior relatively more so than the transverse and vertical. The thoracic walls are flattened somewhat in the fœtus; after birth they show a more marked external convexity. A transverse furrow can be distinguished which marks off the upper narrow part of the chest, which contains the thoracic viscera, from the lower broad part which expands over the upper aspect of the abdominal organs; there is also a slightly indicated vertical furrow on each side which divides the anterior part of the cavity containing the heart and thymus from the posterior containing

PLATE I

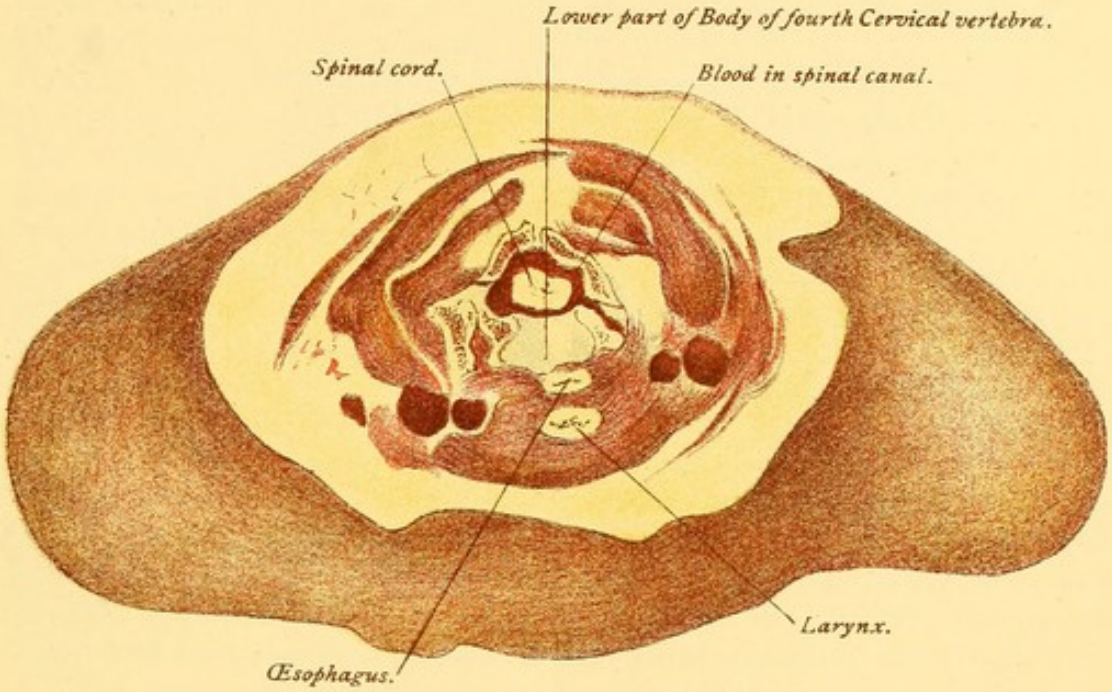
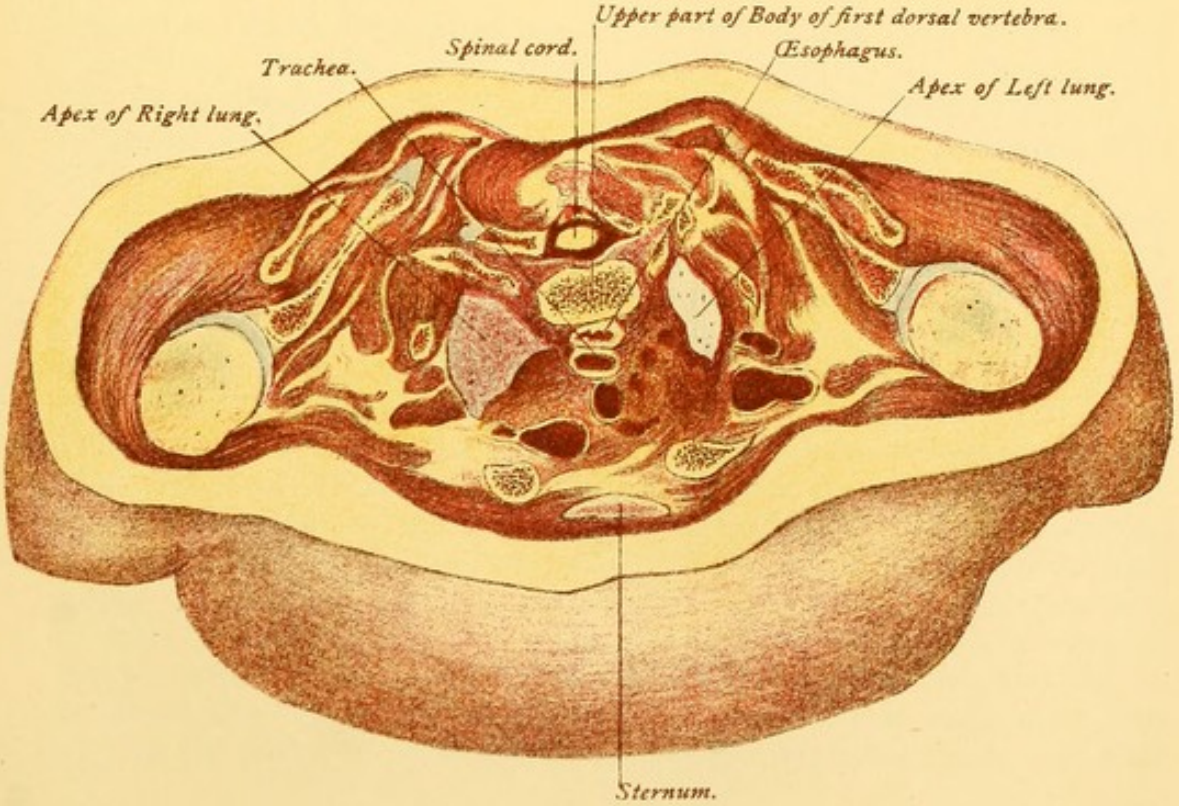


PLATE II



only the lungs. These furrows are more evident in fœtuses before the full time.

The bones of the shoulder girdle (Plate II.) also occupy a higher position than in the adult. Further, the body of the scapula lies more nearly in a sagittal plane on account of the shape of the external aspect of the thorax; in this respect it resembles the same bone in the quadrupeds. It is also rotated so that the glenoid fossa is directed markedly upwards and the inferior angle carried forwards. The coracoid and acromion processes and the greater part of the glenoid fossa lie above the level of the first rib, and the inferior angle reaches the lower border of the fifth rib; so that the whole bone is about one rib higher than in the adult. The result is that the outer end of the clavicle is directed upwards, and the nerves of the brachial plexus pass outwards instead of downwards to the arm. The high fœtal position of parts reminds us that the upper limb was at first a cervical appendage (Chievitz, *op. cit.*, p. 12). The transverse diameter of the shoulders is large: it is from 12 to 14 cms. in the fœtus, but this measurement is doubtless reduced by compaction during the passage of the infant through the birth-canals; moreover, the division of one or both clavicles (unilateral or bilateral cleidotomy) will still further diminish this diameter, for it is due to the clavicles that it is so large and that the shoulders so much resist moulding in labour (125).

The sternum occupies a high level, for its upper border lies opposite to the first dorsal vertebra or even to the disc between it and the seventh cervical; the lower end of the body of the bone is at the level of the fifth dorsal vertebra. The position of the sternum is remarkably oblique, so that the distance of the xiphi-sternal joint from the spine is three times that of the manubrium from the spine. The shortness of the anterior chest wall is largely due to this obliquity, for the sternum itself is not short. The ribs are directed somewhat more horizontal than in the child and adult; the extremities of the first three ascend slightly to their costal cartilages, those of the remaining ones, slightly downwards. The subcostal angle is obtuse, being 100° in the fœtus as compared with 67° to 80° in the adult.

The contents of the thorax are the thymus, heart, lungs, great vessels, and œsophagus. The large size of the thymus gland (Figs. 17 and 18, Plate III.) is one of the most striking characters of the fœtal thoracic contents. Its two lobes, right and left, are often unequal in size, and are in contact in the middle line; but there may be a small central lobe. The greater part of the gland lies in the thorax, the cervical part being almost insignificant; this is to some extent due to the high level of the thoracic orifice and manubrium sterni. It corresponds in vertical extent to the first four dorsal vertebral bodies posteriorly, and to the manubrium and upper part of the body of the sternum and upper three costal cartilages anteriorly. The thymus rests upon the anterior surface of the pericardium, covering the auricles and part of the ventricles of the heart; laterally it is in contact with the pleura covering the lungs; above the level of the heart it rests upon the arch of the aorta, the innominate artery, the left innominate vein, and

the trachea. It may reach the diaphragm inferiorly. It has been described as an elongated body; but, in the fœtus at any rate, I have found its vertical diameter sometimes not much longer than its transverse; its antero-posterior measurement is usually its smallest. It varies in weight from 8 to 13 grms., and bears a relation to the general body weight of from 1 : 250 to 1 : 350. It is noteworthy, as Schäffer has pointed out (*loc. cit.*, p. 591), that up to the end of the sixth month of antenatal life its weight is to the body weight as 1 : 500 or so; at the end of the sixth month it suddenly increases in weight (1 : 250), and retains the relationship to the body-weight then assumed up to the end of fœtal existence.

The heart (Figs. 17 and 18, Plate III.) is relatively heavier in the fœtus than in postnatal life; the relation of the heart-weight to the general body-weight in the full-time fœtus varies from 1 : 114 to 1 : 211; in the adult it is as 1 : 216 (O. Schäffer, *loc. cit.*, p. 551). It is situated more transversely in the thorax and at a somewhat higher level *quâ* the spine. The upper limit (the base) I found to be the disc between the fourth and fifth dorsal vertebræ, and the lower that between the eighth and ninth dorsal vertebræ. According to Chievitz (*op. cit.*, p. 22), however, when the fœtus is in its flexed intra-uterine attitude, the heart limits are two horizontal planes passing through the third and seventh dorsal vertebræ respectively. The posterior end of the lower surface of the heart is at a slightly lower level than the anterior, on account of the backward slope of the diaphragm. The long axis of the organ is placed horizontally, and the apex is directed forwards almost in the sagittal plane; but after birth it comes to lie more transversely in the thorax, and the inter-ventricular furrow which had touched the chest wall at the left margin of the sternum is deflected to a considerable distance from that bone. In the fœtus a great part of the anterior surface of the heart is uncovered by the lungs, but in the upper part the thymus gland intervenes between the heart and great vessels and the posterior aspect of the sternum; the lower portion of the anterior surface is separated only by pericardium from the posterior sternal surface. On the left side of the middle line the anterior relations are the costal cartilages and sternal ends of the upper six ribs, with, in the case of the first and second cartilages and ribs, the thymus intervening; at a lower level the pericardium alone lies between the heart and the ribs, cartilages, and intercostal spaces. The sharp anterior margin of the left lung insinuates itself to a varying degree between the heart and the left anterior chest wall (Plate III.); of course, after birth has occurred and respiration been established, this pulmonary insinuation becomes very marked, and at the same time the anterior margin of the right lung comes forward and covers the part of the anterior surface of the heart which lies to the right of the middle line of the sternum. In the fœtus, however, let it be borne in mind, the chief anterior relations of the heart are with the chest wall and the thymus. The heart may be said to lie midway between the cephalic and pelvic extremities of the fœtus; but with regard to the spinal column, its central point is nearer the upper end than the lower (Fig. 17).

PLATE III.

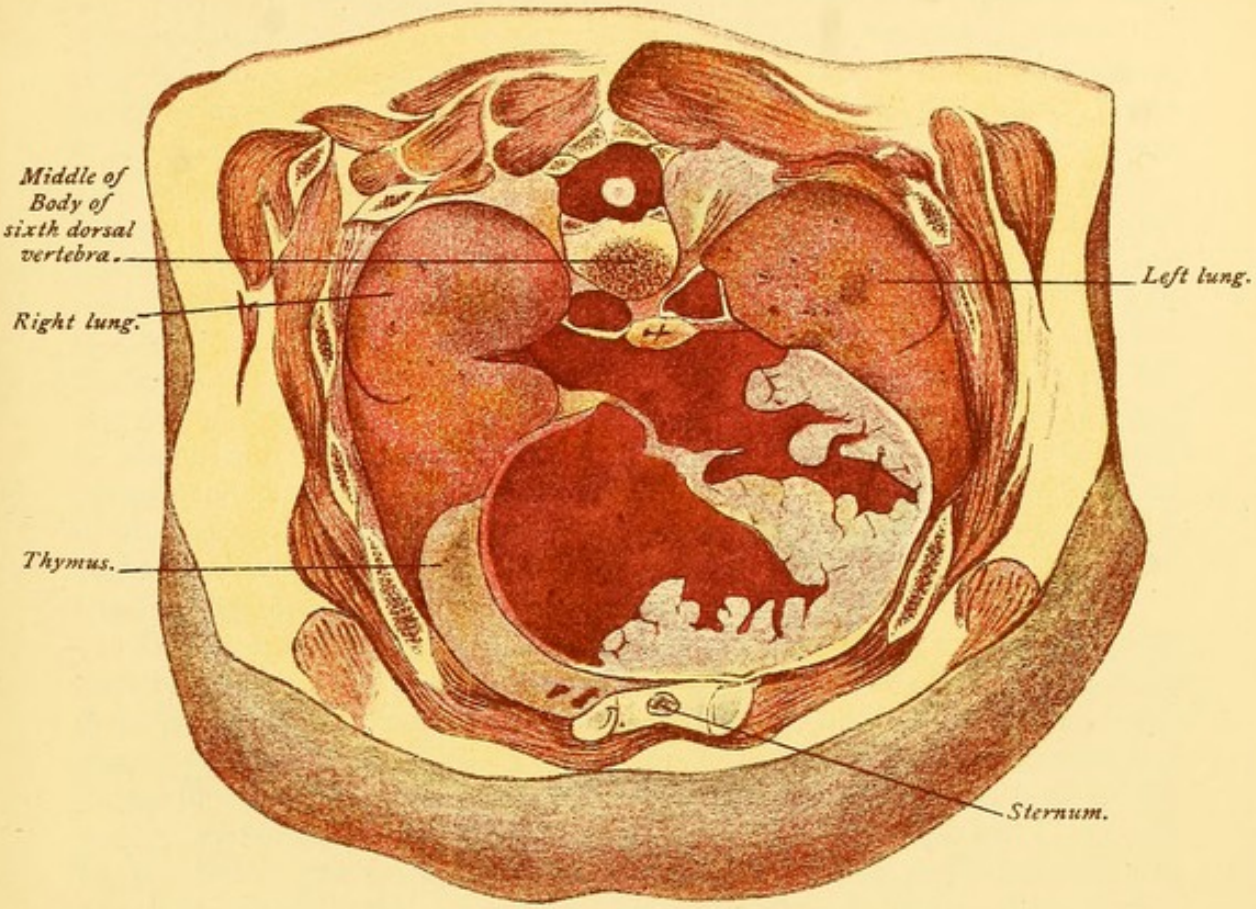
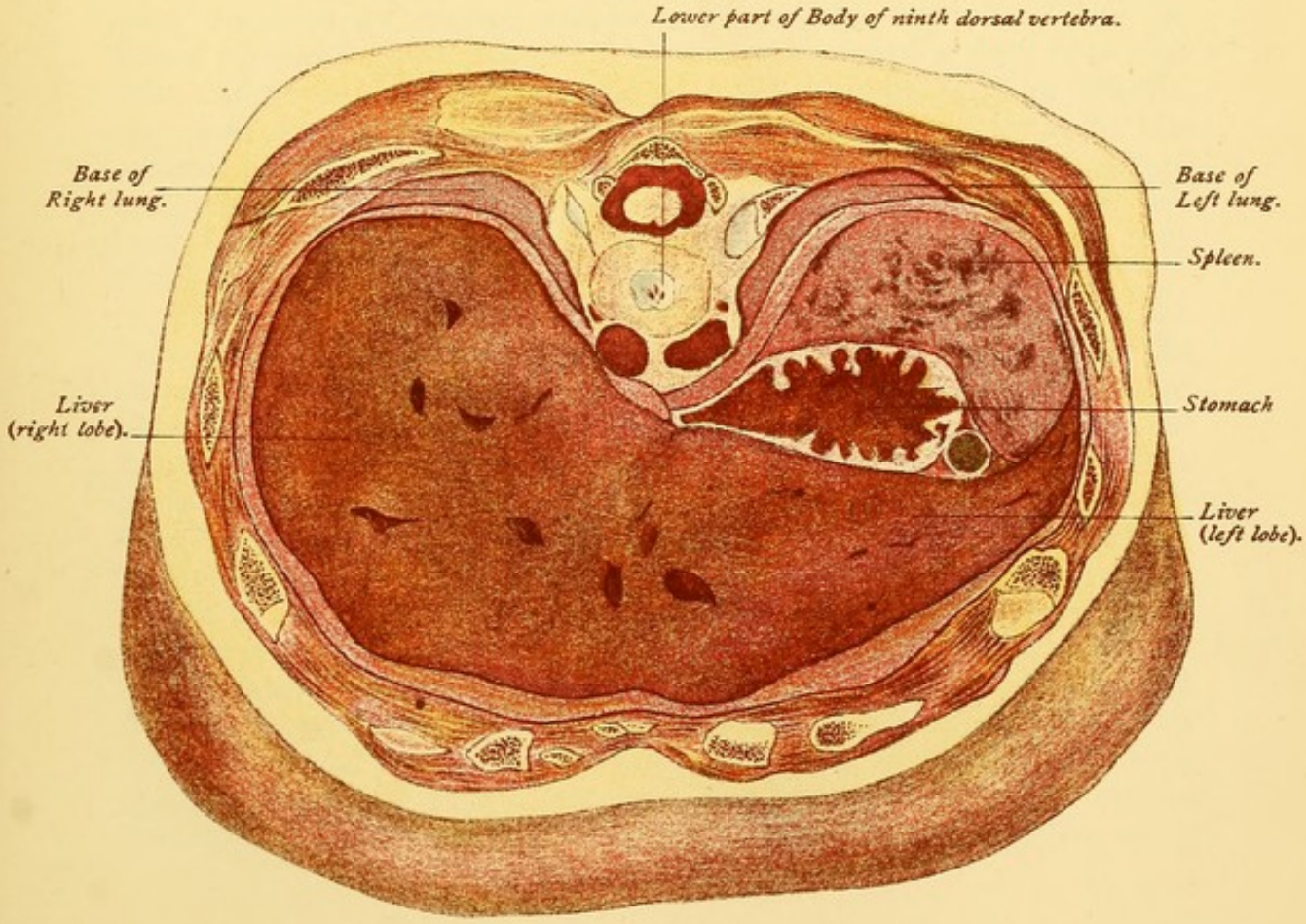


PLATE IV.



The wall of the right ventricle is relatively thick as compared with the wall of the left cavity in the fœtus (Fig. 18); in fact it may be absolutely as thick (0·5 cm. : 0·5 cm.), it may even be thicker (0·7 cm. : 0·5 cm.). The surfaces of the right ventricle meet in a distinct margin, which is, however, more obtuse than in the adult heart (Chievitz, *op. cit.*, p. 22). The foramen ovale (communication between the right and left auricle) is, save in quite exceptional and pathological conditions, open in the full-time fœtus; but both the valvular structures (valve of the fossa ovalis and limbus of Vieussens), which lead to its closure, are easily recognised; by their union the foramen is closed at a variable period after birth, sometimes as early as the second day. During the last three-and-a-half months of fœtal life the valve of the fossa is sufficiently developed to prevent the passage of blood back from the left into the right auricle. Another structural peculiarity in the fœtal heart is the presence, in a complete form, of the valve of Eustachius, the crescentic fold of endocardium in the right auricle, which directs the blood from the inferior vena cava into the foramen ovale.

The lungs (Fig. 18, Plates II., III., and IV.) occupy a comparatively narrow space in the posterior part of the thorax of the fœtus; the right is both heavier and larger than the left. After birth and the establishment of respiration, all the pulmonary diameters show an increase, but it would seem that the right lung expands to a greater extent in the antero-posterior and transverse directions than does the left (1, p. 70). In the fœtus the margins of the lungs are "sharp, well-defined, and curve inwards"; the organs are of a "uniformly dense, firm, fleshy, and liver-like consistency"; they do not crepitate, little or no blood oozes out from an incision, and no air bubbles escape when they are firmly squeezed under water. In colour they are of a dark brownish red. All these characters change with the establishment of breathing; and their change is well known by, and of great value to the medical jurist. A large part of the surface of the right lung comes into relation with the thymus, but only a narrow strip of the left lung above the level of the cardiac impression is in touch with that gland.

The chief peculiarity of the great vessels of the thorax in the fœtus is the presence of an open communicating canal between the pulmonary artery and the aorta, the ductus arteriosus or ductus Botalli. From the posterior end of the upper surface of the heart (as it lies in the fœtal thorax) the pulmonary artery arises and passes backwards in a horizontal and nearly sagittal direction; it gives off from its lower aspect the right and left pulmonary arteries, and is continued as this communicating trunk or ductus arteriosus to join the aorta; it is crossed at the point of junction by the vagus nerve. The aorta proceeds from the heart in a more vertical direction; the highest point reached by the arch is opposite the body of the second dorsal vertebra or the disc between the second and third bodies, and there it gives off the innominate artery; it gives off the left subclavian opposite the third dorsal vertebra; and it is joined by the ductus arteriosus opposite the fourth dorsal vertebra where also the aorta

comes into contact with the spine. The vena cava superior is short and has a vertical direction; the left innominate vein runs transversely and is clearly seen (in vertical mesial sagittal sections) posterior to the thymus gland at its upper part. The relation of the great vessels to the spine alters little at birth.

If the ductus arteriosus be studied more in detail, it is found to be at its origin a distinct continuation of the trunk of the pulmonary artery. Both in direction and in size it looks like the main trunk, with the right and left pulmonary arteries as almost insignificant branches of it. It narrows slightly as it approaches the aorta, and passes somewhat obliquely through its wall; it opens into the aorta at a point not quite opposite to the point of origin of the left subclavian artery; the orifice of the ductus is bordered by a valvular projection of the aortic wall, with a slightly concave free margin; and the space between the opening of the left subclavian artery and that of the ductus has been called, and appropriately enough, the pars communicans of the fœtal circulation (Ziegenspeck). Strassmann (*Arch. f. Gynaek.*, xlv., p. 408, 1894) points out that the opening of the ductus differs from all the other openings into the aorta in its neighbourhood, in being elliptical in shape instead of round, and in having the aortic wall in its vicinity raised in ridges (valvular projection) instead of being quite smooth. These anatomical peculiarities of the ductus serve in some measure to explain the manner of its closure after birth (*vide infra*, Chap. IX.).

The œsophagus leaves the middle line and inclines to the left at about the level of the sixth cervical vertebra; at the level of the fourth dorsal vertebra it turns forwards beside the aorta, and comes to lie in front of it; it then inclines again to the left at the level of the ninth dorsal (disc between the seventh and eighth dorsal, according to Chievitz), where it pierces the diaphragm. The thoracic duct follows its usual course, but is not very evident in the fœtus.

The Region of the Abdomen.

The abdomen in the fœtus (Figs. 17 and 18, Plates IV., V., VI., VII., and VIII.) is large, and has the peculiarity of being connected with the placenta by means of the umbilical cord. The umbilicus may be described as occupying the central point of the body, half-way between the vertex and the heels, or, according to my measurements, a little nearer to the latter than to the former. The attachment of the cord (Plate VII.) is at the level of the disc between the fourth and fifth lumbar vertebræ; but doubtless considerable variations occur with the degree of distention of the abdominal cavity, etc. On the internal aspect of the anterior abdominal wall the constituent parts of the umbilical cord can be seen to break up; the umbilical vein passes upwards in the middle line to the liver; the urachus passes downwards in the middle line to the bladder; and the two umbilical (hypogastric) arteries also proceed downwards, but diverge from the middle line to the sides of the bladder, where they join the internal iliacs, or rather appear to be

PLATE V.

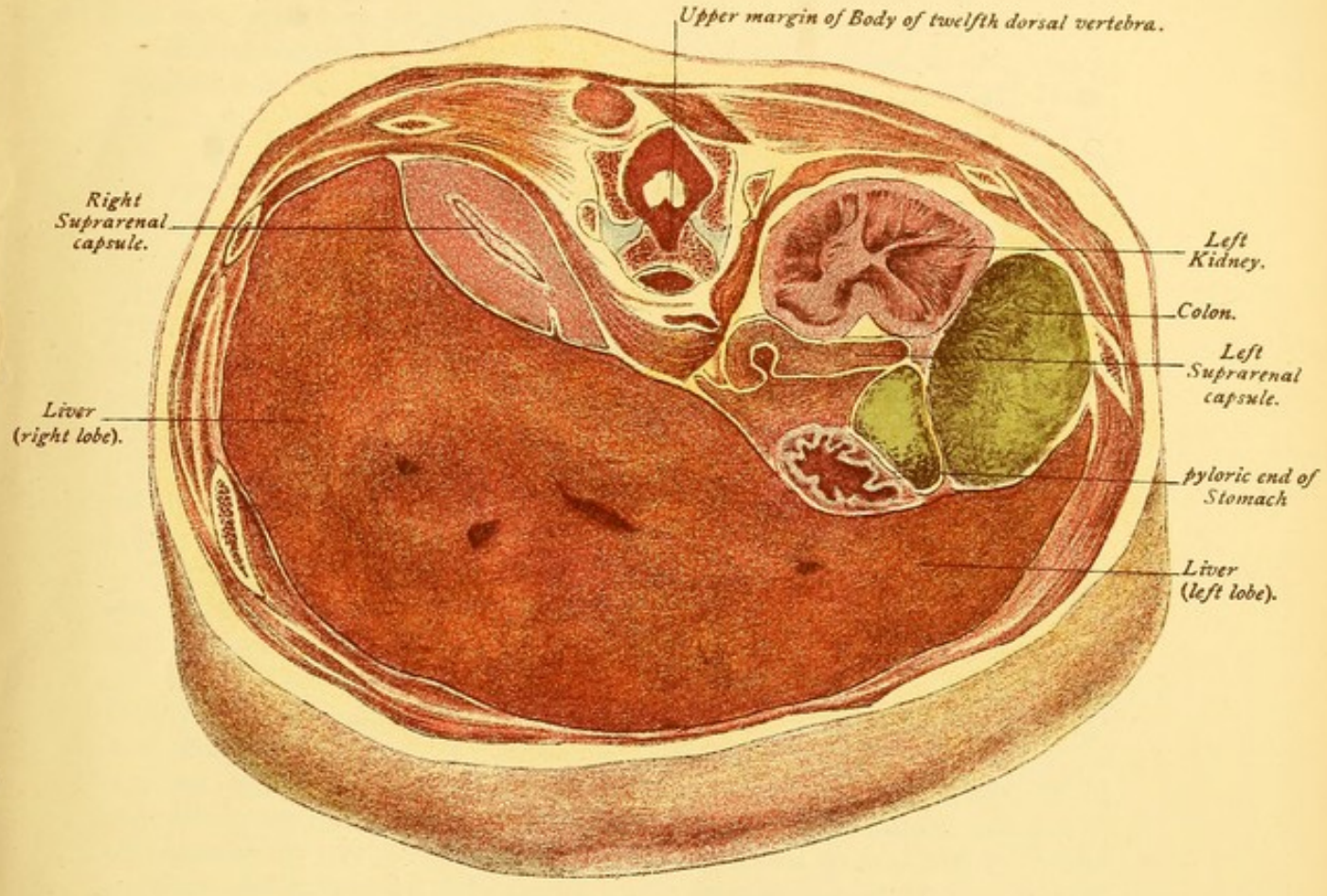
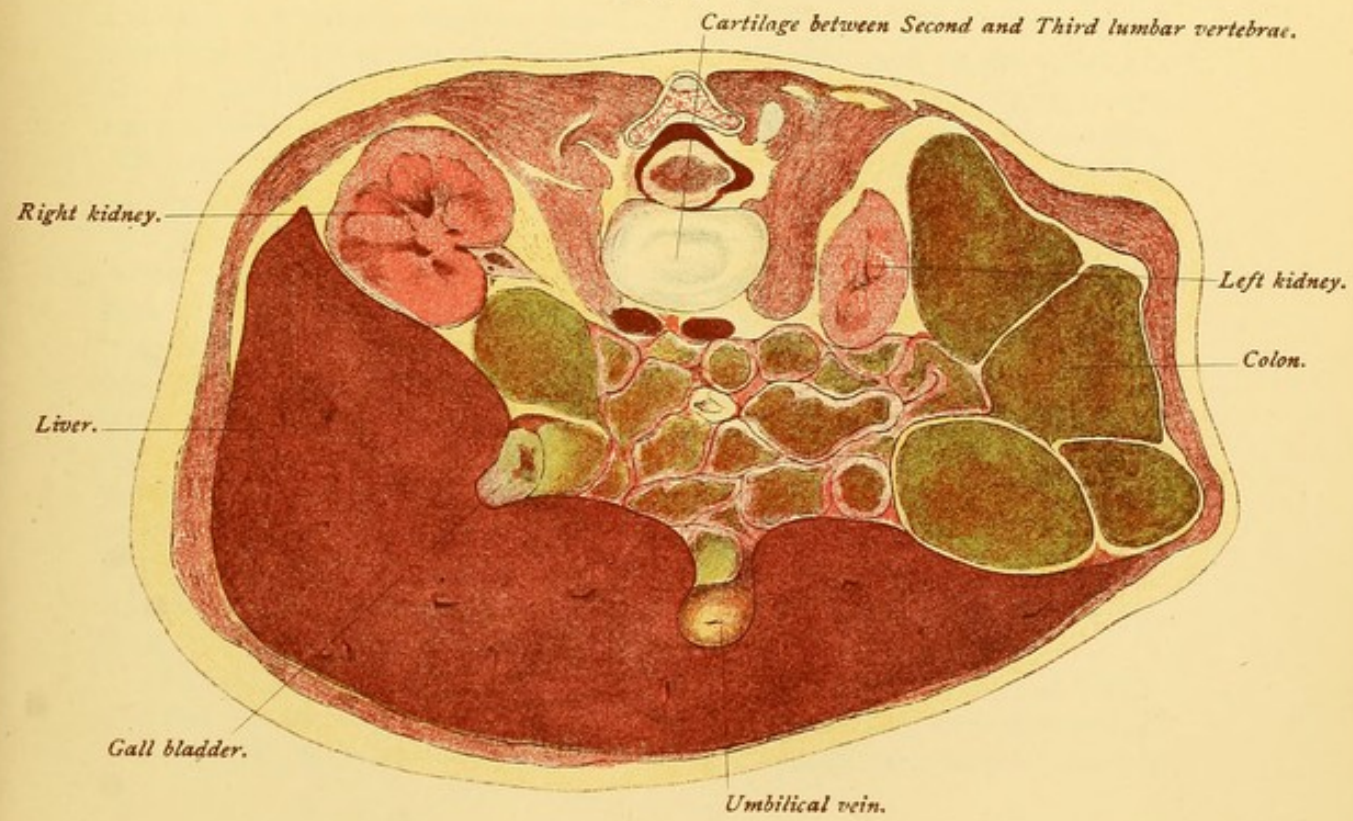


PLATE VI.



joined by the internal iliacs, for the latter are at this age small in size in comparison to them.

When the fœtal abdomen is opened, certain outstanding peculiarities are evident at once. The great omentum is markedly transparent and delicate in texture; the liver is very large (Plates IV., V., VI., and VII.) and appears to occupy nearly one-half of the whole cavity; the left hepatic lobe is relatively very large, and hides from view the stomach (Fig. 18); the large intestine is full of dark green meconium; and the urinary bladder is an abdominal content. As Ribemont has shown, a plane passing along the inferior surface of the liver divides the abdomen into two compartments, each pyramidal in form and nearly symmetrical; one has its base above, occupying the right hypochondrium and epigastric region, its apex below turned towards the right iliac crest, and contains the liver; the other has its base inferior, its apex turned towards the posterior part of the left hypochondrium, and contains the intestinal coils, the spleen, and the stomach.

The liver, as has been stated, is large, very large, in the fœtus; but in the full-time fœtus it is not relatively so large as in the earlier months; its weight is to the body-weight as 1:15 or 1:16, and in the full-time fœtus as 1:18 or 1:19. The form of the fœtal liver has been made clear chiefly by the study of frozen sections. It has five (sometimes six) surfaces: there is a superior surface in contact with the lower surface of the diaphragm to which it is accurately moulded, generally convex but with a localised concavity corresponding to the heart; an anterior surface in contact with the anterior abdominal wall, having a quadrangular shape (triangular in the adult), and sharply marked off from the left inferior surface by the thin anterior border; a right lateral surface, less clearly delimited; a posterior surface, small in extent, very evident in sagittal sections, including the notch for the œsophageal end of the stomach, the posterior part of the longitudinal fissure, the groove for the vena cava inferior, and the lobus Spigelii; a left inferior surface, marked off from the others by the anterior border and by the groove anterior to the lobus Spigelii, of considerable extent, showing the impressions left upon it by the various organs which come in contact with it, being made up of the under surfaces of the right and left lobes and of the quadrate and caudate lobes, and being traversed by the longitudinal and transverse fissures and the fissure for the gall-bladder; and an ill-defined left surface which in later life is merged with the superior surface. Of all these surfaces the anterior and left inferior are the largest, and then, in order, come the superior, right, and posterior. The whole organ is "a right-angled triangular prism with the right angles rounded off," sometimes it is a trapezoid (Mettenheimer, *loc. cit.*, p. 337). The gall-bladder lies about 1·5 cm. to the right of the middle line, is more cylindrical in form than in later life, and is distended with bile.

The stomach (Fig. 18, Plates IV. and V.) is small in size at birth, and can contain only about 1 or 1½ fl. oz. without being over-distended. The fundus is relatively small, and the lesser curvature forms a

more acute angle than in postnatal life. At birth the viscus may be empty, or it may contain a fluid like liquor amnii; in one case in which labour had been instrumental, I found some meconium in it. It lies under cover of the left lobe of the liver, and does not extend to the right of the middle line of the body, the pylorus being situated immediately in front of the body of the first lumbar vertebra (lower border of ninth dorsal, according to Chievitz). The anterior relations of the fœtal stomach, therefore, are with the left inferior surface of the liver; while posteriorly it is in contact from above downwards with the anterior surface of the spleen, the left supra-renal capsule, the upper end of the left kidney, and with the tail and body of the pancreas. Below the greater curvature is the transverse colon; the lesser curvature runs first parallel to the left side of the vertebral column, and then passes transversely to the right side in front of the spine.

The pancreas in the fœtus weighs about 4·5 grammes, and is to the total body weight as 1 : 700 or thereby; it measures about 3·5 cms. in length, and its antero-posterior diameter in the middle line is about 1 cm. It lies opposite the first and second lumbar vertebræ. It has practically the same relations with surrounding parts as in postnatal life, but does not come into immediate contact with the left kidney.

The spleen (Plate IV.) lies almost horizontal with the fœtus in the intrauterine attitude of flexion, and is opposite to the eighth, ninth, and tenth dorsal vertebræ. The liver comes into contact with it behind and external to the stomach, and it has a direct relationship with the left supra-renal capsule instead of with the left kidney. It has therefore four instead of three surfaces: a phrenic posteriorly; a gastric or antero-internal which is in contact with the tail of the pancreas as well as with the stomach; a supra-renal inferiorly; and a hepatic anteriorly. Near the middle line the spleen shows only three surfaces on section, phrenic, gastric, and supra-renal.

The intestinal canal (Figs. 17 and 18, Plates V., VI., VII., VIII., and IX.) increases remarkably in length during fœtal life; the increase is also continuous; and at the tenth month the total length is 410 cms. or so (Merkel, *op. cit.*, p. 22), the addition during the last month having been 25 per cent. No doubt there are great individual variations. With regard to the small intestine a few words of description will suffice. The duodenum commences at the pyloric end of the stomach, opposite the first lumbar vertebra; there it crosses to the right side of the body, its third part crossing over again to the left side of the spine at the level of the second lumbar. According to Chievitz (*op. cit.*, p. 33), the levels are the tenth dorsal and the first lumbar. The jejunum and ileum are less fixed in position than the duodenum; the line of attachment of the mesentery is nearly horizontal; and the coils of intestine follow one another progressively from left to right. There is usually little meconium in the small intestine. The cæcum may be found occupying its adult position in the right iliac and right lumbar regions, with the ileum entering it at the ileo-cæcal valve about the level of the right iliac crest or a few mms. above it; but I have met with several cases in which this part of the large

PLATE VII.

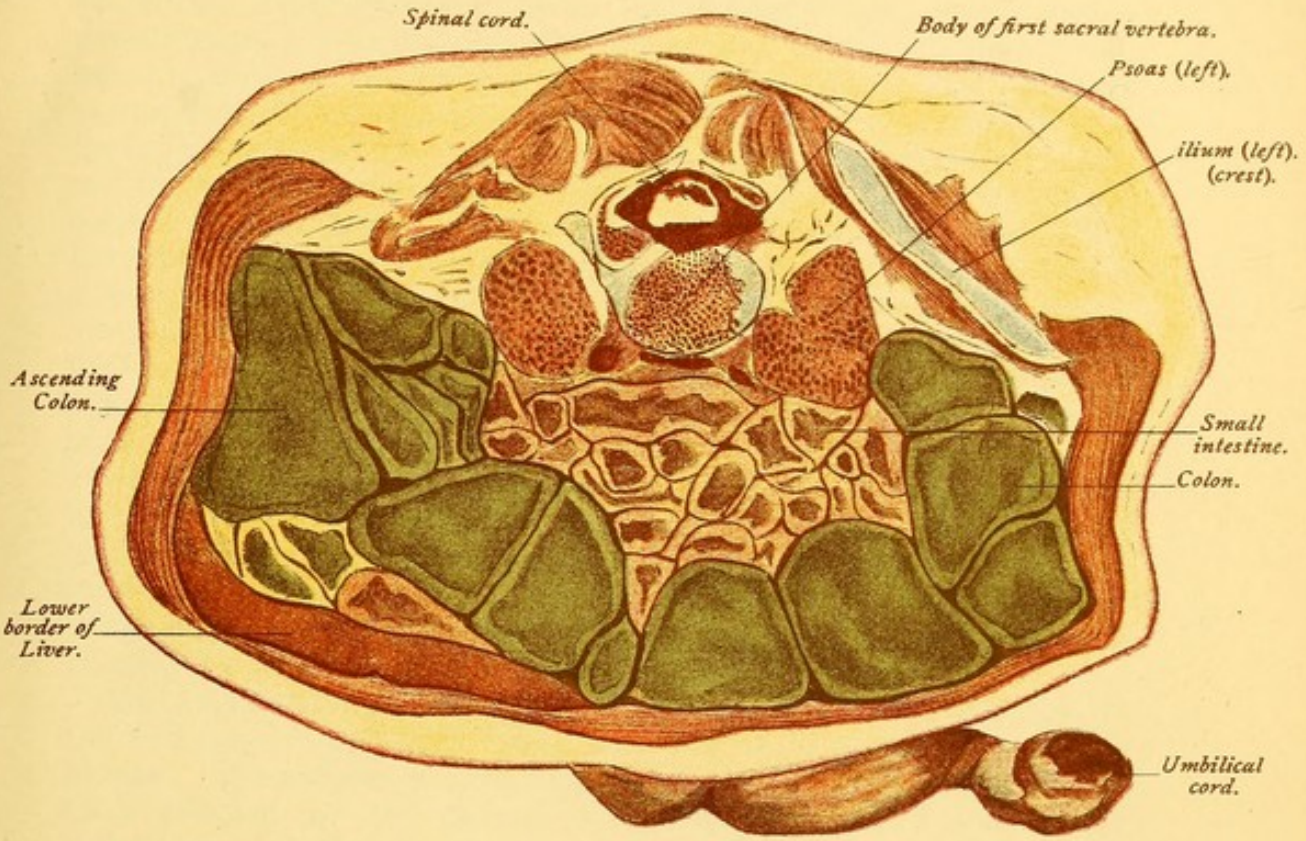
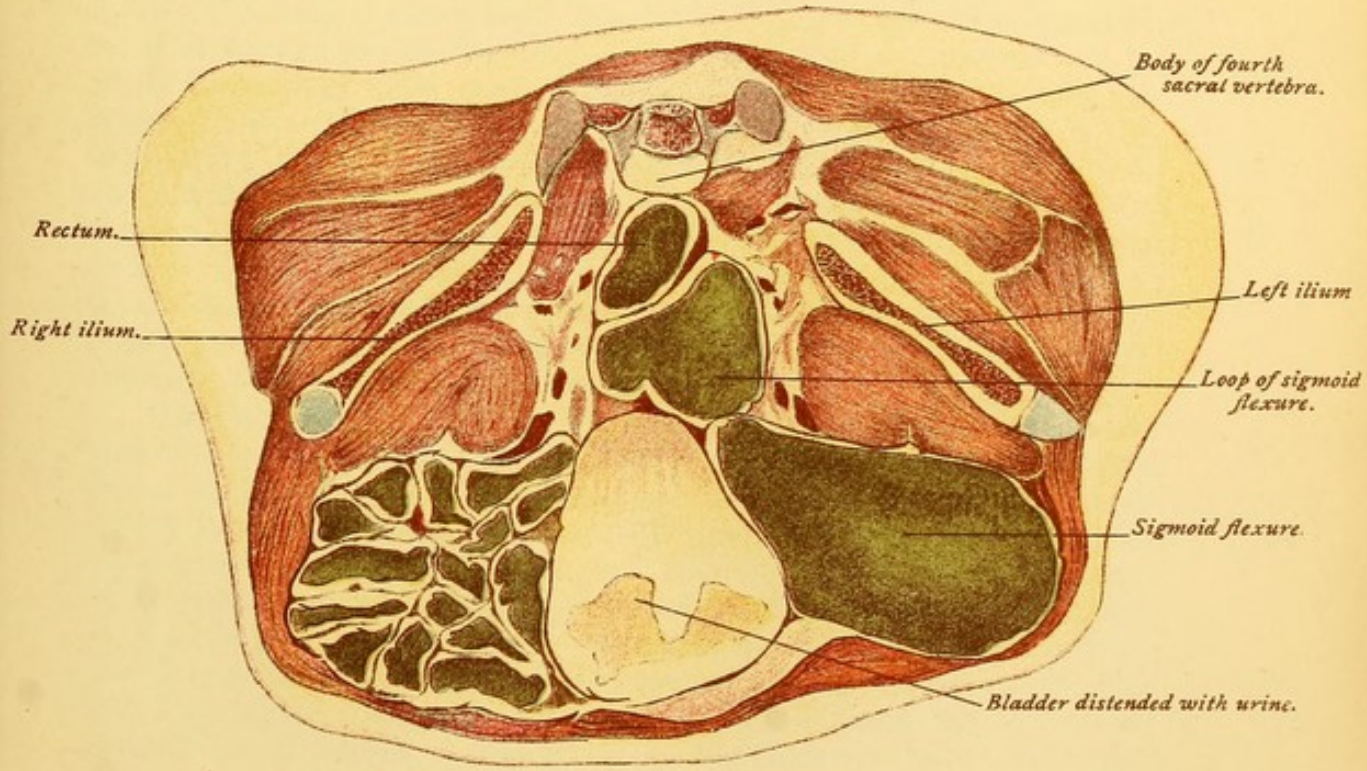


PLATE VIII.



intestine lay at a considerably higher point in the abdomen, and one, at least, in which it occupied the middle line immediately behind the umbilicus, positions which recall the changes which occur during development. It is probable that the cæcum, in the full-time fœtus, has not always reached its permanent position. The appendix vermiformis is well marked at this time in life; it comes off in a conical form from the cæcum; measures from 3 to 4 cms. in length; and has a thin mesentery attaching it to the bowel. The ascending colon may pass upwards to the under surface of the right lobe of the liver and form there a distinct hepatic flexure, but often its course is a very short one and the flexure very feebly marked. The transverse colon has not a direction so definitely transverse as in later life, and not infrequently forms a wide loop passing downwards towards the pelvic brim. The descending colon has a similar arrangement to that seen in the adult; but the sigmoid flexure is of relatively great length, and generally forms a large loop, part of which, in the male fœtus at any rate, lies in the posterior part of the pelvic cavity; there is often a rather long meso-sigmoid. The large intestine in the fœtus is distended with meconium. The length of the whole bowel is to that of the fœtal body as 570 : 100; in adult life the relation is as 450 : 100.

The supra-renal capsules (Fig. 18, Plate V.) are relatively large in the full-time fœtus, each being equal in size to one-third of the kidney. The weight of both together is from 7 to 8 grammes, and their relation to the general body-weight is as 1 : 400 (*circa*). According to O. Schäffer (*loc. cit.*, p. 532), the right capsule is larger than the left in the tenth month of antenatal life, while in the earlier months the left is larger than the right. They have the form of a triangular pyramid, and each rests upon the upper end of the kidney, covering it like a cap; the base descends upon the anterior renal surface as low as the level of the hilum, and is hollowed out to fit its convexity. The apex of the right adrenal lies between the liver and the right crus of the diaphragm, at about the level of the tenth rib; that of the left is wedged in between the spleen and the left diaphragmatic crus, at a point a little above the level of the eleventh rib. The posterior surface rests upon the diaphragm at the side of the vertebral column. Anteriorly the right adrenal comes into contact with the left inferior surface of the liver, and with its posterior surface; the left supra-renal gland is related to the spleen, stomach, pancreas, and small intestine.

The kidneys (Fig. 18, Plates V. and VI.) correspond in level with part of the vertebral column lying between the disc between the twelfth dorsal and first lumbar vertebræ, and that between the third and fourth lumbar vertebræ. In the full-time fœtus the left kidney is usually longer than the right, but this is not an invariable rule. Each weighs about 11 grammes; and their joint weight is to the general body-weight as 1 : 130 (*circa*), in the adult it is as 1 : 225. The hilum lies at the level of the second lumbar vertebra. In the full-time fœtus the renal lobulation is still evident, but is not so marked as in earlier antenatal life. The kidneys have much the

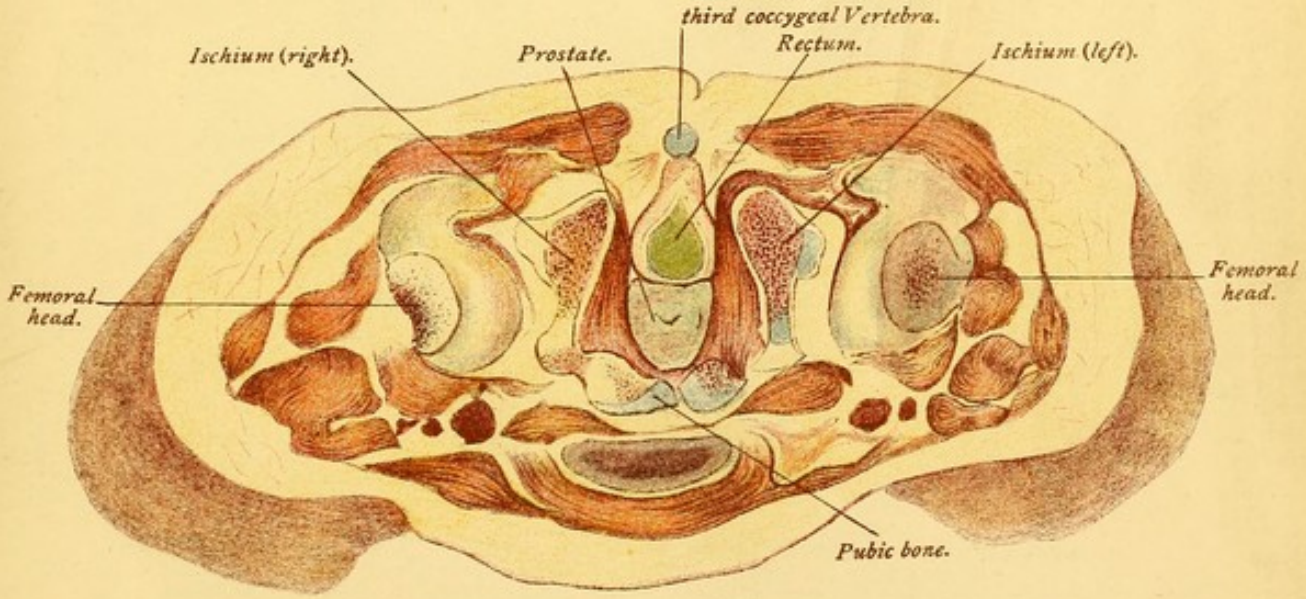
same relations with other viscera, save in so far as they are more extensively covered by the supra-renal capsules. The ureters pass downwards and inwards forming a curve, with slight convexity towards the middle line, and open into the bladder at or immediately above the pelvic brim. The relation of the ureteric openings to the plane of the brim is due to the fact that in the fœtus the bladder (Plate VIII.) is almost entirely an abdominal organ. In the case of two full-time male fœtuses (examined by me) in which the bladder contained urine, a small part of the posterior lower portion lay below the brim; in three full-time female fœtuses, in which the viscus was empty, an almost inappreciable part lay below the brim. The position of the upper end of the bladder varies with the degree of distension: when empty, I have noted it about 2·5 cms. above the symphysis pubis, and when full as high as a few mms. above the umbilicus at one side thereof. The form of the empty bladder is simply that of a tube continuing the urethra; when moderately full it has an ovoid shape, the broad end being directed downwards and backwards; and when greatly distended, an ovoid with the broad end uppermost. The anterior vesical wall is in close contact with the anterior abdominal wall, and there is no intervening pouch of peritoneum. Posteriorly the peritoneum passes over the bladder wall, reaching in the male fœtus to a level immediately below that of the vesical orifice, and here comes into relation with the small prostate gland; in the female fœtus it does not descend so low posteriorly, its point of reflexion on to the anterior urine wall being above the level of the internal urethral orifice. The organs that lie posterior to the bladder in the male fœtus vary: in some cases a loop of sigmoid lies behind it; in other instances, some coils of small intestine; and in yet others, simply the rectum, the intervening pouch of peritoneum being empty.

The bifurcation of the abdominal aorta takes place opposite the third lumbar vertebra (Chievitz, *op. cit.*, p. 38). The umbilical arteries, in their curved course from their origin in the internal iliacs to the anterior abdominal wall, lie entirely above the plane of the brim; they are so large in the fœtus as to look like direct continuations of the internal iliacs, even of the common iliacs; in their abdominal part they are commonly called hypogastric arteries, and in their funic part, umbilical; the portion of each hypogastric which remains pervious after the readjustment changes of birth, is the superior vesical artery.

The Region of the Pelvis.

The region of the pelvis (Plates VIII. and IX.) is comparatively poorly developed in the full-time fœtus. It has been already noted that the bladder is an abdominal, not a pelvic, organ at this time of life, and the same statement has now to be made about the uterus, the Fallopian tubes, and ovaries; the reason is that the pelvis is not yet capacious enough to contain all the structures which afterwards lie within it.

PLATE IX


third coccygeal Vertebra.
Rectum.
Ischium (right).
Prostate.
Ischium (left).
Femoral head.
Femoral head.
Pubic bone.

The sacrum is quite straight, or has only a slight anterior concavity in the fœtus. Its wings are little developed, so that the length of the bone is greater than its breadth, dolichohieric, and the sacral index 76°; but, while this is the generally accepted statement, A. Thomson (*loc. cit.*, p. 372) has asserted that it is platyhieric with an index of 100°. The iliac bones have an almost inappreciable anterior concavity, and their angle of divarication is large. The pubic bones are stumpy, and the symphysis is short. The interspinous diameter of the false pelvis may be given as 5·5 cms., and the intercristal as 6 cms.

The fœtal characters of the true pelvis are interesting. The canal is somewhat funnel shaped, and the pelvic brim is very oblique to the horizon, a character due to the high level at which the promontory lies

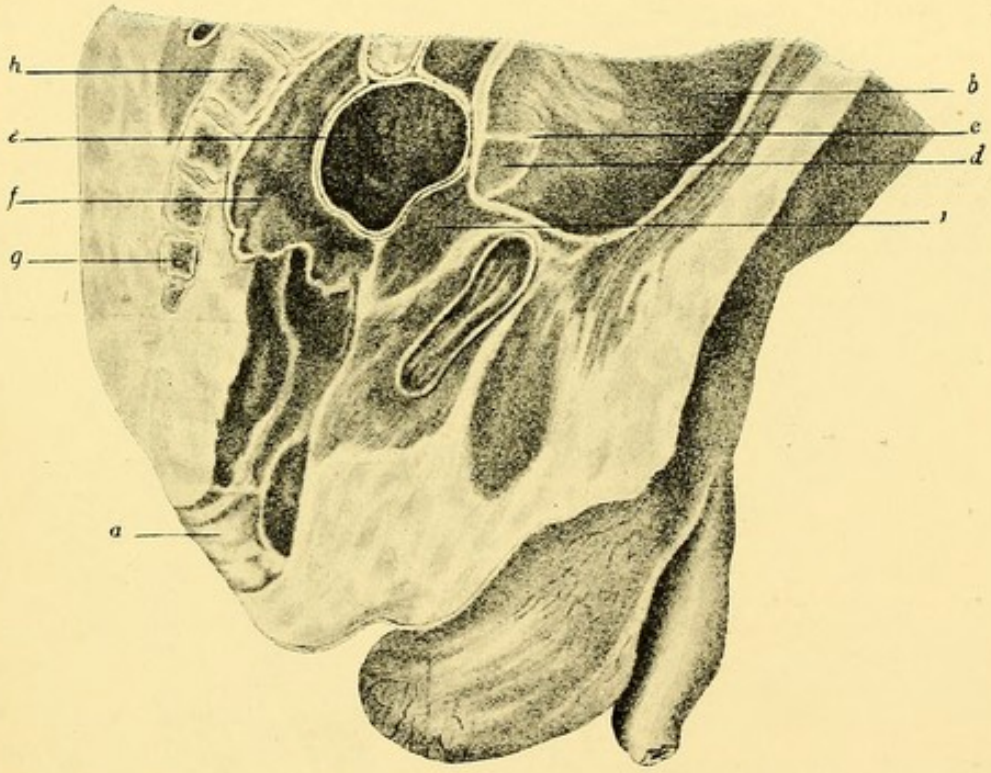


FIG. 21.—Vertical sagittal section of pelvic region of full-time male fœtus (section slightly to right of middle line anteriorly). *a*, Anal aperture; *b*, bladder, greatly distended with urine; *c*, opening of left ureter; *d*, vesical trigone; *e*, loop of sigmoid flexure in pelvis; *f*, rectum; *g*, coccyx; *h*, third sacral vertebra; *i*, prostate gland.

above the symphysis. The plane of the pelvic outlet is practically parallel to the horizon. With regard to the pelvic measurements in the fœtus, somewhat conflicting statements are to be found. It seems generally to have been accepted that at this time in life the antero-posterior diameter at the brim, instead of being less, is greater than the transverse; but both Sir William Turner and A. Thomson have found that the fœtal pelvis is platypellic, and does not, therefore, differ in this respect from the adult. In my own observations I found that while the diameter from the promontory to the symphysis had always a greater length than the transverse, that from the upper border of the third sacral vertebra to the symphysis (which more truly corresponds to the antero-posterior in the adult) was sometimes less than

the transverse, and only occasionally greater than the latter diameter. It must therefore be concluded that the antero-posterior diameter at the true pelvic brim is not constantly longer than the transverse in the fœtus. As a matter of fact I found the oblique diameter to be the longest at the brim. An interesting point in this relation, which has been emphasised by A. Thomson (*loc. cit.*, p. 368), is that even in

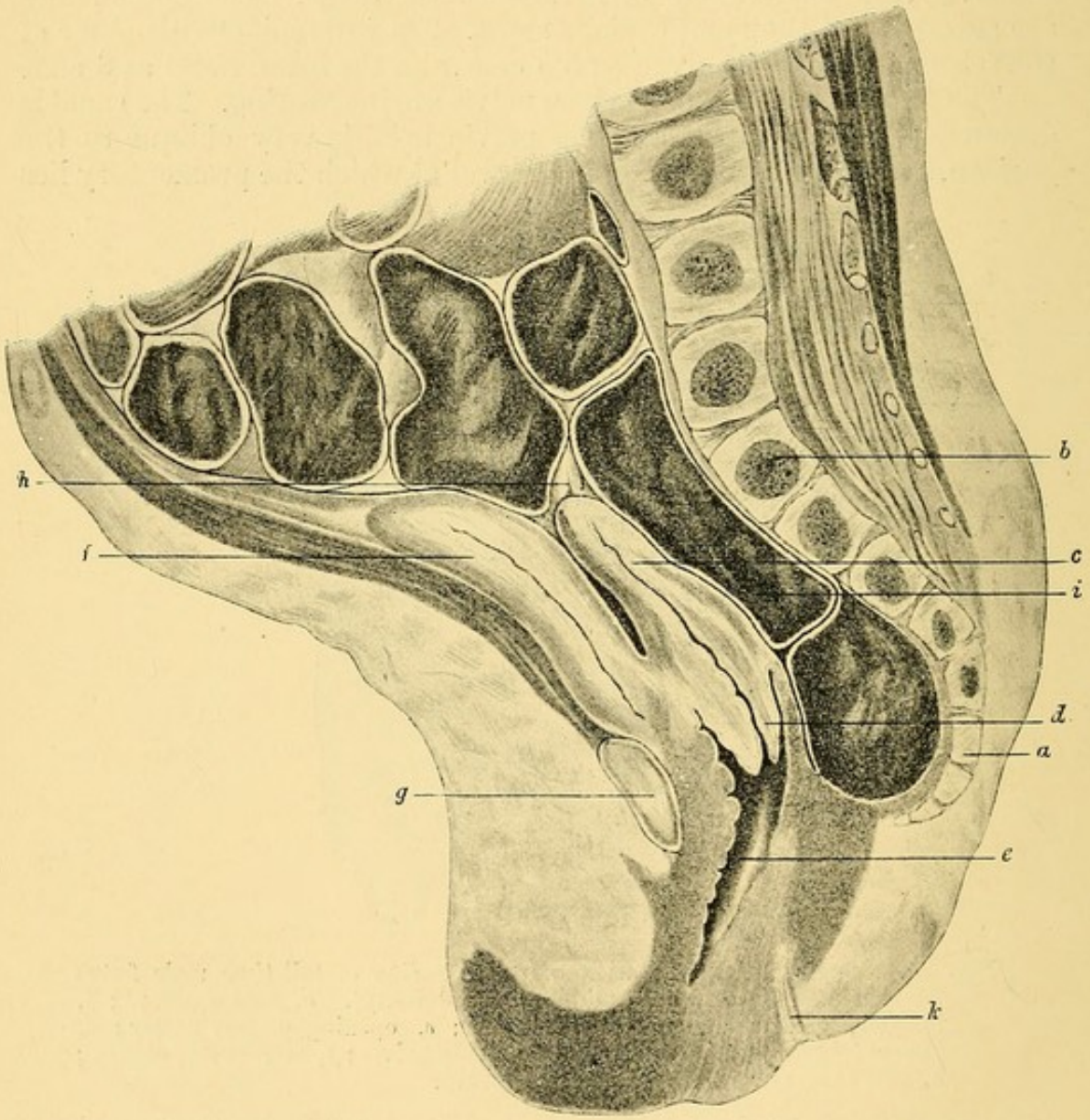


FIG. 22.—Vertical sagittal section of pelvic region of full-time female fœtus (frozen in genu-pectoral position). *a*, Coccyx ; *b*, first sacral vertebra ; *c*, body of uterus ; *d*, cervix uteri ; *e*, vagina ; *f*, empty bladder ; *g*, symphysis pubis ; *h*, right ovary and Fallopian tube ; *i*, rectum ; *k*, anal aperture.

fœtal life the pelvis shows in its diameters and other characters the peculiarities that distinguish the male from the female skeleton ; thus the male pelvis has a more funnel shape than the female, the ischial spines are more inturned (bi-ischial diameter in male fœtus, 12 mms., in female, 14 mms.), the sub-pubic angle measures in the male 50°, and in the female 68°, and the sacro-sciatic notch and hinder part of the ilium are narrower in the male than in the female. The last-

named point has a further interest, for Thomson believes that the increase in width of the pelvic brim and cavity which occurs in post-natal life is due not to transverse growth of the sacrum, but to growth of the posterior parts of the ilia, and that this holds for both sexes. It may therefore be concluded that the fœtal pelvis does not differ so much from the adult type as has been supposed, and that the sexual characters are all present before birth. In the adult the ilia are proportionately wider than in the fœtus; this is really the one outstanding character in which the fœtal pelvis differs from the adult, and it serves to account for the altered relations of the viscera.

The pelvic viscera in the male fœtus (Fig. 21) are the rectum, the prostate, and a loop of sigmoid flexure. The rectum is relatively larger and more vertically placed in the fœtus than in the adult; it is more nearly straight. The peritoneum descends in front of this part of the intestine to the level of the fourth sacral vertebra. The position of a loop of sigmoid flexure in the pelvis has been already referred to.

In the pelvis of the female fœtus (Fig. 22) the lower part of the uterus constitutes an additional content, but a certain part of that organ, with the ovaries and Fallopian tubes, lies above the plane of the brim and is therefore abdominal. From a third to fully a half of the entire uterine length lies above the brim; possibly the empty or distended condition of the bowel may account for variations. The body of the uterus generally lies forward upon the posterior aspect of the bladder; in one of the cases which I examined there was a certain amount of uterine torsion, so that the anterior surface looked towards the left as well as the front, a condition due possibly to the presence of a loop of sigmoid in the right lateral pouch of Douglas. The cervix uteri is relatively thicker and longer than the corpus; in the uterine interior the folds of the arbor vitæ are prolonged to the fundus; the os is not uncommonly gaping; and some rugæ may be seen on the vaginal aspect of the cervix, especially on the anterior lip. The Fallopian tubes (Fig. 23) measure about 2·5 cms. in the full-time fœtus, each has from three to five sinuosities on it, and each runs outwards, backwards, and downwards to the level of the pelvic brim (3). The ovaries, also, lie above the brim; they have an elongated, almost cylindrical form; and they show on section a very large number of ovi-sacs. The vaginal canal is another pelvic content of the female fœtus; in fact, in sagittal sections it appears as if it were almost

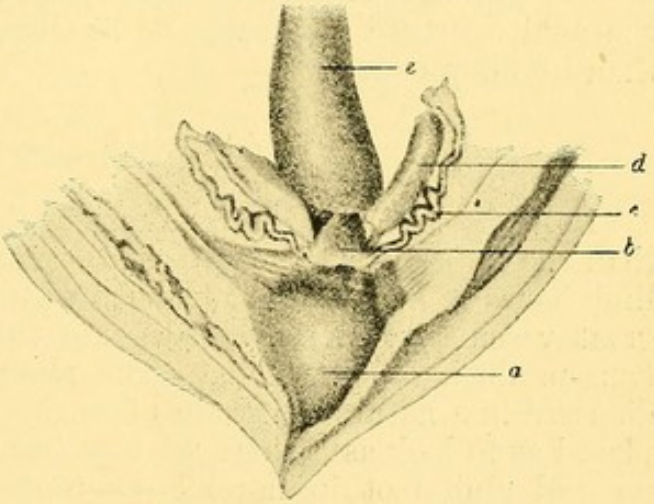


FIG. 23.—Dissectional view of pelvic viscera in six months fœtus from above and from the front. *a*, Bladder; *b*, fundus uteri; *c*, left Fallopian tube, showing tortuosities; *d*, left ovary; *e*, rectum.

the only pelvic content. It has a relatively great length; in its upper portion it has an almost vertical direction, but in its lower part it runs downwards and slightly forwards; and its walls are covered with numerous rugæ. The urethra in the female fœtus is about 4 cms. in length, and about 6 cms. in the male; in the former sex it terminates at the meatus urinarius externus, about 1 cm. in front of a line drawn vertically downwards from the lower border of the symphysis pubis. Between the meatus and the base of the clitoris may be seen a ridge, the male vestibular band (18). With regard to the external appearances of the pelvic end of the fœtus, it is to be noted that the external genital organs in both sexes are somewhat incompletely developed as compared with the later life. The labia majora, for instance, are relatively small, and therefore the labia minora and other parts are less concealed from view than in the adult. On account of the slight development of the gluteal regions in the fœtus, there is a lack of the distinct groove between the buttocks which exists in later life, and so the anal aperture may seem to be situated on an elevation rather than in a depression.

The Extremities.

Both the upper and lower limbs of the fœtus, but the lower more than the upper, are relatively small. Further, the ossification of the limb bones is not yet far advanced (Lambertz, *op. cit.*); but there is great vascularity in the cartilage, in the osseous tissue, and in the bone-producing periosteum. The marrow is red. The limbs are disposed in a natural attitude of flexion in utero, and the feet are so placed as to look as if there were *talipes varus*, but there is of course no real club foot in normal circumstances. The muscles of the fœtus are softer than those of the child or adult; and Chievitz (*op. cit.*, p. 12) has pointed out that they all pursue a straight course.

The Umbilical Cord.

The umbilical cord or funis is the organ of communication between the fœtal body and the fœtal part of the placenta. It is therefore a fœtal structure in its entirety, for even its sheath, which used to be regarded as amniotic in nature, is now known to be by development fœtal skin (Minot, *Human Embryology*, p. 362, 1892; Foulis, J., *Trans. Med.-Chir. Soc. Edinb.*, xix., p. 164, 1900).

The umbilical cord has an average length of about 20 inches (45 to 60 cms.), but it varies within wide limits. In thickness it is comparable to the little finger, but again there are wide differences in measurement; the degree of thickness will depend in great part upon the amount of mucoid tissue in its structure. It is white and cord-like in appearance, and through the glistening sheath the vessels are shadowed forth as bluish streaks. Like a cord of rope, it is rounded without being quite cylindrical, for it is twisted on itself. Looking from the fœtal umbilicus towards the placental end of the funis, it can be seen that in most cases the twist is from right to left over the

anterior surface of the cord, then round the left side to the posterior aspect, and from left to right over it to reach again the anterior surface; rarely the spiral is in the opposite direction. The various structures in the cord are not equally twisted, for the arteries are coiled round the vein (Tarnier), and the total number of twists varies from or two to twenty or even more, but the large numbers are pathological. Here and there on the cord may sometimes be recognised swellings or nodosities (false knots) due to localised excess of mucoid tissue or to torsion-anomalies of the vessels (Thoma, R., *Arch. f. Gynaek.*, lxi. p. 36, 1900). Many so-called explanations have been advanced to account for the twisting of the cord, but none of them has been generally accepted; all that it seems safe to assert is that the vessels grow faster than the cord as a whole, which, therefore, has to be disposed in a spiral fashion. The cause of the unequal rate of growth is unknown. The fœtal insertion of the cord (proximal end) has been considered: at its placental or distal end the funis is attached to the fœtal surface of the placenta at a point not quite corresponding with the centre of that surface, but lying a little eccentric to it; there the cord fuses with the fœtal part of the placenta, and its sheath becomes continuous with the amnion, covering the fœtal surface. The cord may simply lie beside the fœtus, within the maternal uterus (in the cavity of the amnion), or it may, especially if it be of considerable length, be disposed in the form of one or more convolutions round the fœtal body or limbs.

In the full-time fœtus the structure of the cord is comparatively simple. The sheath consists of a stratified epithelium: the outer layer of cells is corneous, and may show stomata; there is a middle layer of clear cells; and beneath that a basal layer of granular cuboidal cells (Minot). Before the fifth month the outer layer is made up of dome-shaped cells, and probably corresponds to the epitrichium of the skin. It may be said that the sheath of the cord is composed of skin, but skin which has not passed the stage which it reaches at the fourth month of intrauterine life. The fully developed epidermis of the fœtal abdomen extends for the distance of 1 cm. on to the cord, where it becomes continuous with the sheath; at the placental end the latter merges with the amnion covering the placenta. Within the sheath the vessels of the cord are held together by a mucoid or embryonic connective tissue, Wharton's jelly, as it is called; this consists of anastomosing cells and a muciparous matrix with connective tissue fibres (fœtal mesoblast); these parts (cells and fibres) tend to arrange themselves in a concentric fashion round the three blood vessels, forming more or less marked systems; and, where the systems touch, the cells are triangular in shape, columns of these cells being found in the funis. Embedded in the jelly of Wharton a group of epithelioid cells with irregular granular contents can usually be recognised; this represents either the yolk-stalk or the allantoic cavity of early intrauterine life, but which it is not quite safe to say. The vessels of the full-time cord are three in number, two umbilical arteries (allantoic in origin), and one umbilical vein (persistent left allantoic vein). The structure of the umbilical vessels is peculiar;

they are composed almost entirely of a middle or muscular coat, being therefore simply muscular tubes. There is indeed a tunica intima, but it is rudimentary in nature; and of the tunica adventitia there is no trace at all, the outer surface of the muscular coat passing insensibly into the surrounding Wharton's jelly. There is no elastic tissue, and the muscle fibres run in various directions, although the innermost layer shows a general longitudinal arrangement. Valves have been described in both the vein and the arteries; they are more constant in the latter than in the former, and are semi-lunar, or, more rarely, diaphragmatic in shape. The calibre of the vein is greater than that of the arteries, but the walls are of almost the same thickness; there are no vasa vasorum. There are no lymphatics in the cord; nerves have been described in it, but even if they are present they do not proceed far from the fœtal insertion. The funis will bear a weight of from 5 to 10 kilos. without breaking; rupture, when it occurs, is near to the placental end.

The Placenta.

By means of the umbilical cord the corporeal part of the fœtus is connected with the great extra-corporeal organ, the placenta. The placenta is in part fœtal and in part maternal in composition. The fœtal portion consists of the vessels of the cord, which have subdivided over and over again, and are spread out in an umbrella-like fashion over the mucous membrane of the uterus of the mother in that part of its area which is called decidua serotina or utero-placental decidua. On the one side (fœtal aspect) of this expansion of the funic blood vessels is the amniotic membrane, while on the other side (maternal or uterine aspect) is the chorion. But while the amnion forms a simple covering membrane for the placenta on the side next to the fœtus, the chorion is greatly expanded in a series of more or less branched processes, the villi, some of which serve as coverings for the subdivisions of the funic vessels, and others simply pass across the intervening intra-placental space to attach the fœtal to the maternal part of the placenta. Further, from the decidua serotina, processes or septa pass in the opposite direction across the intra-placental space towards the fœtal aspect and subdivide that space into compartments. In this way the intra-placental space is divided up into smaller cavities both by the attaching villi of the chorion and by the septa arising from the decidua; into these cavities or intervillous spaces hang the vascular villi. The contents of the intervillous space consist of maternal blood; the blood in the vessels of the villi is fœtal blood; and in this manner the maternal and fœtal blood are brought into close relationship but do not actually mix.

The life-history of the placenta is a short one, for it is formed at the third month and its existence ends with the birth of the fœtus; but in its short life it plays, as will be seen when the physiology of the fœtus is considered, a very important part. The full-time human placenta is a spongy mass, meta-discoidal in shape, measuring about

seven inches in diameter, and from two-thirds of an inch to one inch in thickness, and weighing about one pound. The side of this discoidal mass, which is directed towards the fœtus and liquor amnii, has a smooth and glistening aspect, being covered by the shining amniotic membrane; to this side of the placenta the cord is attached near to but usually not exactly at its centre, and under the amnion the funic vessels can be seen ramifying in all directions. The other side of the placenta (maternal aspect) has a very different appearance: it has a dark red colour, is very irregular on the surface; and here and there there are grooves or sulci which correspond to the decidual septa to which reference has been made, and which subdivide this side of the organ into lobules or cotyledons as they are sometimes called. These cotyledons, it must be remembered, are not primary but secondary formations in the case of the human placenta. At its margin the placenta passes insensibly into the membranes, chorion, and amnion, which meet together at its margin and form the rest of the bag of membranes which contains the fœtus and the liquor amnii. Near the periphery, but in the substance of the organ, is a more or less circular vein, which is connected with the maternal blood supply of the placenta. Before the birth of the infant the whole placental mass is attached usually to the anterior wall of the uterus; and the maternal aspect of the placenta after birth represents the part which has separated therefrom and still carries on it the torn through decidual tissue. Sometimes it is situated on the posterior or lateral wall, rarely on the fundus, and still more rarely on the lower part of the cavity of the uterus.

The blood supply of the placenta is a double one—fœtal and maternal. The fœtal vessels consist of the two umbilical arteries and the single umbilical vein which enter it at the insertion of the cord; they break up in its substance and pass deeply till their ultimate ramifications and twigs, arterial and venous, are found in the villi which hang in the intervillous spaces. The maternal vessels are branches of the uterine arteries and veins which have grown into the decidua serotina, and as it became changed into the maternal part of the placenta have enormously enlarged and extended. The arteries, which have been termed on account of their sinuous character the "curling arteries," open into the intervillous spaces; the veins arise also from these spaces, which indeed communicate not only with the veins of the muscular coat of the wall of the uterus but also with the circular vein of the placenta (coronary sinus, sinus of Meckel). It is still a matter of dispute and discussion whether the intervillous spaces are lined with maternal or fœtal tissue. According to one view, the spaces are really gigantic maternal capillaries lined with endothelium, into which the fœtal chorionic villi project and receive a covering of endothelium which lies upon the epithelium of the villi themselves; according to the other view, the spaces are formed in a tissue arising from a great proliferation of the fœtal epithelium covering the villi, in these spaces the maternal blood circulates, for they communicate freely with both the maternal arteries and veins, into them the villi hang covered by the chorionic epithelium, and

they are in great part lined not by the maternal vascular endothelium but by the fœtal epithelium. If the former view be accepted, there lie between the fœtal and the maternal blood (1) the endothelium of the fœtal vessels, (2) the chorionic epithelial covering of the villi, and (3) the maternal vascular endothelium of the intervillous space; if the latter be the correct view, there lie between the two bloods only (1) the endothelium of the fœtal vessels and (2) the epithelial covering of the villi. According to the researches of Duval, there is in the placenta of the Rodents still less separating-tissue between the maternal and the fœtal blood, for in it the villi hang without epithelial covering into the maternal blood in the intervillous space; while in the placenta of the Ungulata (mare and sow) there are three separating layers of tissue, fœtal endothelium of vessels, fœtal epithelium of villi, and maternal lining of intervillous space. If the second view of the human placenta be accepted, it follows that the organ in the human subject lies intermediate between that of the Ungulata and that of the Rodentia in respect to the amount of tissue which separates the maternal and fœtal blood.

Under the microscope, the villi of the full-time placenta are seen to be covered by a layer of plasmodium or protoplasm in which nuclei are embedded at irregular distances from each other; this layer is the syncytium. It is the fœtal epithelial covering to which reference has been made above. In the placenta of early intrauterine life there is a second layer of large nucleated cells with distinct walls lying below the syncytium of the villi; this has been called Langhans' layer; and it is also in all probability fœtal in origin. Langhans' layer disappears at an early stage in the life-history of the placenta. The syncytium is at first very active, and from it spring numerous buds of various shapes and sizes (proliferation-islands); in it also are to be seen clear or hyaline droplets which may become separated from it and float free in the maternal blood, and about the physiological significance of which there has been much discussion (*vide* Chap. X.). Under the epithelium of the villi is a very delicate connective tissue stroma; so delicate is this stroma in the terminal villi, that the capillaries may be said to lie immediately under the epithelium, and as the capillaries have walls consisting of little more than a single layer of endothelium, it follows that only a layer of endothelium and one of epithelium intervene between the blood in the fœtal capillaries and that of the mother in the intervillous spaces. During the three last months of pregnancy the vessels in the villi, more especially of the marginal part of the placenta, begin to show obliterative changes; there is thickening of the intima and also of the adventitia of the terminal and medium-sized arterioles, and in them the circulation therefore slows and ultimately stops, while the veins and capillaries are unaffected till the changes in the arterioles are completed. In this way the blood supply to certain groups of villi is diminished, and the syncytium soon shows atrophic changes, often in patches. Round the villi fibrinous infarcts form, and these are now regarded by some writers not as pathological structures, but as the natural results of the fact

that the placenta has reached the term of its active existence and is senile. In the maternal part of the placenta, senile changes also occur of the nature of thrombosis in the sinuses, and are associated with the appearance of "giant cells," which may originate the thrombotic conditions. In this manner, as has been pointed out in Chapter IV., p. 39, preparation is being made for the physiological readjustment of functions which takes place at birth.

The Membranes.

The umbilical cord and placenta are organs of the fœtus; they are functional necessities of fœtal life. On the other hand, the amnion in its whole extent, and the chorion and decidual membranes outside the placental area, are structures whose activities are largely past; they are carried on by means of the placenta into the fœtal period of antenatal existence, but their important part was played before the fœtal period began; they constitute the "membranes" of the full-term labour. The amnion is the inner of the two fœtal membranes, and forms a sac containing the fœtus, cord, and liquor amnii. It covers the fœtal surface of the placenta, and at the margin of that structure passes out on all sides to rest upon the chorion. It consists of a single layer of low columnar epithelium with stomata here and there, resting upon a stratum of wide-meshed young connective tissue with stellate and spindle-shaped cells. The connective tissue layer is the external of the two which go to make up the amnion, and it is in contact with the inner surface of the chorion, but is not firmly adherent to it. The chorion outside the placenta is no longer supplied with villi in the fœtal period of antenatal life; it is the chorion læve or smooth chorion. Its inner layer is young connective tissue with vessels; its outer layer consists of epithelial cells lying two or three deep and resting immediately upon the decidua (maternal), and this layer is probably continuous with Langhans' cellular layer over the placental chorion (or chorion frondosum). After the seventh month of fœtal life it would seem that the epithelium of the chorion læve consists solely of this cellular layer, there being nothing outside it corresponding to the syncytium or plasmodial tissue of the villi of the chorion frondosum or to its modification, the canalised fibrin.

The decidual membranes outside the placental area consist of the fused reflexa and vera of early intra-uterine existence; but at the full term of pregnancy they are little more than shadows of their former selves, in fact, it is doubtful if any recognisable trace of the reflexa exists. Through the disappearance of the reflexa the epithelium of the chorion læve comes into contact with the decidua vera. Part of the vera comes away with the fœtal membrane at the time of delivery, and part (containing most of the glands) remains to line the cavity of the empty uterus and form the new mucous membrane (post-partum regeneration).

The liquor amnii will be described more appropriately in the succeeding chapters (Fœtal Physiology).

CHAPTER IX

Physiology of the Fœtus: General Statements; Sources of Information; Fœtal Circulation, Extra-corporeal or Placental, Intra-corporeal with Main Current and Secondary Circulations; Cardiac Activity, Peculiarities; Pulse; Blood in the Fœtus, Characters; Respiration in the Fœtus.

I HAVE already indicated some of the outstanding features of the physiology of fœtal life, and have referred to the lack of well-established facts in connection therewith; but it is necessary—at least so it seems to me—to attempt a fuller exposition of the details of fœtal physiology, and at the same time still further to emphasise the lamentable defects in our knowledge of this department of biological study. In attempting to do the one, I shall doubtless succeed in accomplishing the other. The value of an accurate acquaintance with the facts of fœtal physiology in arriving at sound conclusions with regard to fœtal pathology and antenatal hygiene, is incalculable; but if it is at present unattainable, it is far better for the investigator of this subject to know it, for nothing is more dangerous and in the long run more disastrous than to draw deductions from data which are uncertain and inexact. Let us then consider carefully this question of Fœtal Physiology.

For all that was known of the physiology of the fœtus before the year 1885, we may turn with some confidence to the pages of Wilhelm Preyer's work—*Specielle Physiologie des Embryo: Untersuchungen ueber die Lebenserscheinungen vor der Geburt*—but since that book was published an immense mass of observations has been accumulated and is in great need of sifting. There is scarcely one of the scientific medical journals of France, Italy, and Germany which does not often add directly or indirectly to the number of articles dealing with one or other of the aspects of the physiology of antenatal life, and the extensive bibliographical list of 552 references given in 1885 by Preyer might now be more than doubled in length. There has been no lack of writing, then, upon this subject; but it may be confidently predicted that there will be much more ere the theme is exhausted, and the functions of intra-uterine life investigated and ascertained with any degree of completeness and accuracy.

Our knowledge of the facts of fœtal physiology rests upon observations—(1) upon the full-time fœtus during labour and immediately after birth; (2) upon prematurely expelled but viable fœtuses; (3) upon immature and non-viable fœtuses in abortion-sacs; (4) upon fœtuses of the lower animals, under (*a*) normal and (*b*) abnormal conditions;

and (5) upon infants affected with pathological states developed in utero, in so far as their pathology may throw light upon their physiology. Further, something is to be learned from the modifications in the physiology of the mother which occur during pregnancy, and which are undoubtedly associated more or less nearly with the changes going on in the fœtus; some information also is obtainable from a careful clinical examination of the contents of the maternal uterus (viz. the fœtus) during gestation. We must, further, be ready to apply to the study of fœtal physiology all the discoveries and advances made in connection with the physiology of the adult. With all these means of acquiring knowledge at our command, it might be expected that much would now be known of the functions of intra-uterine life; but the other side of the question must be remembered—the impossibility of studying, of seeing even the fœtus during its actual life in the uterus, the absence of exact information regarding the modifications of maternal physiology during gestation, and the still obscure and unsolved problems of the physiology of the adult. When, after much patience and great care and research, one problem of fœtal physiology has been in some degree cleared up, the first result has usually been to bring forward two or three subsidiary but equally difficult problems for solution. And so, as Preyer wrote almost with a ring of despair in his words, "hier reiht die Physiologie des Embryo Problem an Problem." Let us consider, first, the least difficult problem, that of the fœtal circulation.

The Fœtal Circulation.

During practically the whole of the fœtal period of antenatal life the circulation of the blood is the same. From the third to the tenth month the circulation is known as placental, and during the intervening months it undergoes no marked modifications. During the neo-fœtal period, it is true, the circulation is that of the chorion; but by the end of it there has been a specialisation of the circulatory function, and the blood, instead of being sent to villi over a wide expanse of chorionic surface, is now directed solely to those found over one part of it, that, namely, which is in contact with the decidua serotina, the site of the developing placenta. From the end of the neo-fœtal period onwards to the moment of birth, there is the circulation of the placenta (Fig. 24).

The essential peculiarity of the placental circulation is the sending of the fœtal blood out of the fœtal body to a specially prepared and extra-corporeal organ (the placenta) for purposes of oxygenation and other less understood chemical changes. This entails simply the presence of an efferent vessel (or vessels) to carry the blood to the extra-corporeal organ and of an afferent vessel to bring it back again. We may roughly compare it to a coal-pit connected with a railway system: to the pit there runs a line of rails along which trucks carrying cinders and rubbish pass, and along another line come back again the trucks filled with coal. But the presence of this accessory extra-corporeal system of vessels entails some slight modifications of

the circulation inside the fœtal body, for the blood coming from the placenta has to be distributed to the various parts of the body in such a way that all shall share in it but, some to a greater extent than others. To continue the comparison which has been instituted, the coal from the coal-pit has not only to be sent all over the railway

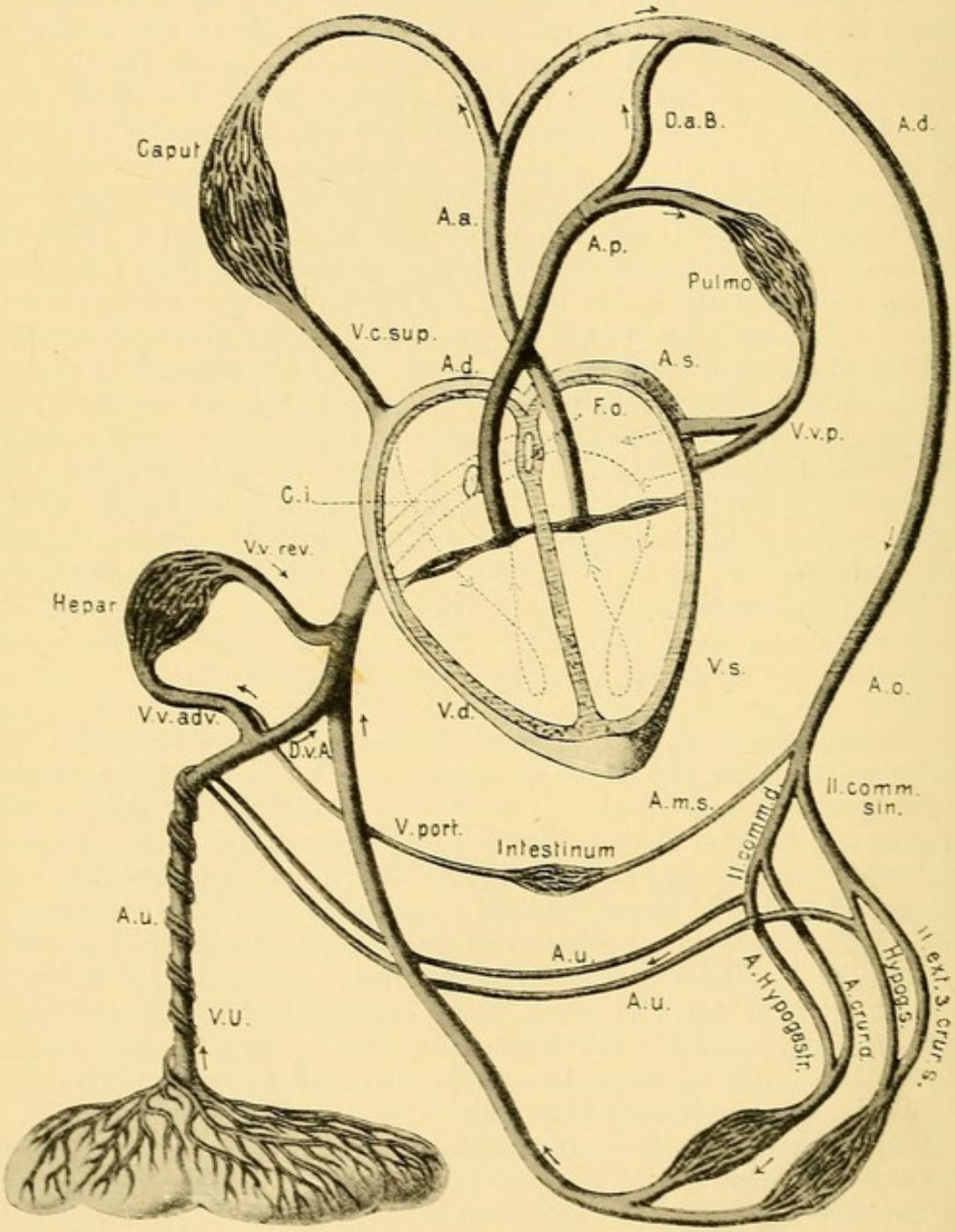


Fig. 24.—Scheme of fœtal circulation (after Preyer).

system, but it has to be sent in special amount and of a special quality to the parts where the traffic is most and the speed of the trains greatest; in order to carry out this object, special lines have to be laid and special depôts built. It will be convenient to consider first the extra-corporeal part of the fœtal circulation, and second the intra-corporeal.

The venous blood is carried from the fœtus to the placenta by the two umbilical arteries, each of which arises from the internal iliac artery of the same side. In the intra-abdominal part of their course they are known as hypogastric arteries, and in the extra-abdominal or funic part as umbilical arteries. Through them impure fœtal blood is transmitted to their ultimate ramifications in the capillaries of the villi, where it may be said to be brought, if not into touch with, at any rate almost within sight of, the maternal blood in the intervillous spaces. Having undergone arterialisation and other chemical and bio-chemical changes, the blood is returned by the ultimate branches of the umbilical vein to the vein itself, and thence through the umbilical cord to the abdomen of the fœtus. In this way venous fœtal blood passes to the placenta by means of two arteries, and arterial blood returns from the placenta by means of one vein. Why there should be two laterally originating arteries and one mesially situated vein to carry out the transit of the blood, is not clear; but fœtuses in which there is only one artery are generally malformed in various ways, and those in which the single artery is mesial in position, and arises directly from the abdominal aorta, are nearly always malformed in one special way, namely, show fusion of the lower limbs or sympodia (102). In the extra-corporeal part of the fœtal circulation, the venous and the arterialised bloods are kept separate; the blood in the arteries is venous, that in the vein is arterial.

The course of the intra-corporeal circulation of the fœtus is much more complicated than that of the extra-corporeal. It will be convenient to divide it, for purposes of description, into a main current which passes from umbilical vein to umbilical arteries, and into four secondary currents, which may be called hepatic, pulmonary, gastro-intestinal, and inferior appendicular, or simply A, B, C, and D.

The main current of arterialised blood coming from the placenta passes in the umbilical vein to the liver; here the first secondary current is given off, that, namely, which passes to the liver (hepatic or secondary circulation A), being joined by the blood returning in the portal vein from secondary circulation C (gastro-intestinal); the main current, however, passes on directly through the special vessel, the ductus venosus Arantii, to join the venous blood in the inferior vena cava which is returning from secondary circulation D (inferior appendicular), and to be joined by the return flow from secondary circulation A (hepatic). The main current, which now consists of the pure blood from the placenta joined by the impure blood from secondary circulations A, C, and D (hepatic, intestinal, and inferior appendicular), pours through the opening of the inferior vena cava into the right auricle of the heart, and is almost immediately directed onwards by the mechanism of the Eustachian valve through the foramen ovale into the left auricle. A quantity of blood, which is small at the beginning of fœtal life, but increases as the full term is approached, does not follow this course, but remains in the right auricle to join the main current again and pass into the right ventricle, of which more anon. The main current has now reached the

left auricle of the heart, from which it is propelled by systole through the mitral valve into the left ventricle, but prior to this it has been joined by the blood returning from secondary circulation B (pulmonary). The mass of blood in the left ventricle, consisting of the main current with the return blood from the four secondary currents, is now, under the influence of ventricular systole, sent on into the aorta by the aortic orifice, and distributed by means of the innominate and the left carotid and subclavian arteries to the head and upper limbs of the fœtus, a portion, however, passing on through the descending aorta to the rest of the body. From the head and upper limbs the main current is brought back to the heart in the vena cava superior, and enters the right auricle, where it is joined by the blood which did not pass through the foramen ovale, and they both pass by the tricuspid orifice into the right ventricle. From the right ventricle at the time of systolic contraction, the current passes into the first part of the pulmonary artery, and immediately gives off part of its circulating blood to secondary circulation B (pulmonary) by means of the right and left pulmonary arteries; but the chief part flows onwards directly through the ductus arteriosus into the aorta, where it is joined by some of the blood which had entered the aorta from the left ventricle. The main current, having been thus twice through the heart, passes first by the thoracic and then by the abdominal aorta to the lower part of the trunk; there part of it goes through the cœliac axis, and the superior and inferior mesenteric arteries to secondary circulation C; the remainder passes on into the two common iliac arteries, some of it (the now much diminished main current) going by the hypogastric and umbilical arteries back to the umbilicus, and so to the extra-corporeal (or placental) circulation, while the rest is distributed to the lower limbs as secondary circulation D (inferior appendicular).

Secondary circulation A may be described in a few words. Part of the arterialised blood from the placenta in the umbilical vein leaves the main current almost at once, and goes by the afferent hepatic veins (venæ hepatis advehentes) along with the blood in the portal vein to the substance of the liver; from the liver the blood returns by the efferent hepatic veins (venæ hepatis revehentes) to join the circulation in the vena cava inferior just before that vessel opens into the heart. It is evident, therefore, why the name "hepatic" has been given to this secondary current.

Secondary circulation B takes its origin from the trunk of the pulmonary artery, while the main current passes on by the ductus arteriosus to the descending aorta; it, however, passes to the lungs, but in small quantity, and, having circulated in the pulmonary capillaries, returns by the veins in a no less venous condition to the left auricle. No aeration of the blood is going on in the lungs in fœtal life, and this current might almost be dispensed with; but at birth pulmonary respiration begins and secondary circulation B suddenly increases in amount, and becomes of vital importance to the infant.

Secondary current C comes off from the main current in the abdomen, and passes by means of the cœliac axis and its branches,

and by the superior and inferior mesenteric arteries and their branches, to the stomach, pancreas, intestine, and spleen; from these viscera it is returned by the portal vein, *viâ* secondary circulation A to the main current in the upper part of the vena cava inferior. Like the pulmonary circulation, this secondary current (gastro-intestinal, as it may be termed) is of small importance in the fœtus, this being explicable by the comparatively inactive state of the stomach and intestines in antenatal life.

Secondary circulation D (inferior appendicular) is that which passes by the external iliac arteries and the continuations of the internal iliacs to the lower limbs and pelvis; the return is by the veins of the lower limbs and pelvis to the vena cava inferior, and so to the right auricle and through the foramen ovale to the left auricle. The blood in this circulation is of a markedly venous type.

It is evident, therefore, from what has been said, that the intra-corporeal fœtal circulation does not show that separation of venous from arterial blood which the extra-corporeal does, and which is also met with in the postnatal circulation. As a matter of fact, it is only in the main circulation, and in a very small part of it, that pure blood is found; no fœtal organ is supplied with pure blood fresh from the placenta. In the umbilical vein and in the ductus venosus the blood is of the best quality; but before it can reach the liver by secondary circulation A, it has been joined by the altered blood of secondary circulation C, and before it can reach the heart it has been joined by the depreciated blood of three secondary circulations, A, C, and D. It is unnecessary to subdivide the blood of the fœtus, as Preyer does, into nine varieties, each having its own degree of venosity; but the following general facts are worth remembering. Although no fœtal organ gets blood direct from the placenta without admixture with depreciated blood, the liver is privileged in receiving it nearly so, for its supply is mixed only with the return current from the gastro-intestinal circulation, which contains the results of the scanty digestive processes of antenatal life. The heart itself, the brain, and the upper part of the body, receive the next best blood; but in this instance the next best is much inferior to the best. The most venous blood is not that which returns to the placenta in the umbilical arteries; in fact that is placed fourth in order of merit by Preyer, who points out that it actually contains some of the blood of the umbilical vein which is unaltered, having passed through no capillary system. The most venous blood is that in the lower part of the vena cava inferior which is returning from secondary circulation D; and it is a striking fact that some of it (the most venous blood) is sent back again to the part from which it has come (lower limbs) without going to the placenta. So some of the best blood goes back to the placenta unaltered, while some of the most venous is sent round the circulation again without going back to the placenta. These peculiarities of the fœtal circulation—disabilities almost they may be called—suggest the conclusion that it is truly a temporary arrangement, so contrived as to pass very easily into the permanent circulation of postnatal life.

The transition, then, between the circulation of the fœtus and that of the infant is accomplished with comparative ease. It is unnecessary in this work, which deals particularly with antenatal pathology and physiology, to discuss fully the changes which take place in the circulation at birth; but some of the more important parts of the readjustment may be referred to. The essential change is the elimination of the extra-corporeal or placental circulation, and the introduction into the main current of the secondary circulations B and D (pulmonary and inferior appendicular). Through the closure of the foramen ovale, the blood in the right side of the heart can only reach the left side by passing through the lungs; so the secondary circulation B is taken into the main current. Through the stoppage of the flow of blood through the umbilical arteries, the main current in the lower part of the abdominal aorta can only return to the heart by passing through the capillary system of the lower limbs and pelvis; so the secondary circulation D is taken in. Further, secondary circulation A (hepatic) unites with secondary circulation C (gastro-intestinal) to form the single secondary circulation which is known as the portal system; in it, therefore, two sets of capillaries are met with (hepatic and intestinal) as indications of its original double character. The postnatal circulation, then, consists of a main current and a secondary current. The course of the main current is as follows: the blood in the inferior vena cava, as well as that in the superior vena cava, is poured into the right auricle; thence it passes through the auriculo-ventricular opening into the right ventricle; thence the current passes on by the pulmonary artery to the lungs, and, having traversed the capillaries of the lungs, is sent by the pulmonary veins to the left auricle; then the circulating fluid reaches the left ventricle, by whose systolic contraction it is propelled by way of the aorta to all parts of the body, returning from the various capillary systems by the superior and inferior cavæ. The single secondary circulation arises from the descending aorta; its current passes by the cœliac axis and its branches, by the superior mesenteric artery and by its branches, and by the inferior mesenteric artery and its branches, to the stomach, pancreas, intestine, liver, and spleen; it returns from the capillary systems of these viscera (with the exception of the liver) by means of the portal vein, which carries it to the liver, where it circulates through its second capillary system; it then passes, with the blood which has come to the liver by the hepatic artery, by means of the hepatic veins into the inferior vena cava, and so rejoins the main circulation.

There are, then, many remarkable differences between the circulation before and that after birth; and yet the transition from the one to the other is carried out with a strikingly small amount of structural change, strikingly small when the results are considered. Through the aspiration of blood to the lungs from the right ventricle, the current ceases or markedly diminishes in the ductus arteriosus, while that in the pulmonary arteries and veins very greatly increases; a permanent character is given to this change by the closure of the

ductus arteriosus. Through the return of a large quantity of blood from the lungs to the left auricle, the blood pressure in it is raised, while there is a fall in the pressure in the right auricle through a diminished return of blood from the placenta and the other parts of the fœtal body; the result is an equalisation of the pressure on the two sides of the foramen ovale, and the flow through it is checked; the result is made permanent by the membranous closure of the foramen. The physiological transition from the antenatal to the postnatal form of circulation is no doubt very rapid, but the anatomical transition may not be fully accomplished for some days or even weeks. Physiological closure of the ductus and the foramen happens first, and anatomical obliteration of their lumina follows later, along with the conversion of the umbilical vein and ductus venosus Arantii into the round ligament of the liver, and of the umbilical arteries into the vesical ligaments. It is therefore quite conceivable that much difference of medical and more particularly of medico-legal opinion should exist with regard to the time after birth when obliteration of these canals is normally completed, and should exist in association with the well-known fact that in most cases the canals are immediately closed in the physiological sense. Into the vexed question of the modus operandi of the anatomical obliteration of the ductus arteriosus, etc., I do not propose to enter; the theories have been many, and the facts as usual rather scanty, but they will all be found well set forth in P. Strassmann's article (*Arch. f. Gynaek.*, xlv. 393, 1894), and in G. Gérard's contributions (*Journ. de l'anat. et de la physiol.*, xxxvi. 1, 323, 1900). It may be remarked that Strassmann's valvular projection at the point of entrance of the ductus into the aorta, referred to in the preceding chapter (p. 112), has been regarded by H. Scharfe (*Hegar's Beitr. z. Geburtsh. u. Gynäk.*, iii. 368, 1900), as an artificial production. In the management of the infant at birth it seems reasonable, from what is known of the transition changes in the circulation, to allow the respiration to be well established before placing a ligature upon the umbilical cord.

Cardiac Action in the Fœtus.

The course of the circulating blood in the fœtus has been described; but the chief cause of its movement—the heart's action—has not yet been considered. It is now that a commencement is made with that part of the subject of fœtal physiology which abounds in problems—"problem upon problem." I now begin to make frequent use of the words "probably," "possibly," and "perhaps"; I lament the necessity, but in the meantime the necessity is real; about all the physiology of the fœtus, with perhaps the sole exception of the course of the circulating blood, these indefinite words will best express the knowledge which we possess. Here and there are scattered facts—in a wilderness of theories; about some things even theories are absent, none having yet been evolved.

In the case of the human fœtus, we can satisfy ourselves by careful auscultation of the mother's abdomen, that the heart is

active, for from the end of the fourth month of pregnancy its beat can be heard. But, further, from the sixth week of antenatal life, the cardiac action may be observed by means of the examination of early abortion-sacs. It may therefore be concluded that during the whole period of the fœtal life (sixth week to end of tenth month), the heart of the unborn is functionally active. It perfectly fulfils all the requirements of antenatal existence; at the same time its action differs in certain particulars from that met with in postnatal life.

In the first place, its activity is much less dependent upon the nervous system in fœtal than in postnatal life—its action is more distinctly automatic. This peculiarity has been over and over again demonstrated by the birth of fœtuses without brain or spinal cord (anencephalic and amyelic), whose heart, beat had been heard before birth, and seen at birth. Further, F. Neugebauer (*Centrlbl. f. Gynäk.*, xxii. 1281, 1898) has shown how long this automatic activity may continue. The case was a somewhat remarkable one: the fœtus, age fourteen weeks, was removed, by operation, from an extrauterine gestation sac; in the process, its head, arms, a leg, and the whole of its spinal cord were torn away, leaving only the trunk with one lower limb attached; yet the heart continued to beat in an automatic, rhythmical fashion for more than three hours; at first the rate was one beat every two seconds, but it gradually slowed until it was one every five seconds; the contraction was noted to be antiperistaltic, beginning with the ventricles and then extending to the auricles; and the movement of the cardiac apex was upwards, forwards, and to the right. In a somewhat similar case reported by Wasten and referred to by Neugebauer (*Centrlbl. f. Gynäk.*, xxiii. 465, 1899), the heart beat for two and a quarter hours. In E. Peiser's observation (*Centrlbl. f. Gynäk.*, xxiii. 1033, 1899), the fœtus was five months old; when its body was quite cold the thorax was opened, and Peiser was then startled to see "the interesting spectacle of the beating human heart" ("das interessante Schauspiel des schlagenden menschlichen Herzens"). The auricles contracted before the ventricles, and the right scarcely preceded the left; the apex was raised and turned towards the right. After twenty minutes the heart was separated from the great vessels and placed in a warm saline solution, where it continued to beat, but with less marked movements. Its activity continued for over an hour altogether. Observations of a like kind were made by E. Opitz (*Centrlbl. f. Gynäk.*, xxiii. 6, 810, 1899). The fœtal heart therefore has a very considerable degree of automatic activity.

In the second place, the fœtal cardiac activity is not so immediately dependent upon the oxygenation of the blood as is the heart's action in postnatal life. The blood in the fœtus, with the exception of that in secondary circulation A, is far from being well oxygenated. Even in the infant at the moment of birth respiration may not be established, and yet the heart may continue visibly to beat for some time, for hours even; cases in which an asphyxiated infant was resuscitated after the lapse of hours, will recur to the

mind of almost every obstetrician who has had a long obstetric experience. I have met with a case in which cardiac activity continued for five hours after birth without the lungs having come into play; the fœtus in this instance was the subject of a number of malformations. There is not, however, any evidence to show that the fœtal heart will continue to beat for anything like this time in the uterus after the death of the mother; as a matter of fact, there is little chance of saving the infant if the post-mortem opening of the maternal abdomen and uterus be delayed longer than five minutes. The circumstances, however, differ widely, and the rapid death of the fœtus after the death of the mother is not to be ascribed solely to defective oxygenation of its blood.

In the third place, it may be safely concluded that the events of the cardiac cycle are not so clearly marked off and so unalterable in their sequence in the fœtus as in the child or adult. For instance, in the observation of Neugebauer already referred to (*loc. cit. supra*), the contractions were anti-peristaltic, beginning with the ventricles and spreading to the auricles. Usually the auricles contract first, the right slightly in advance of the left; then there is a short pause; then the ventricles pass into systole, the right being immediately followed by the left; and then intervenes another pause, scarcely of greater duration than the former. The pauses are of nearly equal length; and the whole cycle lasts from 0·3 to 0·6 of a second, of which more than half is occupied with the ventricular systole. The impulse and the movements of the heart would seem to be the same as in postnatal life, if it be permissible to draw conclusions from the observation of the organ in fœtuses which have been expelled in abortion sacs.

In the fourth place, the fœtal heart rate is much quicker than the adult; but there is a gradation from the one to the other through the rate in the infant and in the child. In the early months of fœtal existence it has been supposed that the rate is slower than in the later months; but the heart sounds are not audible in the beginning of pregnancy, and therefore the estimation of the rapidity of action has had to be made from observations on fœtuses after their expulsion from the uterus, manifestly a method not free from fallacy. From the fifth month onwards to the full term, it seems well established that the fœtal heart beats at the rate of 132 per minute, or thereby, with, under certain circumstances, a slackening in rate down to 100 or less, or an acceleration up to 180 or more. Immediately after the birth of the infant there is, it is believed, a transitory increase in the cardiac rate, followed by a slowing, ascribed to the gradual development of the controlling influence of the vagus.

In the fifth place, the course of the blood through the heart is not the same in the fœtus as in the infant, and the quality of the blood passing through the various chambers also differs. In no chamber of the fœtal heart is there absolutely pure arterial blood, and that of the right auricle is little better (or worse) in this respect than that of the left.

There are other details in which the action of the fœtal heart

doubtless differs from that of the circulatory organ in postnatal life, but over them and other equally obscure matters we must not long linger. For instance, it may very well be that variations in the rate of the heart-beat do not depend upon just the same circumstances. Little is known about the influences which quicken and those which slow the fœtal heart; but (1) activity of the fœtal movements is generally, if not always, followed by increased rate of fœtal pulse; (2) increase in rate of the maternal pulse is sometimes associated with increase and sometimes with decrease in rate of the fœtal pulse; (3) the greater the size and weight of the fœtus, the slower, in a general sense, is its heart beat, but there is no constant relation between the two; and (4) the female fœtus has a quicker pulse than the male, possibly because, as a rule, she is of smaller size and weighs less. It is not known whether changes in the position of the fœtus in utero, *e.g.* from cephalic to pelvic presentation, or from cephalic to transverse, alter the rapidity of the heart's action; and very little is certain with regard to the effect of medicines or food given to the mother upon the fœtal pulse; and yet these are matters into which inquiry is practicable in maternity hospitals if not in private practice.

It is generally stated and believed that in the pains of labour the rapidity of the fœtal heart is diminished—to the extent of as much as ten beats in the minute. Various theories have been advanced to explain this supposed slowing of the heart; it has been ascribed to compression of the placenta by the contracting uterus increasing the pressure in the umbilical arteries, to the general compression of the fœtus by the uterus, to the compression of the fœtal cranium (*e.g.* by forceps) stimulating the vagi near their origin, and to stimulation of the vagi by the venous condition of the fœtal blood produced by the uterine contractions. Objections may be urged against all these theories, and with regard to the last, which is in some respects the most probable, it has to be noted that the interference with the supply of oxygen to the nerve centres in a labour pain must be of a trifling nature. Indeed, Pestalozza (*Rassegna d. sc. med.*, Modena, vi. 405, 473, 1891) has calculated how much oxygen would be required by the fœtus during a labour pain, and has found it to be so small as to give no support to the above view. There is, however, no need for further discussion of this matter, for it is admitted that the supervention of a uterine contraction may not in some cases be followed by slowing, but by acceleration of the fœtal heart. In this relation Pestalozza's cardiogram, obtained while the fœtus was still in utero, deserves a paragraph to itself.

It has now and again been noted that the fœtal heart could not only be heard but be actually felt through the mother's abdominal walls, by the obstetrician during labour. Some seven cases of this kind, including two original ones, were published by D. F. Duval (*Johns Hopkins Hosp. Bull.*, viii. 207, 1897) four years ago, in all of which, through the fœtal presentation being a brow, a face, or an occipito-posterior one, the chest of the infant was brought into close contact with the anterior uterine wall, and through it with the

anterior abdominal wall; in these cases the fœtal heart was felt by the obstetrician's finger and its rate ascertained. Duval, however, does not refer to the important case reported by Pestalozza (*loc. cit. supra*), in which not only was the fœtal heart-beat felt through the maternal abdominal wall, but a cardiographic tracing of it obtained. The case was one of a twin labour, and during the expulsion of the first fœtus, the second one, which was lying transversely with its back to the mother's back, was pushed forward against the anterior uterine wall to such an extent that its heart-beat could be distinctly felt in the upper part of the maternal abdominal wall on the right side. The rate was 140 per minute. With the Dudgeon sphygmograph, the only instrument available in the emergency, three tracings were obtained, two between pains and one during a contraction; of the two taken between the pains, one was during ordinary respiration and the other was while the patient held her breath. At the time when the cardiograms were taken, the membranes of the second infant were still intact, but there was not much liquor amnii; the uterine and abdominal walls were thin, a circumstance which helped to make the observation possible. The tracings showed a rapid rise of pressure to the apex (opening of semilunar valves), followed not by a sudden decrease of pressure, but by a continuance of it ("platform"), and then by a descent to the base line, a fact which may be interpreted as proving that the blood does not get very quickly or easily out of the ventricles. It is noteworthy that in the cardiogram taken during a uterine contraction there was no slowing of the rate of the heart's action. Pestalozza was able to add greatly to the value of his unique tracings, by taking cardiograms of a new-born infant which had not respired, but which was not yet in a state of true asphyxia, of an infant in a condition of true asphyxia neonatorum, and of an infant in whom respiration had been fully established. In the state of simple apnœa the cardiogram exactly resembled those obtained from the fœtus in utero; in that from the asphyxiated infant there was slowing, irregularity, and a broader "platform" in the tracing; while in that from the infant in whom respiration had been established there was a complete loss of the fœtal characters and an assumption of the adult type. Too much reliance must not, of course, be placed upon the evidence obtained from so few observations; but it may in the meantime be provisionally maintained that the human fœtus has a cardiogram which differs from that of the new-born infant which has respired, and that its characters are those shown in Pestalozza's tracings.

It may here be noted that it has been generally believed that the pulse in the new-born infant, and in the fœtus also it is presumed, is one of very low tension, and exhibits no proper apex or wavelets. Indeed, it has been stated that no apex develops till the seventh year and no dicrotic wavelet till the tenth, and this statement I accepted and repeated in my work, *An Introduction to the Diseases of Infancy* (l., p. 163). I now reproduce here two sphygmographic tracings which my friend Dr. Oliphant Nicholson has recently obtained, one from

an infant five minutes old (Fig. 25) and the other from a child of six days (Fig. 26), both in perfect health; it will be noted that in both there is relatively high tension, a well marked apex, and tidal and dicrotic wavelets. It may therefore be concluded that, with a delicate sphygmograph and sufficient care in employing it, such tracings are ob-

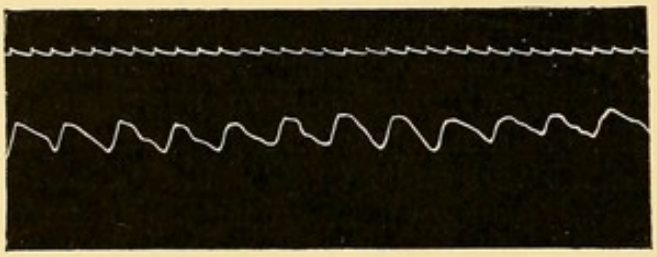


Fig. 25.

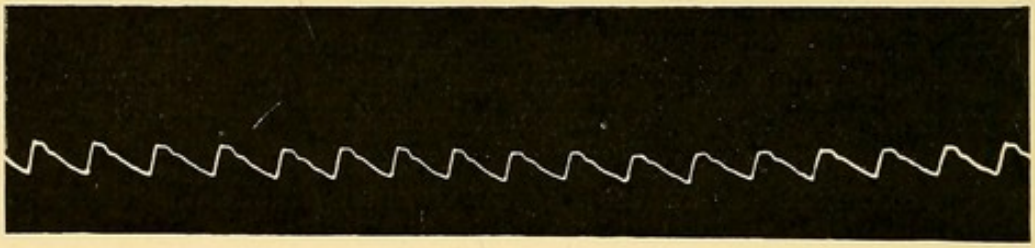


Fig. 26.

tainable from the pulse of the normal new-born infant. No sphygmographic tracings have yet been obtained from the fœtus in utero (membranes unruptured), and it is difficult to imagine conditions in which they could be taken; but the sphygmogram of an infant born prematurely at the seventh month shows a more sloping line of ascent to the apex.

In the chapter which deals with antenatal diagnosis, a further reference will be made to the auscultation of the fœtal heart, and so-called funic souffle.

The Blood in the Fœtus.

Our knowledge of the characters of the blood of the fœtus is in great measure founded upon the examination of full-time infants at or soon after birth; to a small extent only have observations of the blood of prematurely expelled fœtuses been utilised in the research—a regrettable neglect. Let us consider, first, the histological and chemical characters of the blood of the fœtus, and second, its mode of formation or hæmatopoiesis.

The blood of the fœtus, just like the blood of the adult, is made up of corpuscles and of plasma, and the corpuscular elements are of two kinds, red and white cells.

During recent years a good many valuable observations have been made upon the red corpuscles of the fœtal blood, and I may cite specially the work of Elder and Hutchison (*Trans. Edinb. Obst. Soc.*, xx. 154, 1895), of Bidone and Gardini (*Arch. ital. de biol.*, xxxii. 36,

1899), of Ferroni (*Ann. di ostet.*, xxi. 791, 1899), of Sfameni (*ibid.*, xxi. 851, 1899), and of Varaldo (*Arch. di ostet.*, vii. 723, 1900). From these and from earlier investigations on this subject it may be concluded that the red corpuscles are more numerous in the blood of the fœtus than in that of the adult or child. But there is no general agreement as to how much more numerous they are, although it may be stated roughly that the infant at the moment of birth has from one half to a million more red corpuscles per c.mm. than an adult. It is worthy of note, however, that the difference in this respect between the fœtal blood and that of the mother is usually much greater than that between the former and the blood of a non-pregnant adult; for the maternal blood in pregnancy is poor in red cells, and consequently the difference between the number of corpuscles in the mother and her fœtus may amount to as much as two or two and a half millions per c.mm. in favour of the latter. The number of red corpuscles in the fœtal blood may then be put at from six to six and a half millions per c.mm. In premature fœtuses (seven to nine months) the number of xanthocytes rises still higher and is commonly above seven millions per c.mm.; and Bidone and Gardini (*loc. cit.*) have met with a case, an eight months fœtus, in which there were no less than 8,240,823 per c.mm. As the number of red corpuscles in the maternal blood is not greater in the early part of pregnancy, it follows that the disproportion between the corpuscular richness is more marked for premature than for full-term fœtuses; there is a difference of more than three millions in favour of the fœtus (Ferroni). It is a remarkable fact, that even when the mother is anæmic in excess of the ordinary anæmia of pregnancy, the red cells of the fœtal blood, although diminished in their absolute amount, are relatively little interfered with, so that in such cases the disproportion between the two bloods is intensified (Ferroni). From all these facts it may be safely concluded that fœtal blood in the three last months of antenatal life is peculiarly rich in erythrocytes, and that this richness is not directly related to the state of the maternal blood. What may be the significance of this persistent corpuscular richness of the fœtal blood, it is impossible to say with any degree of assurance, but it is noteworthy that in cases of cyanosis from congenital cardiac defects it is maintained long after birth.

In addition to the ordinary non-nucleated red corpuscles, the blood of the fœtus contains a certain number of nucleated xanthocytes (erythroblasts). They persist after birth, but only for a limited time (three days or so), when they average from 1 to 20 to 1 to 8 of the white corpuscles; but in pseudo-leukæmic anæmia of children and in athyria they may reappear in the blood. Some are mononucleated and others contain two nuclei (Varaldo). In premature fœtuses they are more numerous, and the younger the fœtus, the more numerous they are; this at any rate is probable, for it has not been definitely proved.

It may be added that in fœtal blood there are to be seen red corpuscles which stain either in whole or in part with methylene blue (young cells, probably), and others containing granules which stain

with Ehrlich's neutral red. It has also been stated that the xanthocytes differ in size and shape from those of adult blood.

The hæmoglobin of the fœtal blood, like the red corpuscles, is in excess of that in the adult, and greatly in excess of that in the maternal blood. As measured by Fleischl's hæmometer, it averages about 120° (Bidone and Ferroni), but may, especially in premature fœtuses, rise above 125°; it is thus about fifty-two divisions of the hæmometer higher than with the maternal blood. Further, as with the red corpuscles so with the hæmoglobin, an anæmic condition of the maternal blood does not affect the richness of the fœtal blood in this constituent to an appreciable extent, it simply exaggerates the disproportion already existing. It does not appear that the sex of the fœtus has any effect upon the number of corpuscles or the amount of hæmoglobin in the blood; and it has not been observed that there is any relation between the weight of the fœtus and the characters of its blood, an increase in weight not being accompanied by any increase in the number of erythrocytes or in the quantity of hæmoglobin (Ferroni). It may be interpolated here that there is some reason for supposing that a large quantity of erythrocytes and of hæmoglobin in the *maternal* blood in pregnancy is likely to be more often associated with male than with female fœtuses; but there is no evidence that the characters of the maternal blood in these respects have any relation to the weight and length of the fœtus. It is believed that fœtal oxy-hæmoglobin is more difficult to reduce than maternal, possibly because it has a different molecular constitution. G. Zanier (*Arch. ital. de biol.*, xxv. 58, 1896) has made observations on the resistance of the fœtal as compared with the maternal blood in the cow, and has found that it is distinctly greater in the former; but there is need for further research upon this as upon so many other points in the physiology of the fœtus. Some attempts have been made to ascertain the respiratory capacity of the fœtal blood at different ages, and Nicloux (*Compt.-rend. Soc. de biol. de Paris*, liii., p. 120, 1901) has found that from six months to the full term the capacity is practically the same; he estimated that the hæmoglobin of the blood of a fœtus of six and a half months, weighing 1320 grms., was capable of fixing as much oxygen as that of a fœtus at term weighing 3730 grms. In this important and fundamental property of the fœtal blood, therefore, there is little variation in the later months of antenatal life.

With regard, now, to the other corpuscular element in the fœtal blood, the white corpuscles, it has to be noted that they are also increased in number as compared with the adult state. According to Elder and Hutchison (*loc. cit.*), the leucocytes number nearly 18,000 per c.mm., or twice as many as are met with in adult blood; the excess of the white is relatively much greater than the excess of the red, there being in the infant at birth 1 white to 298 red, and in the adult 1 white to 500 red. They are also increased in the blood of the pregnant woman, but not to anything like the same extent. There is, therefore, marked fœtal leucocytosis. The white corpuscles are of various kinds, polymorphonuclear leucocytes, lymphocytes

(small mono-nuclear), large mono-nuclears or transitional forms, and eosinophiles; there are also cells with acidophilic and basophilic granules, although Elder and Hutchison saw none of the latter. Max Carstanjen (*Jahrb. f. Kinderhlk.*, 3 F., ii. 215, 1900) and others have attempted to estimate the relative proportion of the different forms of white corpuscles in the fœtus; and it would seem that the polymorphonuclears are more numerous than the lymphocytes, but that within a few days after birth they are practically equal, and that later still there is lymphocytosis; the transitional forms are perhaps more numerous than in the adult, but the eosinophiles are not relatively increased.

Such are some of the characters of the blood of the fœtus which have been established with a certain degree of probability; some other characters not so fully determined may be referred to. With regard, for instance, to urea, Cavazzani and Levi (*Ann. di ostet.*, xvi. 456, 1894) have found that apparently there is no correspondence between the quantity of this substance in the maternal and in the fœtal blood; further, the amount does not seem to be related to the development or sex of the fœtus, or to the age of the mother, but there is more urea in the fœtal blood, if the expulsive stage of labour has been short; the average quantity is 0·215 per 1000. Cavazzani, also, states that there is more glucose in the maternal than in the fœtal blood, a fact which would seem to show that even eminently soluble substances do not pass through the placenta from mother to fœtus or from fœtus to mother by the simple laws of osmosis. It may be that the placenta has a power of selection; in fact this is almost certain. Nucleon, or phospho-carnic acid, is a substance which has been lately shown by Sfameni to exist in the fœtal blood (*Ann. di ostet.*, xxii. 1009, 1900) to the amount of 0·2106 per cent.; its quantity does not seem to be influenced by the sex of the fœtus, or by conditions of the mother, but the greater the weight of the fœtus the smaller apparently is the quantity of nucleon in the blood. There is twice as much in the blood as in the placenta. The density of the fœtal blood (1060) is greater than of the adult, notwithstanding the fact that the former fluid contains slightly more water than the latter. The fœtal blood, also, is said to contain less water than the fœtal tissues; if this be true, it would seem to prove that the water of the tissues must come from some other source than the blood, possibly from the liquor amnii. As compared with adult blood, that of the infant at birth contains rather less mineral matters. The blood of the male fœtus contains more organic matters, but less water and less soluble and insoluble salts, than that of the female. Sfameni (*Ann. di ostet.*, xxi. 851, 1899), gives the average composition of fœtal blood as follows:—

Water	78·52 per cent.
Solids	21·47 ,,
Organic	20·72 ,,
Inorganic	0·74 ,,
Soluble salts . . .	0·62 ,,
Insoluble salts . . .	0·12 ,,

From the researches of Hugounenq (*Journ. de physiol. et de path. gén.*, i. 703, 1899) it would seem that from 50 to 60 per cent. of the total amount of iron in the fœtal body is in the blood.

Manifestly there is much to be done before the characters and composition of the fœtal blood can be stated with any degree of accuracy, and much more before the meaning of these characters and the bearing of the composition can be satisfactorily determined. At the same time, as has been shown, a beginning has been made. Another subject around which it must be confessed that much obscurity exists, is the mode of origin of the corpuscular elements of the blood in the fœtus. It would seem, however, that from the time of its formation until the full term, the fœtal liver plays a part in the formation of both the red and the white corpuscles; in this organ the blood pressure is low, the current slow, and nourishment abundant, conditions which favour its hæmatopoietic functions. O. van der Stricht (*Arch. de biologie*, xii. 199, 1892) has made a series of elaborate investigations on the formation of both erythroblasts and leucoblasts in the mammalian fœtus, and has found in the liver special hæmatopoietic capillaries in which are formed the white and red corpuscles. The white are not related in any way to the red; they have distinctive characters at all stages in their development. The red corpuscles originate from the erythroblasts by the expulsion or disappearance of the nucleus. In the spleen, also, erythroblasts and leucoblasts arise, the former in the splenic pulp, and the latter in the Malpighian corpuscles. Possibly there is a production of blood corpuscles in other territories in the fœtal body in which the blood pressure is low. J. Beard (*Anat. Anz.*, xviii., pp. 550, 561, 1900) is strongly of the belief that the thymus gland in its epithelial portion is the first source of leucocytes, that it is in fact the parent source of all the lymphoid structures in the body; according to G. L. Gulland, the white corpuscles already existing in the blood (original source uncertain) are caught in the reticular tissue of the fœtal lymphatic glands, and then begin to multiply there (*Journ. of Path. and Bacteriol.*, ii. 447, 1894). It is an interesting fact that Varaldo (*loc. cit.*) has found more leucocytes in the umbilical vein than in the umbilical arteries—there were on an average 4000 more leucocytes per c.mm. in the vein. This excess of leucocytes in the matrifugal as compared with the matripetal blood stream is very important, for it supports the view that there is a physiological migration of white corpuscles from the maternal to the fœtal blood. Varaldo also found that while eosinophilic leucocytes were met with both in the arteries and vein, and that while the blood of both gave the iodophilic reaction of Ehrlich, this reaction was more marked in the blood of the vein, and the leucocytes which contained iodophilic granules were more numerous in it. It would appear, therefore, that not only do leucocytes pass from the mother's blood to that of her fœtus to be retained in the fœtal body, but that these white corpuscles carry with them and in them certain substances whose precise nature is yet to be determined. Again, it may be said that the physiology of the fœtus presents problem upon problem.

Respiration in the Fœtus.

Respiration in the fœtus is a very different function from respiration in the infant and adult; it is carried out in the placenta instead of in the lungs, and the gases pass from maternal to fœtal blood, and not from the atmosphere to the blood. The red blood corpuscles of the mother are the source of oxygen for the fœtus; they represent its atmosphere. Respiration by the placenta has sometimes been compared to respiration by gills, but the resemblance is incomplete and the comparison inexact. There is little need at the present time to enter into the reasons which can be adduced to prove that the placenta acts as lungs for the fœtus, once a greatly debated and uncertain question. Suffice it to keep in mind that (1) the matrifugal blood in the umbilical vein is more arterial in appearance (although the difference is often slight) than the matripetal current in the umbilical arteries; (2) respiratory movements in the fœtus are excited by interference with or stoppage of the circulation in the placenta; (3) oxy-hæmoglobin can be detected by the spectroscope in the blood of the umbilical vein; and (4) that experiments upon animals have definitely proved the occurrence of the placental gaseous interchanges in them which constitute respiration. Further, it has been shown that the current may occasionally be reversed, and that oxygen may pass from the fœtus to the mother; this has been noted in asphyxia of the mother animal, in which case the blood of the umbilical vein has been observed to become more venous in appearance than that of the umbilical arteries; the commencement of artificial respiration of the mother restored the colour of the blood as at the first. There are, however, many other questions concerning fœtal respiration about which little or nothing is known; some of these have been already referred to under the characters of the fœtal blood (*e.g.* the respiratory capacity of the fœtal blood), to others a few words may now be given. There is, for instance, the question whether the fœtus consumes much oxygen in a short space of time, or whether it absorbs little. Preyer (*loc. cit.*) is of opinion that it does not consume much, but that it is very dependent for its life upon what it does consume. Then there is the problem of the continuance of the heart's action for a long time without the establishment of pulmonary respiration, contrasting with its short continuance in utero after the cessation of the placental circulation (*e.g.* in death of the mother). Again, there is the great mystery of the mechanism by which the oxygen of the maternal hæmoglobin passes to the fœtal hæmoglobin, a mystery which is not greatly lessened by the knowledge that there is more hæmoglobin in the fœtal than in the maternal blood, or that the oxy-hæmoglobin of the fœtal blood is a more stable compound than that of the maternal. Some further problems have been already referred to in Chapter IV., namely, the cause of the first inspiration, and the meaning of the occurrence of intrauterine respiration (vagitus uterinus); but a word must be said

in passing concerning the observations of Ferroni on the rhythmical movements of the fœtus still in utero. Ferroni (*Ann. di ostet.*, xxi. 897, 1899) has found that in addition to the rotatory or revolutionary movements of the fœtus, and those due to extension and flexion of the limbs and trunk, there are others of a rhythmical kind of which tracings can be obtained by means of a graphic apparatus. These movements, which occur at any rate in the three last months of fœtal life, had been previously observed by Mermann, Ahlfeld, Reubold, Weber, Bar, Pestalozza, Duci, and others; and various theories had been advanced to explain their nature. Ferroni agrees with Pestalozza and Duci in their division of the movements into two groups, in one of which the tracing shows sharp elevations and depressions, while in the other it exhibits nothing more than a series of undulations. In the former tracings, the elevations, sometimes with a sharp apex and sometimes with a blunt, are followed by pauses, while in the latter the undulations are practically continuous. The frequency of the former is from 15 to 34 per minute, and of the latter from 40 to 75 per minute. They are not pathological phenomena, for the mothers and also the fœtuses were generally found to be perfectly healthy. Both kinds of tracings are doubtless due to rhythmical movements of the fœtal thorax, and not to transmitted pulsations of the maternal aorta; the former are possibly of the nature of singultus (clonic contractions of the diaphragm), while the latter are supposed to be intrauterine respiratory movements (superficial and regular). Sometimes the two kinds have been found combined in one tracing. From the present standpoint these movements are of interest as proof that even before birth the fœtus makes respiratory movements, practises, as it were, thoracic gymnastics in preparation for the great extrauterine function of atmospheric respiration. Whether these movements are powerful enough to draw liquor amnii into the lungs or stomach, must be left for the mean time uncertain; but there can be no doubt that movements of a similar kind are set up immediately after the expulsion of the fœtus from the maternal passages, and have as their result the drawing of air into the lungs. There is here, then, further proof that nature makes no leaps ("non facit saltus"), but prepares beforehand for the transitions of life and even for those of them which seem at first sight so abrupt as does the establishment of pulmonary respiration in place of placental. She makes the necessary transitions easy. Truly, birth marks not a beginning but a stage in life's journey.

CHAPTER X

Physiology of the Fœtus (*cont.*): Temperature of the Fœtus; Chemical Composition of Fœtus, Placenta, and Liquor Amnii; Nutrition of the Fœtus, by Liquor Amnii, Umbilical Vesicle, and Placenta; Secretions of the Fœtus, Hepatic, Buccal, Gastric, Pancreatic, etc.; Excretions of the Fœtus, Intestinal, Renal, Placental; Passage of Substances from Fœtus to Mother; Internal Glandular Secretions in Fœtus, of Thymus, Thyroid, Suprarenal Capsule, and Pituitary Body; Growth of the Fœtus, Determining Factors; Movements of the Fœtus; Sensation in the Fœtus.

THE functions of circulation, blood-formation, and respiration in the fœtus, have presented, as has been shown, many difficult questions for solution; but yet more difficult ones are bound up with the phenomena of antenatal tissue metabolism, secretion, excretion, and innervation. There is, for instance, the nutrition of the fœtus, about which Lobstein wrote that it was "less hypothetical than the subject of generation, but not perhaps in a much more satisfactory state"; and these words, which were penned nearly one hundred years ago (*Dissertation sur la nutrition du fœtus*, Strasbourg, 1802), might almost be repeated at the present time, for although observations have been multiplied, of actual facts there is no great abundance. A century ago there were those who held that the nourishment of the fœtus was accomplished by means of the liquor amnii, but did not know whence it came; there were also those who believed that it was brought about by a communication between the placenta and the wall of the uterus, but did not know how the communication took place; and there were those who ascribed it to the lymphatic vessels of the umbilical cord, but were not sure that these vessels existed. Lobstein's criticism might, with a slight change in terminology, be directed against the teachers of obstetrics of to-day. Nevertheless, there has been progress. Let us see.

Temperature of the Fœtus in Utero.

The observations which have been made, many of them with great care, upon the temperature of the fœtus in the uterus, or in the act of expulsion from the uterus, throw a somewhat unexpected side light upon the problem of tissue metabolism in the unborn infant. These observations include the experimental work upon fœtal rabbits and guinea-pigs, carried out by Runge and Preyer (*op. cit.*), as well as the estimation of the rectal and buccal temperature in the human subject during and immediately after birth, made by Schaefer, Schröder,

Wurster, and more recently by Vicarelli (*Arch. ital. de biol.*, xxxii. 65, 1899). There are two aspects of this subject which may be considered: the first is the relation of the maternal temperature to that of the fœtus; and the second is what may be called the temperature proper to the fœtus itself. It is necessary to look at both these aspects.

It has been found, chiefly by experiments upon animals, that the temperature of the fœtus falls and rises according as the mother animal loses or gains heat. In the human subject the increased rapidity of the fœtal heart in cases of fever in the mother probably points to the same relation. Further, as it is not easy for the fœtus in its secluded position in utero to lose heat, it may be concluded that its temperature will generally be above that of the mother. With a maternal temperature of 42° C., or slightly more, the fœtus will die; and even 40° C. will become a danger to it, for the reason that it doubtless means a higher figure for the infant in utero than for the mother. Of course the period of persistence of the high temperature must be taken into account, and it has been found that fœtal guinea-pigs and rabbits are able to support a temperature of 41° C. for two hours, and considerably higher temperatures for shorter intervals of time. It has been shown experimentally, also, that fœtal guinea-pigs support chilling of the mother animal very well, a fall of as much as 6° C. in half an hour not proving fatal. The fœtus, then, loses and gains heat easily and rapidly, and the conclusion drawn by Preyer is that it does not, while in utero, possess a heat-regulating mechanism.

With regard, in the second place, to the production of heat by the fœtus itself, a large number of observations has been carried out upon the human fœtus during labour—a thermometer being placed in the anus in breech presentations and in the mouth in face cases, while another (curved) thermometer was inserted into the uterus, or simply put into the vaginal canal. The result, briefly stated, of the experiments has been to prove that the living fœtus constantly possesses a higher, but only a slightly higher temperature than the containing uterus and than the vagina. The difference has not been found to be great—on an average from one to two-tenths of a degree Centigrade; but it was practically constant in favour of the fœtus. The temperature of the liquor amnii has been found to be intermediate. In a dead fœtus, the thermometer in the cranial cavity (it was a case of craniotomy) showed a lower temperature than that of the uterus (Vicarelli, *loc. cit.*). Even the new-born infant, immediately after its expulsion, shows a temperature slightly higher than that of the mother's uterus; but soon thereafter there is, as is well known, a very striking loss of heat from exposure to the cold air, evaporation of water from the skin, etc. It is interesting to note that it has been found that there may be the difference of from two to three-tenths of a degree between the temperature of twins; further, well-developed infants have shown a slightly higher temperature than weakly ones. From all these observations it may be concluded with some degree of assurance that the fœtus in utero not only receives heat from the maternal parts, but is also to some extent a source of heat itself. The high temperature of the fœtus proves that metabolism is going on in

it, that there is a certain amount of tissue respiration going on, a conclusion which is strengthened by the fact that such products of oxidation as creatin, hypoxanthin, urea, uric acid, and carbonic acid, are found in it. Probably, as Preyer believes, fœtal oxidation is feeble; but it is certainly present. Possibly fœtal metabolism may be found to have much in common with the tissue-changes of hibernating animals. At any rate, there is, in this phenomenon of heat-formation in the fœtus, a further example of the curious blending of dependence upon the maternal processes and independence of them, which is so characteristic of the life of the unborn infant.

Chemical Composition of the Fœtus, Placenta, and Liquor Amnii.

The consideration of the chemical composition of the fœtus and its annexa, although not yet possible with completeness and accuracy, is nevertheless calculated to throw further side lights upon this so intricate subject of the nutrition of the unborn infant. In a matter with this degree of complexity and obscurity, all side lights, even if only rush-lights, are to be welcomed.

The fœtus, according to Fehling's tables, contains at the full term 74·4 per cent. of water and 25·6 per cent. of fixed substances, while in the adult body the proportions are 58·5 per cent. of water and 41·5 per cent. of fixed substances. As the steps of fœtal development are retraced, the amount of water in the fœtal organism increases, being 82·9 per cent. at the eighth month, about 83 per cent. at the seventh, about 86 per cent. at the sixth, from 89 to 90 per cent. at the fifth, about 91 per cent. at the fourth month, and 97·5 per cent. at the sixth week. In fact, as has been pointed out by Fehling, the fœtus at the second month of antenatal life (neofœtal period) contains a larger proportion of water than the blood, mucus, and milk, and indeed resembles lymph in this particular. With regard to the mineral constituents, there is an increase during fœtal life from 0·001 per cent. of the total weight at the sixth week to 2·55 or 3 per cent. at the full term. The fat increases from 0·57 per cent. at the fourth month to 2·44 per cent. at the eighth month, and 9·1 per cent. at the full term; and the albuminous substances from 4·87 per cent. at the fourth month to 11·8 per cent. at the full term of pregnancy. These figures cannot be taken as in any sense final, as the number of analyses made is still very small, and each chemical constituent would require to be taken by itself and carefully investigated under different conditions as to nutrition, etc. Some work of this kind has been done; for instance, Thiemich (*Centrlbl. f. Physiol.*, xii. 850, 1899) has endeavoured, in the case of fœtal dogs, to ascertain the influence of the nourishment of the mother upon the fat of the fœtus, and has found that the kind of fat given in the food does not apparently affect the fat of the fœtus; he concludes that the fat of the fœtus is not at all, or only in small part, derived from the fat of the food given to the mother-animal. L. Hugounenq, also, has specially carried out a series of researches on the mineral constituents

of the human fœtus and new-born infant (*Journ. de physiol. et de path. gén.*, i., p. 703, 1899; ii., pp. 1, 509, 1900), and has elicited some interesting facts. The fœtuses cremated varied in age from four and a half months to full term, and were eight in number. It was found from these analyses that the fixation of mineral elements was little marked in the beginning of antenatal life, and very marked towards the end of it; that, as a matter of fact, the global weight of salts fixed in the three last months of pregnancy was about twice as great as that in the six first months; and that at the time of birth the fœtus had subtracted about 100 grms. of minerals from the maternal organism. In a fœtus of four and a half months, weighing 522 grms., the ashes weighed 14·0024 grms., while in a full-time infant of 3300 grms. the weight of the ashes was 106·1630 grms.; in a fœtus of six months, weighing 1165 grms., the mineral constituents weighed 30·7705 grms. The great fixation of minerals in the three last months is therefore undoubted, if it is permissible to draw deductions from one series of estimations. The iron is an important mineral constituent, and was therefore specially investigated by Hugounenq. He found that its fixation-law was the same as that of the minerals generally, viz. twice as much was fixed during the three last months as during the whole preceding period of antenatal life. In the full-term fœtus the total quantity of iron varied from 0·383 to 0·421 grm. of Fe_2O_3, or from 0·268 to 0·294 grm. of the metal (about 0·397 per cent. of the ashes being Fe_2O_3). It was calculated that about 50 per cent. or 60 per cent. of the iron was contained in the blood and the rest in the tissues; of the tissue-iron most would be in reserve in some organ, *e.g.* the liver or spleen. It is supposed that this reserve iron is to make up for the lack of the metal in the mother's milk, for it has been observed that human milk does not in its mineral constituents exhibit the same parallelism with the ashes of the fœtus as does the milk of some of the lower animals, a parallelism which has been sometimes termed Bunge's law. An interesting comparison in tabular form of the mineral constituents of human milk and of a full-time human fœtus is given by Hugounenq, and may be reproduced here:—

	Fœtal Ashes.	Mother's Milk Ashes.
Anhydrous phosphoric acid (P_2O_5	35·28 per cent.	21·30 per cent.
Lime (CaO)	40·48 ,,	14·79 ,,
Magnesia (MgO)	1·51 ,,	2·87 ,,
Chlorine (Cl)	4·26 ,,	19·73 ,,
Anhydrous sulphuric acid (SO_3).	1·50 ,,	—
Peroxide of iron (Fe_2O_3)	0·39 ,,	0·18 ,,
Potash (K_2O)	6·20 ,,	35·15 ,,
Soda (Na_2O)	8·12 ,,	10·43 ,,
Anhydrous carbonic acid (CO_2).	1·89 ,,	—

The storing up of iron in the fœtus during the third trimester of pregnancy is accompanied by a diminution in the maternal reserve of that metal. This, at any rate, has been proved for the guinea-pig by

Charrin and Levaditi (*Journ. de physiol. et de path. gén.*, i., p. 772, 1899). These observers found no appreciable difference in the iron constituents of the liver in the pregnant animal, but in the spleen a diminution was demonstrable both chemically and histologically. The fœtal hypersiderosis is accompanied, therefore, by a maternal hyposiderosis; and it may be remarked in passing that it is possible that this state of the mother in pregnancy may predispose her to anæmia and greater liability to infection.

A few words must now be said regarding the other mineral constituents of the fœtus, and we still make use of the analyses of Hugounenq (*loc. cit.*). The following table gives the percentage amounts of the various substances for 100 grms. of ashes in fœtuses of different ages:—

Sex . . .	F.	F.	F.	F.	F.	F.	M.
Age . . .	4–4½	4½–5	5–5½	6	6½	Term.	Term.
Weight in kgs. .	0·522	0·570	0·800	1·165	1·285	2·720	3·300
Ashes in grms. .	14·0020	14·7154	18·3752	30·7705	32·9786	96·7556	106·163
CO_2 . . .	—	1·50	0·96	0·90	0·32	1·89	1·16
Cl . . .	8·99	9·91	8·59	7·75	8·53	4·26	4·54
P_2O_5 . . .	34·74	32·33	34·36	34·94	35·39	35·36	36·26
SO_3 . . .	1·46	1·27	1·80	1·78	1·46	1·53	1·23
CaO . . .	32·60	38·21	32·50	34·64	34·13	40·55	40·68
MgO . . .	1·74	—	1·58	—	1·17	1·51	—
K_2O . . .	9·12	1·21	8·28	7·21	8·45	6·20	7·56
Na_2O . . .	12·23	13·75	12·62	10·62	10·95	8·12	5·96
Fe_2O_3 . . .	0·43	0·33	0·40	0·39	0·38	0·39	0·40

The predominance of the soda over the potash is to be accounted for by the relative abundance of cartilage in the fœtus; and the marked increase in the potash in the last weeks is due to its presence in the red blood corpuscles and in striated muscle. In the second half of pregnancy the fixation of phosphoric acid shows inconsiderable variations; on the contrary, the proportion of lime increases greatly in the last month, so that at the end of antenatal life the fœtus assimilates more lime than phosphoric acid. Consequently, it follows that the unborn infant does not assimilate all its phosphate of lime in that form, but fixes first the phosphoric acid (as nuclein or lecithin), and then the lime. If the alkaline bases, the phosphoric acid, and the lime be left out of account (and their variations are due to the development of the red blood corpuscles and the bone), the centesimal composition of the ashes of the fœtus remains fairly constant during the second half of intrauterine existence, although, of course, the total amount of the mineral constituents increases much in the last weeks. This is a conclusion of some importance in approaching the problem of fœtal nutrition.

It is a remarkable fact that the analysis of the placenta has been almost entirely neglected; it is only within recent years that any attempt has been made to supply this defect in our knowledge of the chemistry of generation. To V. Grandis (*Arch. ital. de biol.*, xxxiii., pp. 429, 439, 1900) and P. Sfameni (*Ann. di ostet.*, xxi. 851, 1899, and xxii. 1009, 1900) we are indebted for some careful estimations of the

composition of the placenta. There were difficulties in the way of an exact analysis, *e.g.* the impossibility of draining off all the fœtal blood from the organ; but Sfameni believes that the figures in the following table show not only the composition of the fœtal blood and the true placental tissue, but also the differences between them:—

	Placenta.	Fœtal Blood.
Water . . .	83·67 per cent.	78·52 per cent.
Solids . . .	16·32 ,,	21·47 ,,
Organic . . .	15·45 ,,	20·72 ,,
Inorganic . . .	0·86 ,,	0·74 ,,
Soluble salts . .	0·73 ,,	0·62 ,,
Insoluble salts . .	0·13 ,,	0·12 ,,

The reaction of the placental tissue was neutral. It is noteworthy that the amount of water contained in the placenta is very large (the percentage given by Grandis, 83·89, is practically the same as that of Sfameni); in this respect the organ stands midway between renal tissue, with 82·7 per cent. of water, and the grey matter of the cerebral cortex, with 85·8 per cent. Of the substances removed by extraction (1·925 per cent., according to Grandis), most are albuminous in their nature, and only a small part is true extractive. The conclusion seems to be clear that the placenta contains easily diffusible albuminous substances, which may be carried without difficulty from it by a physiological solution circulating in the vessels; Grandis, however, does not attempt to decide whether these are elaborated in the placenta or come from the mother. Sfameni has shown that the placenta contains nucleon (phospho-carnic acid), but not in such amount as does the fœtal blood. Grandis has made a special analysis of the ashes of the after-birth, which amount to 1·073 per cent. The following table gives the percentage composition of the ashes:—

	Placental Ashes.	Albuminous Ashes extracted from unirrigated Placenta.	Albuminous Ashes from irrigated Placenta.
Cl . .	11·4	—	—
S . . .	0·204	—	—
Na . .	24·93	0·251	0·728
K . . .	6·57	—	—
PO_4 . .	33·46	55·18	14·5
CaO . .	2·32	—	—

The chief facts brought out by this analysis are—(1) the large quantity of phosphorus found; (2) the extractibility of most of the phosphorus-containing matters with water, and the precipitation of these with the albuminous substances; (3) the preponderance of soda over potash; and (4) the large quantity of lime. An excess of lime may show itself by concretions on the maternal surface of the placenta, and Sfameni points out that these concretions do not disturb the growth of the fœtus, that in fact the more insoluble salts there are in that organ the heavier the infant. I can support this observation, for I met with a placenta with concretions some years ago, and the fœtus was markedly large and healthy.

It is possible that before these sheets have passed out from the press further analyses of the placenta may have been made, supporting or controverting the conclusions which have been stated above; in the meantime, it is to be noted that the chemical investigations, so far as they have been carried, go to show that the placenta is something more than a means of communication between mother and fœtus, something more than a mechanical filter,—that it is in fact a special organ, consisting in great part of highly differentiated tissue (epithelial in type).

The liquor amnii, unlike the placenta, has often been the subject of chemical analysis. The reason is not far to seek. The amniotic fluid has been the central position, so to speak, around which the great battle of the manner of fœtal nutrition has raged. Has this fluid or has it not a power of nourishing the fœtus? Whence comes it? Is it of fœtal or maternal origin? Does it or does it not contain the renal excretion of the fœtal kidneys? Is it swallowed by the fœtus? These and many other allied questions have been asked and variously answered, until the literature on this subject has grown to great dimensions. Further, the questions are of no recent origin, but are almost as old as Obstetrics itself, for till the nature of the placenta was to some extent understood the amniotic fluid seemed a probable enough food for the unborn infant. There has always been much discussion about the liquor amnii, "de aquis in quibus fœtus humanus quasi natat," as the old writers used to put it. Manifestly the chemistry of the fluid, if it were sufficiently known, will throw light upon all the vexed questions; many analyses have therefore been made, but have not as yet thrown as much light as was expected, and are consequently being continued, with what result time alone will tell.

In the meantime it may be stated that the liquor amnii is chemically a serous fluid simply. It has a specific gravity of 1007 to 1013 or thereby, and a slightly alkaline reaction. It varies greatly in quantity, as every obstetrician knows, but possibly it may be safe to say that usually at full term it amounts to a little less than a litre; it may also be said that it does not seem to bear any constant relation to the weight of the mother or of the fœtus or of the placenta, nor to the length of the umbilical cord. The water of the amniotic fluid amounts to from 97 to 98 per cent., and may, in the second half of pregnancy, even reach 99 per cent.; albumin and mucin have been found in it to the extent of from 1 per cent. to 0·6 per cent.; extractives from 0·7 per cent. in the earlier months to 0·03 per cent.

in the latter; and salts from 0·9 per cent. to 0·3 per cent. The salts have been investigated in the case of the liquor amnii of the cow, and have been found to consist of NaCl, 0·586 per cent.; NaO, 0·367 per cent.; KO, 0·060 per cent.; Ca, 0·014 per cent.; Mg, 0·0038 per cent. Urea is commonly but not constantly found, but apparently not in greater quantity than is common in serous fluids (from 0·030 per cent. to 0·045 per cent. at the close of pregnancy). In the case of a diabetic mother, sugar was met with in the liquor amnii (H. Ludwig, *Centrlbl. f. Gynäk.*, xix. 281, 1895) to the amount of 0·30 per cent. Lockhart Gillespie (*Trans. Edinb. Obst. Soc.*, xix. 151, 1894) has investigated the proteids and more particularly the albumoses of the liquor amnii at the third and at the sixth month of pregnancy, and has found a trace of albumose in the former and ·1685 per cent. (proto, ·0485; hetero, ·045; and deutero, ·075) in the latter; the total amount of proteids (including the albumoses) was ·3819 per cent. at the third month and ·9485 per cent. at the sixth. In the latter, also, ·09 per cent. of pepton was met with. Gillespie is of opinion that the presence of the lower forms of proteid bodies in the amniotic fluid, although difficult of explanation, may be due to the action upon the albumin of digestive ferments similar to those described as being present in pleuritic or ascitic effusions. Finally, it may be noted that various substances given to the mother may be found in the liquor amnii. *e.g.* iodide of potassium.

It must be confessed that the chemistry of the liquor amnii, after all, does not throw much light upon the question of fœtal nutrition—it may be that we do not know how to interpret aright the meaning of the analysis. It certainly seems to be of inconsiderable value as a food stuff in the later months of antenatal life, unless partaken of in relatively enormous quantities; but it may play an important part as a supply of water to the growing organism at all periods in fœtal existence. Although not food, it may very well be drink to the unborn infant. It may also be said in passing that its chemistry does not clear up the vexed question of its maternal or fœtal origin. Some years ago, Krukenberg (*Arch. f. Gynæk.*, xxii. 43, 1884) wrote in slightly hopeless fashion: "Die physikalisch-chemische Untersuchung des Fruchtwassers giebt also keine Auskunft über die Herkunft desselben"; and the same judgment might be pronounced to-day—"keine Auskunft über die Herkunft"—no information (or little) about its origin, although for other reasons we are inclined to regard the liquor amnii as of mixed origin, partly maternal, partly fœtal.

Nutrition of the Fœtus.

The most difficult problem in fœtal physiology is doubtless the nutrition of the unborn infant. Notwithstanding its exceeding difficulty, it has from time immemorial attracted investigators and philosophers, and their work and speculation, if they have accomplished nothing else, have at least done this: they have demonstrated its exceeding difficulty. Like the problem of the exact nature of reproduction and of the origin of sex, the question of how the infant grows

in the womb has fascinated and perplexed generations of seekers after truth, but has not discouraged them. *Difficile est, fateor, sed tendit in ardua virtus.*

In what has been already stated with regard to fœtal circulation and the chemistry of the blood, the fœtal tissues, the placenta, and the liquor amnii, the way has been paved for the more intimate consideration of the central problem of fœtal nutrition. The wideness of the problem and the great number of investigations to which it has given rise forbid more than an indication of the salient points of the theme. Let us in the first place endeavour to clear away some of the difficulties, by discussing in order the liquor amnii, the umbilical vesicle, and the placenta as a source of food-supply to the fœtus. Thereafter we may look at the matter of metabolism in the fœtus and the question of fœtal secretion and excretion.

Whatever may be thought with regard to the nutritive properties of the *liquor amnii*, there can be no doubt that it plays an important part in antenatal life. It is an organ of protection to the fœtus, saving it from shocks, injuries, changes in temperature, and excessive pressure; it gives freedom of movement with a minimum of muscular effort to the unborn infant; and it is useful as a fluid dilating wedge in the hours of parturition. Does it, however, serve any other purpose or play any other part in intrauterine existence? That it receives excretions from the fœtal skin and occasionally from the fœtal kidneys is generally admitted—epithelial squames, vernix caseosa, and hairs are met with in it as well as the products of renal activity (urea, kreatinin), and when benzoic acid is given to the pregnant mother-animal it is met with as hippuric acid in the liquor amnii (Gusserow). Further, it is the source of the chief water supply of the fœtus; this also cannot be doubted. No doubt it receives some water from the mother by the placental route in the blood of the umbilical vein; but, as has been seen, the composition of the matrifugal blood (in the umbilical vein) when compared with that of the fœtal tissues (vide *supra*) proves that all the water cannot be thus obtained. Consequently, it follows that much of the liquor amnii must be absorbed through the fœtal skin (in the earlier months of fœtal life), and swallowed by the mouth and taken into the stomach and intestines (in the later months). Of the swallowing of the liquor amnii there can be no doubt, for products of the activity of the fœtal skin (hairs, epidermis, vernix) could not in any other way find entrance to the intestinal canal and be discovered as constituents of the meconium. It may be granted, then, that there is a certain circulation of liquor amnii through the fœtal tissues—a swallowing of it, an absorption of it, and an excretion of it; and it is probable that there is a circulation of it through the maternal organism also, that in fact the liquor amnii is being secreted and absorbed again by the maternal tissues. It is, therefore, a water supply to the fœtus. Is it also a food supply? It must, I think, be admitted that to a certain extent it is. It can hardly circulate in the way that has been described without losing some of its constituents to and taking up new substances from the fœtal tissues. It is true it does not contain much

nutriment, but it is equally true that it contains some; and if, as is extremely probable, it is absorbed and swallowed in relatively large amount, the quantity of food that is thus conveyed to the fœtus may be not inconsiderable.

The part played by the *umbilical vesicle* or yolk-sac in the nutrition of the human fœtus is apparently not great. At any rate it can only be of use to the fœtus in the early weeks of fœtal life, for it soon is left behind in development, and can scarcely be said to enlarge at all after the neofœtal period. Nevertheless there is evidence that in these early weeks it contains true yolk, and it is therefore more than probable that it is a source of food supply to the organism in the transition period of neofœtal life, if not later. In other vertebrate fœtuses, the yolk-sac, as every student of Embryology knows, plays a very important nutritive function; but in mammals it is to all intents of no consequence as a direct source of food supply, although in some mammals it takes part in the nutrition of the fœtus in another way, to be now referred to. In the Rodentia, Insectivora, and Chiroptera the umbilical vesicle becomes united by its vessels (vitelline or omphalo-mesenteric) with the diplo-trophoblast (Hubrecht) or subzonal membrane plus epiblast, to form a temporary structure connecting mother with fœtus, the vitelline or omphaloidean placenta. By and by the vitelline is replaced by the allantoic placenta, but it is most important to remember that for a time the nourishment of the fœtus is carried on by a placenta the vessels of which are those of the umbilical vesicle. I have elsewhere (102) shown reason for supposing that sometimes at least a vitelline placenta may intrude itself into the embryological history of the human fœtus, that in the sympodial monstrosity, and possibly in other terata as well, the allantoic vessels do not develop, and yet a placenta is grown which carries the fœtus to the full term of gestation, and that this placenta is formed by the vascularisation of the chorion by the vitelline vessels. Further, in the non-placental mammals, such as the Marsupials, in which there is no true placenta, either vitelline or allantoic, the organ which absorbs nourishment for the fœtus from the mother before the former is transferred to the marsupium, is the umbilical vesicle. The young of the Marsupials is born in a very immature condition, but through the medium of the milk-nutrition of the marsupium is carried safely on to full development. Through the formation of a vitelline and later of an allantoic placenta, the period of utero-gestation in the higher mammals can be prolonged, the fœtus can be more fully developed in utero, and the mammary method of nutrition can be postponed to a later date. It may therefore be regarded as probable, both on the grounds of phylogenesis and of ontogenesis, that the umbilical vesicle and more particularly its vessels play a certain part in the nutrition of the fœtus; normally, however, vitelline nutrition is of short duration, being limited by the close of the neofœtal period, or very soon thereafter. With some forms of monstrosity it may be greatly prolonged, and, even when no malformation exists in the infant, persistent and pervious vitelline vessels may be traced in the cord and full-time placenta, and these may contain blood. An example of these per-

manent vitelline vessels I met with some years ago; the specimen is here figured (Fig. 27). More recently Bovero has described a similar case, in which he was able to inject the vessels (*Internat. Monatschr. f. Anat. u. Physiol.*, xii. 31, 1895).

To summarise at this stage in our consideration of the subject in hand: the liquor amnii is a certain but small source of food supply to the fœtus, even in the later months; the part played by the umbilical vesicle and its vessels is under normal circumstances finished in the early weeks of utero-gestation, but may be less

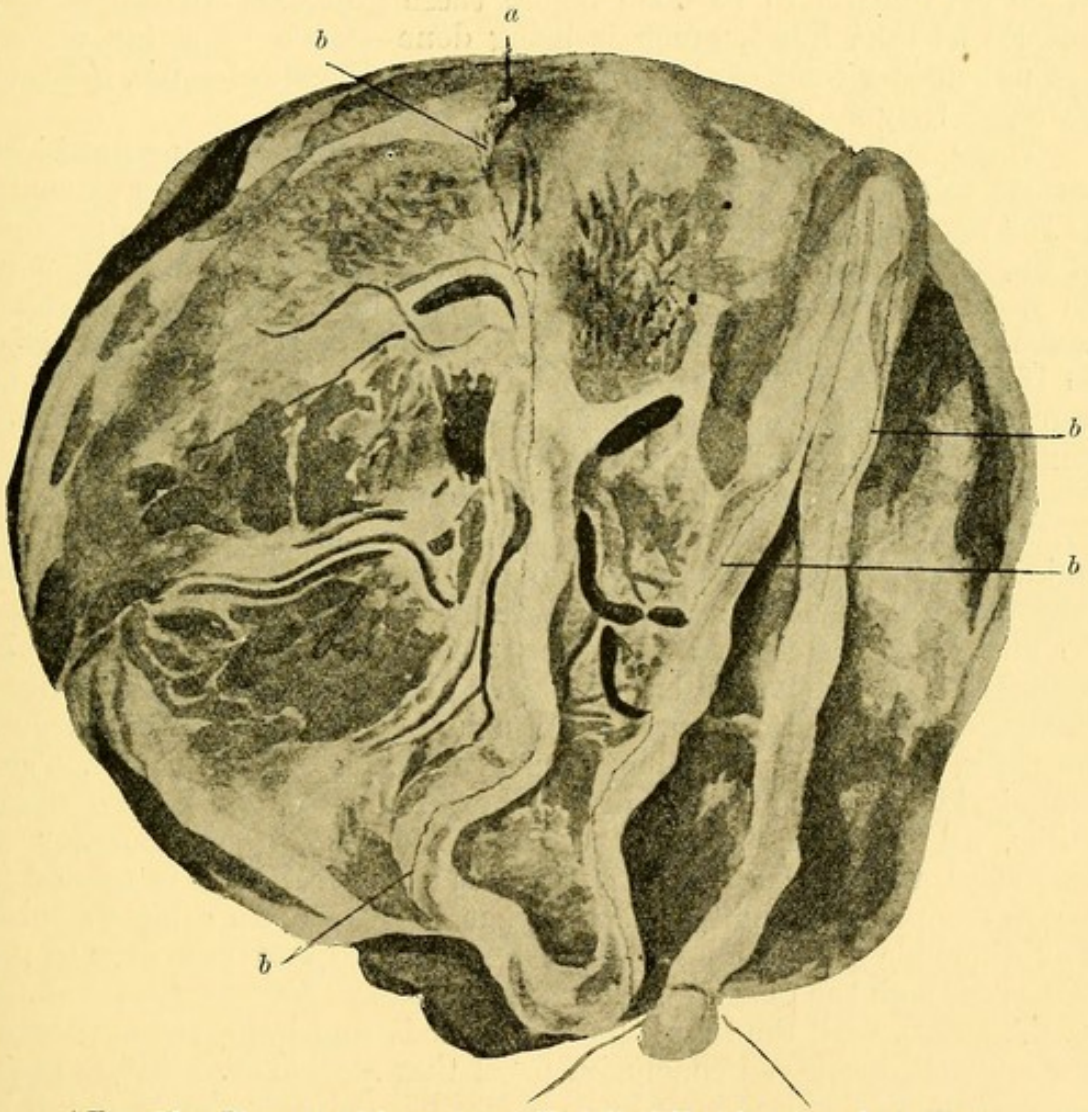


FIG. 27.—Placenta with persistent Umbilical Vesicle (*a*), and vitelline vessels (*b*, *b*, *b*, *b*). Reduced by about one-third.

temporary under certain unusual conditions. Manifestly, there must be some other organ of fœtal nutrition which has not yet been referred to, for it is impossible to accept the feebly nutritious liquor amnii and the temporary yolk-sac as sufficient sources of food for the rapidly growing unborn infant. That organ is universally admitted to be the placenta.

The reader will be not unprepared for the conclusion that the *placenta* is the chief organ of nutrition of the fœtus; for the side lights upon the subject that have been got from the study of the

temperature of the fœtus, of the chemical analyses that have been made of its tissues and of the placental substance, and of the histology of the blood of the umbilical vein and arteries, have all tended to throw into prominence the placental factor in the problem. At the same time, it must be admitted that most of the evidence which we possess is of the indirect kind; and it is even now far from certain to what extent the placenta acts simply as a transmitter of prepared nourishment, and to what extent it is also an organ which alters the composition of the food-stuffs coming to it and has a true secretion. Much yet remains to be done before these problems are cleared up; but let us take heart, much is being done—*tendit in ardua virtus.* Let us consider some of the proofs which have been collected, indirect although they may be.

There is, in the first place, evidence that in the human subject certain substances pass from the maternal blood through the placenta to the fœtus. It is difficult, however, to obtain proof of the passage of the substances which go to build up the body of the fœtus; it may be necessary to suppose that all the chemical constituents which make up the structure of the body of the unborn infant have passed to it in one form or another, and in one chemical combination or another from the mother's blood through the placenta, but exact demonstration is really impracticable, for we cannot, as it were, earmark any one substance in the maternal dietary and recognise it again in the fœtal body. Indirect proof, however, is forthcoming, and is indubitable. Substances which do not normally exist in the fœtal organism can be administered to the mother, and their presence can be afterwards demonstrated in the placenta and fœtus. The substances which have been employed have nearly always been medicinal; and chloroform, salicylic acid, iodide of potassium, alcohol, mercury, and methylene-blue may be mentioned as examples. The chemical substance has not always been found to pass to the infant (thus, all observers are not agreed as to the transmissibility of mercury), but its occasional passage is really all that is needed to prove our present point, which is, that in the human subject soluble and diffusible substances in the maternal blood may pass over to the fœtus through the placenta. Recently, Nicloux (*L'Obstétrique*, Ann. v., p. 97, 1900), with the help of new methods and improved apparatus for analysis, has given conclusive proof that alcohol administered to a parturient woman one hour or so before her delivery can be found in the blood of the umbilical cord. Further, the transmission of certain diseases from mother to fœtus in utero, *e.g.* syphilis, malaria, small-pox, is evidence that the substances which are neither nutritive nor soluble may pass through the placenta, and this fact may be held to be indirect proof of fœtal nutrition by the placental route; but this side of the subject is not at present emphasised, for it will be referred to again. The analyses of the blood of the umbilical vein and arteries as carried out by Varaldo (*loc. cit. supra*) may also be advanced in support of the contention that the placenta is the great means of transmitting nutriment to the fœtus, and it may further be held to give a hint as to the manner of its transmission; for it was found that

there were more white blood corpuscles in the blood of the umbilical vein than in that of the arteries, and that more of them contained iodophilic granules in the former than in the latter. It seems, therefore, to be reasonable to conclude that some of the leucocytes are retained in the fœtus, and that they may, as was indeed supposed by earlier observers, be carriers of nutriment.

In the second place, experiments upon the lower animals may be adduced as giving more complete proof of the passage of certain chemical substances through the placenta, from mother to fœtus *viâ* the placenta; and it is true that we can more scientifically regulate and check such observations than we can the clinical researches upon the human subject. On the other hand, it must not be forgotten that there are considerable differences between the structure of the human placenta and that of the lower mammals, and it does not necessarily follow that what is demonstrable in the case of the rabbit or guinea-pig will be true for the infant. Nevertheless, these experiments have been of service, and by their means it can be asserted that such substances as chlorate of potash, iodide of potassium, salicylate of soda, bromide of potassium, lithium, mercury, antipyrine, quinine, arsenic, alcohol, morphine, copper, lead, benzoate of soda, etc. etc., occasionally, if not always, pass in the matrifugal blood stream to the fœtus. Further, the fact that sometimes the substance experimented with could be found in the fœtus and in the placenta but not in the liquor amnii, seems to exclude the possibility of the liquor amnii being more than a most occasional means of conveyance of materials from mother to fœtus. Experiments upon animals have also shown that bacteria and their toxines, substances which differ very markedly from the soluble and diffusible chemical compounds to which we have referred, may pass through the tissues intervening between the maternal and fœtal bloods in the placenta; it is true that they do not always so pass, and that it is not yet known what circumstances determine their passage or non-passage, but their occasional transmission is further proof in support of the belief that food substances may also reach the fœtus in this way.

In the third place, it may be with justice alleged that the placental route is really the only one by which nourishment can pass to the unborn infant in the later months of pregnancy. By exclusion we come to this conclusion, for a well-nourished fœtus may be found with almost entire absence of liquor amnii; or, again, although there be a sufficient quantity of amniotic fluid, the fœtus may suffer from an imperforate condition of the œsophagus, an anomaly which of course prevents the fluid being taken into the digestive tract, and yet the nutrition may show no sign of having been interfered with. With regard to nourishment by the umbilical vesicle, it is unnecessary to point out that such a method is inconceivable in the later months of antenatal life, as the food supply contained in it is quite inadequate. Teratology furnishes a very strong argument in favour of the view that the placenta is not only the chief but practically the sole means of the transmission of nourishment to the unborn infant; for fœtuses so deformed as to possess scarcely any organ save the placenta, or a

portion of the placenta of another fœtus, may yet be nourished and brought through nine months of intrauterine existence to the full term; the one organ which is essential to their nourishment (I say nothing meanwhile regarding structural integrity) is the placenta. It may be hazarded that, did the human fœtus not possess a placenta, it would be impossible for it to be carried beyond the second month of antenatal life; it is the evolution of the placenta that has prolonged intrauterine existence, and made it possible for the fœtus to be much further advanced in development when born. On this subject and on some allied questions John Beard discourses most suggestively in his *Certain Problems of Vertebrate Embryology* (Jena, 1896).

The placenta, then, is at any rate a transmitter of nourishment from mother to fœtus. But, is it something more? Does it prepare, elaborate, and otherwise alter the food-stuffs passing through it? There is undoubtedly a considerable mass of evidence to show that it does not simply permit materials to pass through from the one blood to the other by the plain and uncomplicated laws of osmosis; it plays a more intricate and subtle part than that. It has a certain selective power, as is shown by the fact to which reference has already been made, that the quality of urea in the fœtal and maternal blood is not the same. Further, it would seem that a larger quantity of one chemical substance passes from mother to fœtus at one time in pregnancy than at another, for in the later months there is a marked increase in the amount of iron and of potash and lime in the infant; these materials are needed by the fœtus then to form the bones, the red corpuscles, and the striped muscles, and, perhaps, to make up for the future deficiency in iron of the maternal milk; and the placenta apparently has the power of supplying them in the necessary abundance. Again, the placenta would seem to have the property of storing up in its substance certain minerals, *e.g.* mercury; this, at any rate, is the finding of certain experiments upon guinea-pigs made by Porak (*Arch. de méd. exp. et d'anat. path.*, vi. 192, 1894). In its power of storing up mineral and possibly also microbic poisons and of fixing glycogen, the placenta resembles the adult liver, and possibly it may possess this faculty in order to set the fœtal liver free for other functions (hæmatopoiesis?). We must avoid "the guesser's darkening of knowledge," but one is tempted to speculate upon many matters concerned with the part played by the placenta in fœtal nutrition. Does it, for instance, yield a special secretion to the fœtus? Does it also send to the mother an internal secretion, as has been suggested by Letulle and Nattan-Larrier (*loc. cit.*), a secretion which is neither glycogen nor fat nor mucin, but an albuminoid? Does it in any degree save the fœtus from the effects of maternal malnutrition? Why is it that at first the placenta and the fœtus seem to grow almost *pari passu* in weight, while later in antenatal life the former scarcely gains at all, and the latter continues to increase at a wonderfully rapid rate? Hier reiht wirklich die Physiologie des Embryo Problem an Problem!

The matters which we have been discussing, difficult and almost insoluble though they may well appear, must nevertheless yield in

complexity to certain others as yet barely touched upon. I refer to the problems of the metabolism of the fœtus, its intracorporeal as distinguished from its placental or extracorporeal biochemistry. That the fœtus does not act simply as an absorber of prepared nourishment, is certain; that it acts to a certain extent independently in the building up of its own tissues, is proved by its temperature and by the chemistry of its excretions. The belief is also strengthened by the study of its secretions. Let us consider, therefore, this aspect of the nutrition of the fœtus.

Secretions of the Fœtus.

The great size of the liver, and the fact that it receives the purified and food-containing blood from the placenta before it can reach the other organs of the fœtus, lead us to expect that this gland plays a large part in the metabolism of the body. There is good reason to believe that this expectation is well founded. The presence, for instance, of considerable quantities of glycogen in the fœtal liver at birth goes to show the activity of its glycogenic function; at the same time the detection of this material in most young fœtal tissues (*e.g.* muscle, heart), and its production in the placenta diminish, in theory at least the part taken by the hepatic cells in this physiological act. Another sign of hepatic functional activity is found in the presence of bile in the gall bladder; apparently this secretion is poured out from the third month of intrauterine life until the full term. It would seem also that it is really bile, for it contains both bile acids and bile colouring matters, although bilirubin is probably not produced in appreciable quantity till the mid-term of pregnancy. It does not, at the same time, appear clearly what purposes the bile serves in the fœtal economy, for it can hardly play a great part as an intestinal antiseptic, and it is not much needed in digestion, and yet its early presence indicates some functional importance. It gives to the meconium its characteristic dark green colour; so much we are assured of; what else it does in fœtal life is obscure, "bleibt unklar." It may be worth while to give here the chemical analysis of the fœtal liver, as determined by Doléris and Butte (*Nouv. arch. d'obstét. et de gynéc.*, ii. 378, 1887)—

Water	70·70	
Solids	29·30	
Organic substances		27·981
Inorganic substances		1·319

About the buccal secretions in the fœtus little is known, save the fact that in the new-born infant the presence of ptyalin can usually be detected; but why there should be at the end of fœtal life a saliva with an amylolytic power which will not apparently be needed (under normal circumstances and while an exclusive milk diet is maintained) till several months of postnatal existence have passed, is a hard problem even among problems which are not easy. There is evidence that the buccal secretions (salivary as well as mucous) are not free in

the fœtus; but it is, on the other hand, not known to what extent the mouth is kept moist by the ingestion of liquor amnii. It is possible that a small amount of gastric digestion may go on in fœtal life; for in the case of the human fœtus, at any rate, it has been noted by Doléris and Butte (*loc. cit.*) and others, that fibrin may be digested by a solution made from a scraping of the mucous membrane of the stomach of an infant that had perished in birth (craniotomy). Pepsine, therefore, is present in the stomach at birth; and, according to the observations of Kölliker and Langendorff, it is there as early as the fourth month of intrauterine existence. It is safe to state, in this connection, that there is evidence that there is sufficient digestive ferment in the fœtal stomach to digest all the albuminous substances of the liquor amnii which may be swallowed. On the question of the nature and source of the contents of the fœtal stomach, the communication of George Robinson (*Month. Journ. Med. Sc.*, vii. 506, 1846–47), although written more than fifty years ago, may be profitably studied.

With regard to the activity of the pancreas in fœtal life, there is good reason to believe that pancreatin, the fat-emulsifying ferment, is present to some extent. As to trypsin, the peptonising ferment, the evidence is not so clear; some observers have found it, although not in all cases, while others have not noted it at all (*e.g.* Doléris and Butte). The third or diastatic ferment of the pancreas does not seem to be present either at birth or earlier in antenatal life. Little is known regarding the intestinal secretions in the fœtus; little, that is, that is in any degree certain. There is no doubt some secretion of succus entericus, but what its composition is and to what extent the various intestinal glands take part in its production, must remain for the present obscure. Some reason exists for supposing that the glands of Brunner may act in a different manner in the fœtus as compared with the adult. But speculation can serve no useful end, when so little is known.

Other secretory activities in the fœtus are found in the sebaceous glands and in the serous membranes. The vernix caseosa, with which most fœtuses are covered at the time of birth, is composed principally of sebum from the skin glands and of desquamated epidermic scales; possibly the epitrichium may contribute to its formation. It contains from 78 to 84 per cent. water, and from 9 to 10 per cent. fats. It is doubtful if the sudoriparous glands are active in antenatal life; if they are, their activity is in all probability restricted to the terminal weeks; the purposes which these glands serve in the adult can hardly be said to exist in the infant before birth. The mammary glands, however, are functionally active, both in male and female fœtuses, as is demonstrated by the presence in them of a milky secretion at the close of intrauterine existence; the glands of the vagina also must be physiologically operative, for I have often had occasion to note the large quantity of thick white mucus lying in that canal in female fœtuses. It is stated, on the other hand, that the lachrymal glands do not secrete in the case of the fœtus or infant at birth. The activity of the serous membranes is shown by the presence of cerebro-spinal fluid, and, under pathological conditions, by the occurrence of ascites, hydro-

thorax, and hydro-pericardium. It is therefore quite clear from the evidence of the secretions that not a little independent metabolism is carried on in the fœtal tissues; but further proof is forthcoming from other sources.

Excretions of the Fœtus.

The fœtus has excretory as well as secretory activities. The meconium with which the lower part of the intestine is distended is made up of swallowed liquor amnii, lanugo hairs, vernix caseosa, and epidermic squames, of bile, mucus, succus entericus, pancreatic secretion, and of intestinal shed epithelium. One or more of these elements may be absent: when the bile is wanting, as in congenital obliteration of the bile ducts, there is found the so-called meconium amnioticum, which is of a yellowish brown or even of a grey colour; when there is imperforation of the œsophagus, the component parts which are obtained from the liquor amnii will not be found. Special ovoid, yellowish green corpuscles (meconium corpuscles) have been described. Chemical analyses show that the meconium contains from 20 to 30 per cent. of dried solids, which consist of mucin, biliverdin, bilirubin, bile acids, cholesterin, fats, fatty acids, and ashes (chloride of potassium and sodium, phosphate of iron, lime and magnesium, and sulphate of lime and soda). The absence of peptones, albumin, leucin, tyrosin, lecithin, glucose, lactic acid, and lactates, and of the products of decomposition (indol, phenol), has been noted. According to B. Moore (Schäfer's *Textbook of Physiology*, i. 474, 1898), the meconium also contains a substance giving two absorption bands, one to the red side of the D line, and the other, broader and darker, between the D and E lines of the spectrum. Under normal circumstances there are no micro-organisms in the meconium during fœtal life, and I have taken meconium from the rectum of a still-born infant some hours after birth, and found that it gave no growths on culture media. It does not appear that intestinal peristalsis can be very active in antenatal life, for it is very rare, save in cases of intrauterine asphyxia, to find that any meconium has been voided into the liquor amnii; but at the same time it is necessary to bear in mind that the researches of E. Rossa (*Arch. f. Gynaek.*, xlvi. 303, 1894) go to prove that it may be imperative to revise our ideas concerning the frequency of antenatal defæcation and its prognostic significance in connection with fœtal life. Certainly I have seen the membranes and cord stained green with meconium when the infant was born alive, and when apparently there had been no attempts at premature respiration. While few writers have even suggested the possibility, of the occasional passage of meconium into the liquor amnii, many have strongly maintained that there was a regular emptying of the contents of the bladder during fœtal life. That the kidneys may excrete a fluid which is in all its characters urine, cannot in the present state of our knowledge be doubted. The fœtal bladder may be found distended with this fluid at the time of birth, the fœtus in breech presentations may micturate during the act of birth, still-born and premature

fœtuses may show on post-mortem examination a bladder full of urine, substances (*e.g.* methylene-blue) given to the mother in labour may be discovered in the urine passed by the new-born infant, and in cases of valvular obstruction of the urethra an enormous dilatation of the bladder and ureters may be met with. I have repeatedly found urine in the bladder of still-born fœtuses, both mature and premature; and recently I dissected the dead but fresh fœtus of a woman who died from eclampsia and jaundice with almost entire anuria—the fœtal bladder was over-distended with urine; so that the fœtal kidneys may apparently be active when the maternal are not. From all these facts it is clear that the secretion of a fluid by the kidneys in antenatal life takes place. That the fluid is urine is also supported by the evidence at our disposal. It is true that it is very pale in colour, that it is very watery, and that its specific gravity is only 1010 or less; but it contains urea in small amount (0·15 per cent. according to T. A. Helme, *Brit. Med. Journ.*, i., for 1893, p. 1261), uric acid in relatively large amount, chlorides, and kreatinin. It not infrequently contains albumin, a fact which is explained by C. Flensburg (*Nord. Med. Ark.*, n. F., iv., Hft. 2 and 3, pp. 1–38, 1894) as due to the increase in the uric acid; it occasionally contains bilirubin and indican; and it may contain substances such as methylene-blue administered to the mother (H. Reusing, *Ztschr. f. Geburtsh. u. Gynäk.*, xxxiv., p. 40, 1896). The giving of benzoate of soda to the mother with the detection of hippuric acid in the urine of the new-born (Gusserow's experiment), has already been referred to. There is therefore no room left for doubt that the fœtal kidneys are at least occasionally active during fœtal life; but it is quite reasonable to suppose that their activity is not in any case very great or long-continued. Like several other functions of the fœtus, that of urine secretion can apparently be dispensed with if the placenta continues to act in a normal fashion; but there is the provision for the renal function becoming more active in the presence of placental disability. With regard to the emptying of the fœtal bladder into the liquor amnii, there seems to be more than the usual difference of opinion among those who have studied the physiology of antenatal life. There is nothing impossible in the supposition that the fœtus occasionally micturates into the liquor amnii, for the passage of urine takes place immediately after and even during birth, and the chemical composition of the liquor amnii and of the fœtal urine is not unlike; but there is no sufficient evidence that this happens constantly or even often during intrauterine existence, and in normal circumstances it does not seem probable that the liquor amnii is mainly derived from the fœtal renal secretion. This seems to be a fair conclusion to draw from the experiments of L. Schaller (*Centrlbl. f. Gynäk.*, xxii., 321, 1898); he gave to the pregnant and parturient woman phloridzin (a glucoside which produces glycosuria), and found sugar constantly in the urine of the new-born infant and very rarely in the liquor amnii. With regard to the origin of the liquor amnii, when that fluid is in excess (hydramnios), it may not be possible to speak so emphatically; the occurrence of cardiac and renal hypertrophy in the twin with the

hydramniotic sac (in uniovular twins) suggests a possible renal origin of some of the amniotic fluid at least (*Vide*, F. Schatz, *Physiologie des Fötus*, Berlin, 1900; P. Strassmann, *Arch. f. Physiol., Supplement-Band*, 218, 1899).

I have thus brought forward evidence to show that the fœtus has excretory as well as secretory activities, and have instanced the intestines and the kidneys, but there can be little doubt that a much more important and more constantly active excretory organ than either of these exists in the placenta. The reverse current, that is to say, the passage of substances, soluble and even formed, from the fœtus to the mother through the placenta, has been practically established by experimental and clinical evidence; theoretically, also, it seems necessary to regard the placenta as the great excretory organ of fœtal life. Since the time when W. S. Savory (*Lancet*, i., for 1858, pp. 362, 385) experimentally induced tetanus in pregnant cats by injecting strychnine into the kittens in utero, evidence has been gradually and on the whole steadily accumulating to demonstrate that this belief is well founded. Gusserow (*Arch. f. Gynaek.*, xiii. 56, 1878), for instance, obtained similar results to Savory; Preyer (*op. cit.*, p. 219) also got positive evidence from the use of hydrocyanic acid, nicotine, and curare, in the case of guinea-pigs; and it has been shown that, in asphyxia of the mother animal, the blood of the umbilical vein of the fœtus becomes markedly dark in appearance, indicating that oxygen is being drawn from the fœtus to the maternal organism. Doubtless carbonates and other products of normal fœtal metabolism pass in this matripetal current through the placenta, although it is difficult, in the human subject at any rate, to get direct evidence of it. It has been suggested that in eclampsia the determining factor in producing the convulsions in the mother may be the passage of toxines from the fœtus into her circulation, and in support of this Lannois and Briau (*Lyon méd.*, lxxxvii. 323, 1898) have found that salicylate of soda, iodide of potassium, and methylene-blue injected into the fœtus may be detected in the maternal tissues and urine. Charrin (*Ann. de gynéc. et d'obst.*, L., p. 197, 1898), from experiments upon the passage of toxines (of diphtheria, of the *Bacillus pyocyaneus*), has come to the conclusion that such substances deposited in the fœtus, either directly or through the spermatic fluid of the father, can be transmitted to the mother; if they do not pass easily or in great quantity through the placenta, a condition of maternal immunisation may be produced, as is seen in Colles' law in syphilis. It is interesting to note that a similar view was held by A. Harvey as long ago as 1848 (*Month. Journ. Med. Sc.*, ix., 1130, 1848–49; xi., 299, 387, 1850; *Glasgow Med. Journ.*, vi. 385, 1858–59), although without the scientific proof now afforded by experimental fœtal pathology. L. Guinard and H. Hochwelker (*Journ. de physiol. et de path. gén.*, i. 456, 1899) have experimentally shown that rose aniline trisulphonate of soda passes easily from fœtus to mother, and can be found in the maternal urine and even in the blood; if, however, the fœtus be killed (as by strophanthus) and the fœto-maternal circulation stopped, it does not pass, and it is only

found in the fœtal tissues; the death of the fœtus, therefore, suspends the fœto-placental interchanges.

From all that has been stated, it may, I think, be safely concluded that, both on account of its secretory and its excretory processes, the fœtus must be regarded as the sphere of very considerable metabolic activity. Before, however, I leave this aspect of the physiology of the fœtus, it may be well to refer to the question of the part played in antenatal vital processes by the thymus, thyroid, and suprarenal glands, and by the pituitary body. This is an obscure corner of an obscure department; but we can at least benefit by realising how obscure, for we may thereby be stimulated to endeavour to throw some illumination upon it.

Function of the Fœtal Thymus, Thyroid, Adrenal and Pituitary Glands.

The possible hæmatopoietic function of the *thymus* as the parent source of the white blood corpuscles, has been already alluded to, but it may perform other functions during antenatal life and in the early part of childhood. According to H. Roger and C. Ghika (*Journ. de physiol. et de path. gén.*, ii. 712, 1900), the epithelial part of the thymus has entirely disappeared at the third month of intrauterine life, and its structure is clearly lymphoid; there are no concentric corpuscles of Hassall to be seen at this time, so that it is probable that they are not derived from the primitive epithelial portion of the gland. After the sixth month, at which date there is a marked increase in weight of the thymus, the corpuscles are quite easily seen. The structure of the organ becomes more complicated in the presence of infective agencies, so that it possibly plays a part in the defence of the organism; but whether it does so or not before birth must be regarded as uncertain. It is stated by K. Švehla (*Arch. f. exper. Path. u. Pharm.*, xliii. 321, 1900) that the thymus of the human fœtus does not contain the active ingredient (which lowers the blood pressure and quickens the pulse) that forms after birth. Another interesting and perhaps suggestive fact has been brought out by the investigations of Katz (*Progrès méd.*, 3 s., xi., p. 385, 1900), and by Bourneville (*ibid.*, p. 389), who have found that the thymus atrophies and disappears earlier after birth in infants with little or no intellectual development. This may be taken in conjunction with the belief of G. Gauthier (*Rev. de méd.*, xx., pp. 39, 225, 410, 1900) that the sole function of the thymus is to act as a regulator of growth in the early part of life. As a matter of fact, the antenatal as well as the postnatal function or functions of the thymus are at present unknown. I have, however, been struck by the extraordinary frequency with which I have met with a normal thymus in fœtuses with various malformations and teratological states.

The *thyroid gland* is a remarkable body, and the part it has played in the history of Physiology is also remarkable. After having been

for years regarded as a comparatively unimportant organ, as at most a hæmatopoietic organ of not the first rank, it has recently come to take a high and honourable place among the most important structures of the body. The thyroid along with the parathyroids, which are the link binding it to the thymus, is now known to be the great regulator of body metabolism, and to be essential for growth in at any rate the early years of life; defects in it are the causes of disease, and there is a thyroid theory of cretinism, of exophthalmic goitre, of obesity, of infantilism, and of various skin diseases, besides suggestions that the thyroid may be at least one of the causes of eclampsia (in pregnancy), of adenoids, and of hæmophilia. After birth, at any rate, the thyroid has an internal secretion (iodo-thyrin), which may be described as exercising an antitoxic, or, better, a medicinal effect upon the toxic or pathological products of proteid metabolism; these toxic principles are neutralised and stored up as colloid or thyro-proteid in the thyroid gland. Possibly the iodine in the iodo-thyrin has the most important action in maintaining the nutritive equilibrium; possibly, also, the parathyroids have a functional association with the thyroid in preparing the iodine for the iodo-thyrin. Diminished thyroid activity leads to slowing of the nutritive processes, while increased leads to undue rapidity of metabolic changes; both these conditions may exist as purely functional states —hypothyroidism and hyperthyroidism. There is a great deal of investigation yet to be undertaken before we shall know all the relations which exist between normal and abnormal thyroid activity and the pregnant state. The physiological hypertrophy of the thyroid of the pregnant woman was not unknown both to the medical profession and to the laity of past ages; and no doubt it plays a part in safely carrying on the wonderful and exacting series of nutritive and developmental changes which tests the maternal organism to its utmost limits (M. Lange, *Ztschr. f. Geburtsh. u. Gynäk.*, xl., p. 34, 1899). It is also known that there is thyroid hypertrophy at the time of commencing puberty, that ovulation is accompanied by hyperæmia of the thyroid, and that the thyroid is active during lactation. Further, it is supposed that the vomiting of pregnancy, and possibly the thinness of the face which then often is noticeable, are due to increased secretion from this gland. It is surmised, also, that the marked flow of the milk about the third day of the puerperium is due to the sudden increase of thyroid secretion in the maternal blood caused by the birth of the fœtus. This statement brings us then to the difficult question of the function of the fœtal thyroid. Has the thyroid gland of the unborn infant the same regulating function in connection with the metabolism of antenatal life as the thyroid of the mother has over the metabolism of the adult body, or as the thyroid of the infant has over the metabolism of infancy and childhood? Has the maternal thyroid in pregnancy the double function of regulating both the maternal and the fœtal metabolic processes? When the thyroid of the one is defective, can the thyroid of the other supplement it? These and a great many other questions cannot in the present state of our knowledge be satisfactorily answered; but some things are

partly known and others have been surmised; and to these we may briefly refer, always keeping in mind the imperfect nature of our acquaintance with these problems. In the first place, it is supposed that the secretion of the thyroid cannot contain iodine, for that element is not to be found in the fœtus; and if the iodine be of great functional use, then the fœtus must be dependent for it upon the maternal and not upon its own thyroid. The goitrous cretin is born, it is surmised, with a healthy thyroid, but through absence of iodine in his environment the thyroid degenerates some time after birth; it would be interesting to know exactly the state of the thyroid in the offspring of goitrous parents. In the fœtal thyroid from the third month onwards there is found a colloid material called thyromucoin; the reappearance of this substance in later life is regarded as the cause of exophthalmic goitre; as Gauthier (*Rev. de méd.*, xx., pp. 39, 225, 410, 1900) expresses it, this substance in the adult plays the part of a noxious material, for it is "utilisable seulement dans un organisme fœtal où tout est à créer, à transformer et à détruire." With regard to experiments upon animals, it has been stated that the removal of the thyroid in a pregnant animal will cause the birth of a fœtus with rickets (Gauthier). Further, it has been found experimentally that in cases where the thyroid of the bitch was in part removed, the fœtal puppy showed a hypertrophied thyroid containing no colloid. W. Edmunds (*Brit. Med. Journ.*, i., for 1900, p. 1341) removed the lobe of the thyroid and the parathyroids on one side, and on the other nearly the whole of the lobe, but left one parathyroid; about four months later the animal (a bitch) gave birth to a puppy whose thyroid showed absence of colloid and a hypertrophic state, which was regarded as compensatory to the maternal defect. K. Švehla (*loc. cit.*) found for the thyroid as for the thymus, that in the human fœtus the gland did not contain the material that quickens the pulse rate and lowers the blood pressure. From this confused mass of facts and speculations it can only at present be gathered, that it is improbable that the thyroid during fœtal life acts in the same way or in the same degree as it begins to do after birth; the maternal thyroid may have to secrete iodo-thyrin for both the maternal and fœtal organism; but it is possible that in cases of maternal thyroidal defect the fœtal gland may to some extent take on its postnatal function; and these conclusions do not necessarily mean that the thyroid is not active in intrauterine life, but only that it is not active in the same way as after birth. Further, Švehla's observations and experiments seem to show that the thyroid of the fœtus of the cow possesses this power over the circulation before birth, which, as has been stated, that of the human fœtus does not.

Along with the thymus and the thyroid glands, it is convenient and appropriate to refer to the *suprarenal capsules* of the fœtus. There is a hypertrophy of the maternal suprarenal capsules in pregnancy, and in the fœtus these organs are, as is well known, relatively large in size; but the exact meaning, or even an approximation to the meaning, of these conditions is not forthcoming. In the adult the effect of the internal secretion of the suprarenal capsules would

appear to be to raise the blood pressure, and to slow the heart or to quicken it if the vagi be cut. There is, therefore, a degree of physiological antagonism between the thymus and thyroid and the suprarenal capsules; and it is interesting that in pregnancy all the three are large,—the thyroid and suprarenals in the mother, and the thymus and suprarenals in the fœtus. At the same time, it seems to be clear from the experiments of Švehla (*loc. cit.*) and others that the adrenals in the human fœtus do not contain the vasoconstrictor principle, although those of the fœtal calf apparently do. Why there should be this difference is not in any measure clear.

The effects of functional activity of the *pituitary body* in the fœtus are not yet known. In the adolescent and adult it appears to control the growth of the body, and possibly does in later life what the thymus and thyroid do in earlier postnatal life. Lesions of the pituitary apparently cause acromegaly, which is a form of gigantism of the adult. It has been thought that the thyroid and pituitary may supplement each other in their physiological effects, and that the pituitary may take on a vicarious action, for enlargement of the pituitary has been noticed after thyroidectomy; but experiments seem rather to show that the internal secretion of the pituitary has an action more allied to that of the suprarenal glands. At any rate, extracts of the hypophysis increase the force of the heart's beat and raise the blood pressure. As has been said, nothing is known about the action of the pituitary before birth; but it is interesting to note that, while some ascribe acromegaly to a continuance of the antenatal function of the gland in postnatal life, others (M. Collina, *Arch. ital. de biol.*, xxxii., 1, 1899) find the cause in a perversion of its function, toxic substances increasing and setting up irritation in the tissues of the limbs. That is to say, some consider that the pituitary secretion does good during fœtal life, but harm if it continue to be poured out later; while others think that it must be altered after birth in order that it may produce a pathological effect. About all the internal secretions of the fœtus, it is permissible to suppose that they have a different action in antenatal as compared with postnatal life; but it is simply a supposition.

From what has been said regarding the intracorporeal metabolism of the fœtus, it must have become abundantly clear to the reader that the problems which have been touched upon have taxed, and will yet tax, the best efforts of the most skilled physiologists for some time to come.

Growth of the Fœtus.

If the complexity of the problem of fœtal nutrition has been fully appreciated, it will be evident that it can be no easy task to determine what conditions favour and what hinder the growth of the unborn infant. Nevertheless some writers have attempted to settle these points by very simple means, and have almost of necessity failed. It is a matter of everyday experience that new-born infants differ markedly from each other in size and weight, even when there is good reason to believe that they have been born at

the full term of antenatal life, and even when the mothers have enjoyed uniformly good health. It has not yet been found possible to predict even approximately what the length and weight of the infant will be, and although attempts have been made to regulate the growth of the fœtus by controlling the diet of the mother, they have not met with conspicuous success. The factors of fœtal nutrition are so numerous, and their relations are so intricate, that it is impossible to arrive at the coefficient of nutrition, so to speak. Many writers, however, have worked at this problem. While some have held that the development of the fœtus depends upon the age of the mother, her parity, the duration of her menstrual flow, and the date of the commencement of her reproductive life, others have seen a connection between the size of the infant and its sex, the length of its cord, and the amount of its liquor amnii. Now, some of these factors (*e.g.* the age of the mother and the sex of the fœtus) apparently have some influence upon antenatal growth, although it is often clear, in the light of the knowledge of fœtal physiological problems which we now possess, that the reasons given for a belief in the efficiency of the factors are quite inadmissible. But the chain of factors which controls the rate of fœtal nutritive processes is too long to make it easily possible to pick out the separate links and assign to each of them their relative importance. Among the possible factors may be named: the health of the mother, her food supply (although it must not be concluded that a starved mother will give birth to a puny infant), her employment (for there is some reason to suppose that if the pregnant woman can rest in the last months of gestation the weight of her offspring will be greater, Bachimont, *Thèse de Paris*, 1898), the structural and physiological integrity of the placenta, the activity of the fœtal organs of assimilation, and the state of the growth-dominating glands both in mother and fœtus. Furthermore, even if these factors were known, there remains the unknown, and almost unknowable, influence which the fœtus brings with it from its embryonic and germinal life into its fœtal existence—I mean the hereditary tendency to grow into a large or a small infant. F. La Torre (*Nouv. arch. d'obst. et de gynéc.*, iii., pp. 138, 185, etc., 1888), in his articles on this problem—"ce nœud gordien," as he justly calls it—appreciated to some extent this difficulty, for he abandoned such factors as the menstrual history and state of parity of the mother, and gave great value to the state of health of the father, "le facteur père." In appealing to this factor, he admitted that the size to be attained by the fœtus was to a large extent determined before the commencement of truly fœtal life (second month of antenatal existence). This influence, certainly, cannot be neglected; neither can the state of the mother before pregnancy and her heredity be left out of account. Further discussion of this Gordian knot of a problem is not in the present state of our knowledge profitable. To have recognised the difficulties which surround it, is, however, not without some small degree of profit. We know that it is a Gordian knot, and that we have not even the means of cutting it, far less of untying it.

Movements of the Fœtus.

From the time, usually about the mid-term of pregnancy, when the mother feels "life" or "quickening," until the birth of the infant, there is no room for doubt that the fœtus is capable of moving in the liquor amnii. Women rely upon the occurrence of these "movements" to enable them to confirm the diagnosis of pregnancy which was provisionally made when the menses ceased and the morning sickness began; the "stirrage" also brings to the maternal mind the welcome intelligence that the infant is alive and not dead in the womb. But there is abundant evidence, both from the experiments upon the lower animals and from the examination of abortions, that the fœtus moves before the mid-term of antenatal life; in fact, it may be reasonably concluded that during the whole of fœtal existence and even in the neo-fœtal period fœtal movements occur. I have seen rigor mortis in a five months fœtus (80), and J. Tissot (*Arch. de physiol. norm. et path.*, 5 s., vi. 860, 1894) has seen it constantly in fœtal kittens dying in utero; and in these and similar observations we find evidence of an indirect kind as to the occurrence of muscular movements before birth. Doubtless antenatal muscular action is neither so powerful nor so prolonged as postnatal (and the cadaveric rigidity is not so intense), but it is capable of being brought into action, and it is brought into action probably from the sixth week onwards.

Fœtal movements are independent of the supply of oxygen, and, what is still more surprising, they appear to be independent also of the cerebrum and medulla, for they occur in anencephalic and even in acephalic fœtuses, and may persist after craniotomy. For the postnatal activity of the respiratory muscles, however, the medulla oblongata is necessary, as was well shown in the case of anencephaly reported by Onodi (*Monatschr. f. Geburtsh. u. Gynaek.*, xi. 718, 1900), in which the monstrous fœtus survived birth for two days and breathed, the medulla and pons being present, although the cerebrum and cerebellum were absent. This independence of the nervous centres was, it will be remembered, manifested also by the muscular activity of the fœtal heart (*vide* Chapter IX.).

Several varieties of fœtal movements can be recognised both by the obstetrician and by the mother: there are the movements of revolution or rotation, by which the fœtus changes his position or presentation; there are the extensions of the limbs and spine, by which there is a temporary loss of the typical fœtal attitude of flexion; and there are the rhythmical, heaving movements which have been ascribed to the diaphragm and intercostal muscles of the unborn infant, and which have been compared to swallowing movements, to hiccough (fœtal singultus), or to intrauterine respiration. As has already been stated, Pestalozza (*loc. cit.*) and Ferroni (*loc. cit.*) have specially investigated the last-named movements and have obtained graphic representations of them. From another standpoint, fœtal movements may be subdivided into passive,

irritative, reflex, impulsive, and instinctive; this is the suggestive classification adopted by Preyer (*op. cit.*), but rather from the study of the muscular manifestations of the new-born than of the unborn infant, so it may be concluded. The passive movements of the human fœtus are chiefly of importance as affording to the obstetrician the valuable sign of pregnancy known as ballottement. Of the irritative movements little is known, save that they are sometimes excited by poisons circulating in the mother's blood. The reflex movements are very prominent in the new-born infant, and are probably well marked also before birth (Finizio, *Pediatria*, viii. 254, 1900); the tickling of the palms or soles causes flexion of the digits after the infant is born, and possibly the pressure of the uterine walls or of the other fœtal parts may produce similar results in utero. The impulsive movements have been compared by Preyer to those of half-awakened hibernating animals, and are neither reflex nor instinctive; they are not caused by peripheral stimulation nor by cerebral initiation; purposeless movements of the limbs are instances of them. Among the instinctive movements which probably the fœtus is capable of making, are sucking and swallowing. Little is known regarding the stimuli which excite fœtal movements. Laying a cold hand upon the maternal abdomen nearly always does so, a fact which the obstetrician makes use of in difficult cases of diagnosis. So apparently does a cold drink; and indeed any shock or jar to the maternal system may act as an excitant. Ch. Féré (*Sensation et mouvement*, p. 94, Paris, 1900) has gathered together some other excitants or supposed excitants of fœtal movements. They are loud sounds and strong smells, the red rays of light (as in the case of a hysterical pregnant woman in a photographic saloon), maternal emotions (anger, fear), and dreams, fatigue, and hunger. It has been noted that one of the difficulties in obtaining a skiagram of the fœtus in utero is the liability of the unborn infant to be thrown into violent movements by the Röntgen rays (Bouchacourt, *L'Obstétrique*, v., pp. 20, 137, 1900). It is probable that various medicines taken by the mother influence the frequency and force of the movements of the unborn infant; and it has been noticed that in women who have been in the habit of taking morphia, abstinence from that drug has led to spasmodic activity of the fœtus in the uterus. Féré (*loc. cit.*) regards all fœtal movements as reflex in character; the various excitants all lead directly or indirectly to uterine contractions, and these, by compressing the fœtus, produce the muscular activity.

Sensation in the Fœtus.

There can be no doubt that the fœtus possesses cutaneous sensibility before birth, and that pinching the skin of the limbs and other parts sets up reflex movements; but that there is sensibility to temperature is doubtful, at least the liquor amnii prevents sudden changes in the heat of the surrounding parts, and so interferes with the testing of this part of the nervous system. There may be some sensation of taste before birth; but it is difficult to imagine the

existence of any degree of hearing, sight, or smell. At the same time the faculty of perceiving smells and sounds exists before birth, and is manifest in prematurely born infants; and the retina is sensitive to light and the pupil reacts to mydriatics and myotics at the time when the infant, premature or mature, is expelled from the womb. Féré (*loc. cit.*) points out that the maternal sensations of sight, hearing, smell, and taste are, as it were, reduced for the fœtus to the common elementary form of movement. All that need be said, all that can be said, about mental processes in the unborn infant is that there is much sleep.

The attempt has been made in the preceding pages to give the reader some idea of what is known of the physiology of the fœtus, for upon it must be built up our views of the hygiene of antenatal life, and upon it must be founded the explanation of the peculiarities of fœtal maladies. How defective our knowledge is, will have been very apparent; but there is at least one hopeful circumstance to record—the number of earnest attempts that are every day being made to supply the defects and to increase the sum total of what is surely known of vital processes in the infant still within the uterus, but already evincing a degree of independence in its life.

CHAPTER XI

Fœtal Pathology: General Principles. Scope of Fœtal Pathology; Causes of Limited Knowledge; Fœtal Morbid States; Classification; Causes of Peculiarities of Fœtal Diseases—(1) Influence of Intrauterine Environment; (2) The Placental Factor; (3) The Embryonic Factor.

THE fœtal period of life is, as I have been trying to make clear, full of wonders. There is the wonder of its anatomy, as revealed by the study of the mechanism, which shows such accurate adaptation to the varying needs of the various months of antenatal life. There is the wonder of its physiology, the marvel of the mechanism in action, with all its minor wonders of fœtal circulation, respiration, nutrition, excretion, motion, and sensation. There is the mystery of the interrelation with semi-independence of the maternal and fœtal economies, the intertwining of two lives. There is the transition of birth, accomplished as a rule so smoothly and yet so complicated, so profound—truly a wonder among wonders. There is the no less wonderful but less evident transition from the embryonic to the fœtal state. Truly, Nature is a past-mistress in the art of making transitions easy and of utilising the materials and forces of one economy for the construction and working of another; her secret, if we may guess it, is that she makes careful preparations long before the transition actually happens, and so the process is quick, safe, and smooth.

We are now in a position to study, with some hope of understanding its intricacies, the fœtal mechanism thrown into disordered action or thrown out of action altogether—I refer to fœtal diseases and intrauterine death. Here, also, we shall find much to marvel at—the safeguards with which Nature has surrounded the delicate fœtus in utero, the protection of the fœtal against the diseased maternal organism and of the maternal against the diseased or dead fœtal organism, the tendency to rapid repair or recovery, and the interesting peculiarities of morbid processes occurring in immature structures. In this chapter fall to be considered the general principles which seem to me to govern the manifestations of disease in the fœtus, and to account for the characters which antenatal maladies possess. But, first, what are the morbid states of the fœtus?

Scope of Fœtal Pathology.

Fœtal pathology is characterised by diseases as distinguished from embryonic pathology, which has malformations and monstrosities as

its peculiar possession. If the question be asked, "What are the diseases to which the fœtus is liable?" the reply must be that with some inconsiderable exceptions it is liable to all the diseases to which later life is liable. I made the discovery of the wide scope of fœtal pathology some years ago, when engaged in writing my work, *The Diseases of the Fœtus* (2, 4); I found that in two volumes (the only ones which have been published) I was able to discuss fully no more than the congenital diseases of the subcutaneous tissue and some of those of the skin; and it soon became clear to me that I was engaged in attempting to write a whole system of medicine from the fœtal standpoint. When Grætzer wrote his work, *Die Krankheiten des Fötus*, he was able to put most of what was known of fœtal pathology into 273 pages; but that was in 1837, and the additions that have been made to our knowledge of the subject in more than sixty years have been enormous. One had to commence to attempt to write a book to realise how enormous the additions had been. In a broad sense the pathology of the fœtus is co-extensive with that of the adult. The fœtus enjoys a partial immunity from the attacks of certain parasites which produce skin diseases in post-natal life, and it is to some extent protected from external violence by its environment; with these exceptions it has the same wide pathological possibilities as has the child or adult. Further, it is apt to be affected with certain maladies in a peculiarly aggravated form. Fœtal diseases, then, are, with few exceptions, the diseases of postnatal life modified in certain ways.

Limited Knowledge of Fœtal Pathology.

While, however, the scope of fœtal pathology is wide, the opportunities of studying it are few and our knowledge of it is limited. It has been urged that if it be true that the fœtus is liable to all the maladies of postnatal life, it is surprising that they are not better known and more often met with; and it has been added that some diseases (their number is being rapidly reduced) have not been seen even once in the fœtus. These objections can be very easily removed. The sick fœtus, unlike the sick child or adult, is not available for inspection save when he is expelled from the uterus, an occurrence which may take place at any stage in his malady—may not, indeed, take place at all till after the incidence of intrauterine death or the supervention of intrauterine recovery. If a physician's sole knowledge of his patient were limited to a single peep at him once in a period of seven months, it is not to be expected that his acquaintance with his maladies would be either extensive or accurate. Further, if he were unable, should his patient chance to die, to make an examination of his corpse till some days or weeks had elapsed, and brought with them structural changes, it is not likely that the conditions then found would throw much light upon the original malady. There are other reasons why the pathology of the fœtus is comparatively little known, such as the low estimate of the value of fœtal life and the invasion of the subject

by such unscientific imaginings as those associated with maternal impressions. I have already referred to the lack of knowledge of the details of fœtal physiology—a lamentable defect, when it is remembered that physiology is the key to pathology—and there is the innate difficulty of the subject. These reasons are sufficient to explain the paucity of published observations of some of the diseases of antenatal life. It may be added, however, that the peculiar environmental conditions of the fœtus, and the projection of the embryonic element into its life, in a large degree tend to mask the resemblance between its diseases and those of the child or adult, and even to make them appear essentially different.

Classification of Fœtal Morbid States.

Many systems of classification have been used by writers on fœtal pathology: some are catalogues and not really classifications at all; others are etiological, pathological, regional, or prognostic; and yet others combine all. "A true classification," it has been said, "is a compendious expression of perfect knowledge": it need scarcely be stated that such a classification of fœtal morbid conditions is not at present possible. It is also clear that "some provisional classification is a necessary condition of increase of knowledge," and such a provisional classification can be got for fœtal pathology.

The plan which I adopted in my work on the *Diseases of the Fœtus*, and further elaborated in the index of *Teratologia* (16), may be regarded as a combination of the regional and the etiological. It is manifestly far from perfect; it is purely provisional, and is intended only as a convenient and suggestive method of grouping together many morbid states. It consists of seven primary divisions—(1) transmitted diseases, (2) transmitted toxicological conditions, (3) idiopathic diseases, (4) neoplasms, (5) traumatic morbid states, (6) diseases of the fœtal annexa, and (7) the pathology of fœtal death. The last-named division is entirely for convenience, and will be dispensed with when the pathologist is able clearly to differentiate between the changes due to disease and those that are post-mortem. The dimensions of the third group (idiopathic diseases) must not be regarded as in any degree fixed, for future investigations can hardly fail to enlarge the first group (transmitted diseases) at its expense. One disease, namely congenital elephantiasis, may be said to be at present on its way from the one group to the other; at any rate the record sent to me by Dr. Moncorvo of Rio de Janeiro (*Trans. Edinb. Obst. Soc.*, xxi., 25, 1896) seems to suggest this conclusion, for in it a woman who suffered from lymphangitis in her pregnancy gave birth to an infant with congenital elephantiasis, in whose blood was the streptococcus of Fehleisen, and the deduction was that the new formation was due to lymphangitis, set up by the streptococci coming from the maternal circulation. With regard to the neoplasms, there can be no doubt that their origin in the fœtal period is more than questionable: the dermoids, the teratoids, the teratomata, and the included fœtuses are certainly embryonic or germinal rather than fœtal; but, as has been

already insisted upon, the classification is intended for convenience rather than for strict accuracy, and in the meantime the tumours may be allowed to remain in it. An outline of the scheme of classification is given below:—

Classification of Fœtal Morbid States.

I. Transmitted Diseases—

1. The Exanthemata, Malaria, etc.
2. Tuberculosis, Sepsis, Elephantiasis, etc.
3. Syphilis.

II. Transmitted Toxicological States—

1. Lead-poisoning, etc.
2. Poisoning by Morphine, Mercury, Strychnine, etc.
3. Alcoholism.

III. Idiopathic Diseases—

1. Subcutaneous Tissue and Skin, *e.g.* General Dropsy, Ichthyosis, etc.
2. Osseous System, *e g.* Fœtal Rickets, Achondroplasia, etc.
3. Alimentary System, *e.g.* Fœtal Ascites, Peritonitis, etc.
4. Respiratory System, *e.g.* Pneumonia, Hydrothorax, etc.
5. Circulatory System, *e.g.* Endocarditis, Hydropericardium, etc.
6. Hæmopoietic System, *e.g.* Thyroiditis, Thymitis, Hepatitis, etc.
7. Genito-Urinary System, *e.g.* Nephritis, Distended Bladder, etc.
8. Nervous System, *e.g.* Paralyses, Contractures, etc.

IV. Neoplasms—

1. Of the Head and Face, *e.g.* Pre-auricular Appendages, Cysts, etc.
2. Of the Neck, *e.g.* Cervical Cysts, Chondromata, etc.
3. Of the Trunk, *e.g.* Sacral and Coccygeal Cysts, Fibromata, etc.
4. Of the Extremities, *e.g.* Exostoses, Lymphangiomata, etc.
5. Of the Internal Organs, *e.g.* Sarcomata, Rhabdomyomata, etc.

V. Traumatic Morbid States—

1. Fractures.
2. Dislocation.
3. Wounds.
4. Congenital "Amputations."

VI. Diseases and Morbid Conditions of the Fœtal Annexa—

1. Placenta, *e.g.* Tubercle, Œdema, etc.
2. Umbilical Cord, *e.g.* Knots, Rupture, etc.
3. Chorion, *e.g.* Abnormal Vascularity, etc.
4. Amnion and Liquor Amnii, *e.g.* Adhesions, Hydramnios, etc.
5. Decidual Membranes, *e.g.* Inflammation, etc.

VII. Pathology of Fœtal Death—

1. Maceration, Mummification, etc.
2. Rigor Mortis.
3. Putrefaction.

It will be seen from a consideration of the scheme of classification, that the number of fœtal morbid states is large. Even if the neoplasms be excluded, there still remain many interesting and important maladies for investigation. It may yet be possible to separate the morbid states characteristic of fœtal life from those characteristic of the neofœtal epoch, just as there is reason to regard mummification as the special post-mortem change of the neofœtus and maceration as the special alteration of the fœtus; but in the meantime our knowledge is insufficient to permit generalisations of this kind.

Peculiarities of Fœtal Morbid States.

A limited acquaintance with fœtal diseases is sufficient to make it plain that the maladies of the infant still in utero differ from those of the child after birth in many ways; but the causes of these differences are not so plain. There must, however, be causes for the peculiarities of fœtal disease, and it has seemed to me that there are at least three factors which must be taken into account; these factors may be named the environmental, the placental, and the embryonic. They may be best studied in that order.

Modifying Effect upon Fœtal Morbid States of the Intrauterine Environment.

Many of the peculiarities of fœtal morbid states find an explanation in the altogether special conditions which characterise intrauterine existence. This influence is evident, or is to be discovered if intelligently looked for, in most fœtal maladies; but it is unnecessary here to do more than draw attention to its presence in connection with the exanthemata, with icthyosis, with fractures and wounds, and with the phenomena of fœtal death.

The modifying effect of environment is seen in the characters which some of the exanthemata take on when they occur in utero. Fœtal variola is a case in point. The eruption resembles that which occurs on mucous surfaces in later life, a fact which is due in all probability to the influence which the circumambient liquor amnii exerts upon the skin of the fœtus. It keeps it moist; and it is uncommon to find a noteworthy formation of crusts, and the resulting cicatrices are very little marked. The pustules do not appear to affect the face to the same extent as they do in the smallpox of later life; this may be ascribed to the fact that in utero the face is not more exposed to the light than any other part of the body. The external manifestations of erysipelas seem to be rare in the fœtus, and here also the liquor amnii may be influential; probably, however, their place is taken by

internal morbid changes, such as endocarditis, an instance of which has been recorded by Bidone (*Teratologia*, i. 182, 1894).

The idiopathic maladies as well as the transmitted show the effects of the antenatal environment; in fœtal ichthyosis, for instance, the absence of friction may be regarded as one at least of the causes of the enormous epidermic thickening which is so characteristic of the disease. What the action of the liquor amnii can be in cases of ichthyosis is not clear. It is noteworthy, however, that this fluid, which is usually protective, may under certain circumstances become pathogenic; for E. Opitz (*Centrlbl. f. Gynäk.*, xxii. 553, 1898) found that the liquor amnii in hydramnios, when injected into animals, increased the formation of lymph and greatly irritated the kidneys, while the normal liquor had no such effects.

Apart from the great traumatism of birth, the fœtus is singularly free from accidents. Now and again cases of severe maternal injury, in which the fœtus has participated, have been put on record, *e.g.* gunshot wounds of the abdomen and the so-called cow-horn Cæsarean sections; but such occurrences are the rarities of surgical literature, a circumstance which must be in great measure ascribed to the protection afforded to the unborn infant by its environment. Even the records of fœtal fractures and wounds, regarded usually as due to *contre-coup* in falls or contusions of the mother, must be received with some scepticism. Some time ago, Dr. W. Easby of Peterborough communicated to me the details of a case in which the left clavicle at birth had the appearance of a badly united fracture. The child was a healthy, well-formed girl, with no other deformities and no osseous fragility; there was nothing in the labour or the pregnancy to suggest an explanation of the state of the clavicle. Such cases may, in the absence of any more feasible theory, be ascribed to *contre-coup*, but the evidence is slight. There have been observations in which a cicatrix was found over the site of the united fracture, and the conclusion has been drawn that this represented an intrauterine compound fracture. Further, in the case of the arm and leg bones, the fracture has been met with in association with partial or complete absence of one of the bones or other malformation, *e.g.* partial defect of the fibula in cases of fracture of the tibia. To my mind these observations rather support the idea that intrauterine fractures rarely arise through external violence; it would seem as if they had their origin in what may be called amniotic traumatism. It is conceivable that through the formation of an amniotic adhesion, the trace of which is left in the cicatrix, the soft cartilage of the developing bone is distorted, perhaps even broken, and the appearance of a healed fracture produced. According to this view, the accompanying anomalies, defect of a bone or of part of one, would be easily explicable by amniotic pressure. The cases in which numerous fractures have been found at birth do not come into this category; probably they are always due to extraordinary fragility of the whole osseous system, a fragility so great that slight traumatic causes, such as jolts, would be sufficient to produce them. The intrauterine environment, therefore, may have this double modifying effect upon fœtal traumatic states:

it may make fractures from external violence very rare except when there is abnormal brittleness of the bones; and it may lead, through the occasional occurrence of amniotic bands and pressure, to the formation of so-called "badly united fractures."

With regard also to the cases of wounds on the skin of the fœtus or areas of absence of the skin, there can be no doubt that these are not commonly caused by maternal traumatism—indeed, the history of accidents is usually wanting; they find an explanation in the tearing through of amniotic bands during the process of parturition. Similarly, the so-called fœtal or spontaneous amputations are scarcely traumatic in the ordinary sense of the term, although they may be due sometimes to funic or amniotic pressure acting in a somewhat traumatic manner. These morbid states lie on the border-line between fœtal pathology and teratology; they affect structures which retain their embryonic characters when the other parts of the organism have passed into the fœtal period.

When the fœtus dies in the interior of the uterus, the post-mortem changes which ensue are rarely of a putrefactive kind; and this peculiarity finds its explanation in the fœtal environment. In its intrauterine position the fœtus is protected from putrefactive organisms, save only in the cases in which rupture of the membranes has taken place before the supervention of labour. Further, it is surrounded by the warm liquor amnii, a medium which specially favours the occurrence of the macerative changes which are the pathological expression of fœtal death. Maceration, then, is the process which the fœtal body undergoes when death occurs *in utero* and when the membranes remain unruptured. Occasionally, however, another non-putrefactive change is met with, namely, mummification, the result of which is the production of the fœtus compressus or papyraceus. This occurs more especially when the dead fœtus is not alone in the uterus, but is in the presence of a living twin, which in the process of growth pushes it to one side and compresses it. Mummification seems specially to characterise early fœtal or neofœtal death. In cases of intrauterine death, therefore, the peculiarities of the environment not only impress themselves upon the fœtal organism, but also have an important and beneficial effeet upon the mother, saving her in many instances from blood-poisoning.

There is one point in connection with fœtal death to which it is necessary to allude because of its important medico-legal bearings—namely, rigor mortis in the unborn infant. There is no evidence to show that the fœtal environment prevents the occurrence of rigor mortis, yet it is commonly believed that if the new-born infant shows post-mortem rigidity, it must of necessity have been alive at the time of birth. This dictum, which has Caspar's weighty authority to support it, has not seldom had an important bearing in cases of trial for suspected infanticide. I have elsewhere (80) entered fully into this question, and have proven, both from personal observations and from published cases, that the fœtus which dies in utero, even when it is also premature, shows unmistakable rigor mortis, and that this muscular rigidity may be the cause of difficulty in labour. The

immature condition of the muscular system and the peculiarities of the environment may lead to a shorter and less intense rigidity; but that it occurs is certain.

The Placental Factor in Fœtal Pathology.

The modifying effect upon fœtal morbid states of what may be called, for the sake of brevity, the placental factor, might have been considered under the head of the Intrauterine Environment, for the placental influence is really essentially environmental; but it is so important and so altogether special in its action, that it has seemed best to me to discuss it separately.

The predominant part played by the placenta in the physiology of the fœtus has been referred to; its rôle in fœtal respiration, secretion, excretion, and metabolism has been considered; it has been suggested that it is much more than a simple mechanical or biological filter, through which materials pass by the laws of osmosis from one economy to another; and it has been hinted that it is an important gland, with a secretion, with powers of independent metabolic activity, and with physiological possibilities which are at present much underestimated. In the placenta the maternal and the fœtal blood come into physiological, although not into anatomical contact; they come near enough to each other to exchange some of their constituent parts, but they do not touch. It cannot be doubted that the placenta has an equally important effect upon the pathological developments of fœtal life. What this effect is must, in the present state of our knowledge of fœtal physiology and pathology, be left in some degree uncertain; but there are several standpoints from which it may be regarded, and from these points the reader is invited to survey it.

In the *first* place, the presence of the placenta makes it possible for the fœtus to be diseased in structure to a very advanced degree without the suspension of its vitality. An enormous amount of morbid change may be present without the cutting short of intrauterine life. So long, for instance, as the fœtal malady attacks organs whose functions are performed in whole, or even in part, by the placenta, the induced morbidity is only potential. The lungs may be solid from pneumonia, and yet no inconvenience be caused to the fœtus *quâ* the state of its lungs so long as the placental economy is maintained. The kidneys may have their whole substance converted into cysts without the fœtus suffering to any appreciable extent, and the intestinal canal may be blocked in several places without symptomatological effects. The potential morbidity of intrauterine life becomes real at birth; for instance, an imperforate condition of the bile-ducts which has not interfered with fœtal health begins to set up marked symptoms as soon as there is an organic severance from the maternal economy. The potential mortality of the fœtus is another effect of the placental predominance. An amount of structural change quite incompatible with extrauterine existence may be present in utero without causing fœtal death. A fœtus with general dropsy may come to the full term

with its peritoneal, pericardial, and pleural cavities loaded with fluid and with advanced changes in its internal organs; it may even show signs of life at birth; yet it invariably dies in a few minutes, or at most hours, thereafter. The general dropsy was compatible with an intrauterine, but not with an extrauterine existence. With the occurrence of birth the infant found itself in conditions in which its diseased organs were no longer able to conserve life: the potential mortality became real. I have already referred to the enormous amount of teratological change which might be present in the fœtus without causing its intrauterine death. It is thus possible for a monstrous embryo to be born into its neofœtal period of existence and to be carried through the whole of fœtal life without interruption. The monstrosity is produced in the embryonic epoch; but the wrong lines of development then laid down continue to be followed in the fœtal period, and the process is only brought to a conclusion by death, when the organism is projected into a non-placental environment. In this manner the placenta, by preventing intrauterine death, no doubt often saves the mother from the risks of premature confinement; but for this effect the prolongation of the life of a diseased or monstrous fœtus would seem to be an unmixed evil (44).

The placental factor in fœtal pathology may be looked at from a *second* standpoint: the placenta may be regarded as a protection to the fœtus, as a barrier preventing sometimes, if not always, the passage of poisons and toxines from a diseased maternal organism to the fœtus. Porak (*Arch. de méd. expér. et d'anat. path.*, vi. 192, 1894) and others have experimentally demonstrated some of the ways in which the placenta acts with regard to poisons in the maternal circulation. It has been shown that it has a real affinity for some toxic substances; and in it accumulate copper and mercury, but not lead. In addition to its pulmonary, renal, and intestinal functions, the placenta fixes glycogen and acts as an accumulator of poisons, and so resembles in its action the liver in the adult. This has been referred to in the preceding chapter. But the storing up of poisons in the placenta is not so general as the accumulation of them in the liver of the mother. While the placenta stores up poisons, it does not on that account altogether prevent their passage into the fœtal tissues; it does not act as a complete barrier. It offers, however, a varying degree of obstruction to their passage; it allows copper and lead to pass easily, arsenic with greater difficulty, and mercury apparently not at all, for Porak always found it in the placenta and never in the fœtal organs. These observations, it must be remembered, were made on guinea-pigs, and do not of necessity apply to the human subject; but in the absence of other evidence they have a considerable value.

With regard to the action of the placenta as an accumulator of pathogenic microbes and their toxines, and as a barrier to their passage to the fœtus, a great deal has been learned during the last fifteen or twenty years; but the problems which yet remain for solution are very numerous and the difficulties associated with them

are extraordinary. The idea that the placenta acts *always* as a filter, keeping back the bacilli and cocci which may be present in the maternal circulation, and so saving the fœtus from their evil effects, must be abandoned. That the placenta acts *often* as a prophylactic filter is also open to grave doubt. Bacteriological researches have shown that through it can pass the bacilli of anthrax, of fowl cholera, and of typhoid fever, the pneumococcus, the streptococcus, the spirillum Obermeieri, the bacillus of glanders, the pathogenic organism of hydrophobia, and perhaps the hæmatozoon of malaria. Further, it is not necessary to admit the existence of a placental lesion to explain the passage of the micro-organism; for in the case of animals, at any rate, the most rigorous examination of placentas through which bacteria have been transmitted has sometimes shown neither macroscopic nor microscopic changes in them. For the infants of even seriously tubercular women to be found showing tubercular changes at birth is a rare occurrence, and it is only during recent years that congenital tuberculosis has been definitely proven by the discovery of the tubercle bacillus in the fœtal tissues and in the placenta. In this disease, therefore, if in any, it might be expected that the beneficent rôle of the placenta would be demonstrable. Georges Küss (*De l'hérédité parasitaire de la tuberculose humaine*, Paris, 1898), who has investigated the whole question of tubercular heredity in a very complete fashion, is of opinion that even when the tubercle bacilli make their way into the placenta, that structure has still the power of protecting the fœtus from the microbic invasion. He adduces in support of his statement the two cases of Lehmann, in which the infants were free although the placentas were tubercular, and those of Schmorl and Kockel, in which, although there was placental tuberculosis and some bacilli were found in the vessels of the chorion, yet neither the microscope nor experimental inoculations revealed the presence of fœtal bacillosis. Küss also noted that the fœtuses that showed infection always had a much less marked bacillosis than might have been expected from the intensity of the maternal blood-infection and from the advanced state of the placental lesions. It seems, therefore, fair to conclude that in tuberculosis, at any rate, the number of germs that pass through the placenta is very small. It must also be borne in mind, however, that even where the organs of the fœtus of a tubercular mother appear healthy, inoculation of animals with pieces of them sets up in some instances undoubtedly tubercular processes. Possibly infective toxines may pass even when the bacilli do not. The placenta cannot, therefore, be regarded as a complete or certain barrier to microbic invasions even in the best circumstances.

Third, it is now necessary to look at the placental factor from quite the opposite standpoint, viz., as the chief, if not the only avenue of access for germs to the fœtus. Practically the only other way possible from the mother to the fœtus is by the liquor amnii. Certainly the researches of P. L. Ferrari (*Lo Sperimentale*, Ann. xlix., sez. biologica, fasc. l., p. 62, 1895) on the structure of the amniotic membrane seem to show that through its stomata materials may pass

from the lymphatic system of the mother into the liquor amnii and then to the fœtus by the mouth and intestinal tract (*vide* Chapter X.) While, however, it is right to regard this as a possible mode of entrance, it cannot be looked upon as a common one. Probably "water-borne infection" is very rare in the fœtus. It follows, therefore, that the placental route is practically the only one from mother to fœtus; and it is a matter of some importance to determine the circumstances that increase or diminish placental permeability to poisons and germs. Our knowledge of these circumstances is imperfect, but the following conclusions seem warranted. It is, for instance, apparent from the study of the comparative anatomy of the placenta, that its permeability must vary in different species, according to the thickness of tissue intervening between the maternal and fœtal circulations. It would appear from the extensive researches of Duval, that in this respect the human placenta occupies an intermediate position between that of the rodents and that of the ruminants. In the rodent the barrier is very slight; in the ruminant there is a fourfold barrier, two capillary walls and two epithelial layers, between the maternal and the fœtal blood. There would seem to be no need for a lesion in the former case, while in the latter some morbid change would almost appear to be necessary, before germs or their toxines could pass from mother to fœtus. Again, there is reason to believe that placental permeability varies at the different epochs of pregnancy; this conclusion seems, at any rate, to be warranted in the case of the rodents. The experiments of Charrin and Duclert (*Compt. rend. Soc. de biol.*, p. 563, July 13, 1894) are, however, full of interest in relation to the question of placental transmission, and deserve notice. These observers found that certain conditions of the maternal blood favoured the passage of germs through the placenta; the presence in the blood of microbic toxines, *e.g.* tuberculin, as well as of acetate of lead, alcohol, or lactic acid, seemed to increase in a marked manner the permeability of the placenta. Previous inoculation with corrosive sublimate, on the other hand, seemed to make it more difficult for microbes to pass. It would almost appear as if the prolonged presence of the microbes in the neighbourhood of the barrier led to the breaking down of it by the action of the toxinic products of microbic vitality. The experiments, it must be borne in mind, were performed on guinea-pigs; nevertheless they have at least a suggestive value as regards the human subject.

There can be no doubt, therefore, that although its permeability varies, the placenta is the avenue by which germs and poisons reach the fœtus. This circumstance has a very considerable bearing upon the position of primary lesions in the fœtus. The infection reaches the body of the unborn through the blood, and traverses first the placenta and the umbilical cord, then the umbilical vein, then either the liver or the ductus venosus, then the heart, and so is distributed to the whole organism. It is no matter for wonder, therefore, that the primary pathological changes are commonly found in the placenta, liver, or heart. In this way it is quite easy to understand how, in

such a case as that reported by Bidone (*loc. cit.*), erysipelas in the mother does not produce skin lesions in the fœtus, but streptococcic endocarditis. The locality of the lesions is determined by the route of invasion. Similarly, in congenital tuberculosis it is rare to find the morbid process in the lungs, and in half the certain reported cases the pulmonary tissue was devoid of lesions. It is true that the liver was not invariably tubercular, but it is possible that in such cases the infection passed outside the liver straight through the ductus venosus to the heart and general circulation. If primary lesions exist at all in fœtal syphilis, they are to be sought for not on the skin or the mucous surfaces, but in the placenta or liver or heart. What has been said of the distribution of diseases applies also to the invasion of the fœtal body by mineral or vegetable poisons, and Porak (*loc. cit.*) has called special attention to this in his experimental work. Thus a great many of the peculiarities of fœtal diseases are to be accounted for, and it becomes more and more apparent that the pathology of the fœtus is simply postnatal pathology modified by the special physiological conditions which exist during this period of life.

There is a *fourth* aspect in which the placental factor in fœtal pathology has to be considered, viz. the lethal effect upon the fœtus of lesions of the placental substance. It has been pointed out that the presence of the intact placenta preserves the life of the fœtus even when its organs are most extensively diseased. The placenta is in this sense the most vital organ that the fœtus possesses; but it is also the most vulnerable. When it is itself the seat of lesions, the life of the unborn infant is immediately in grave danger. All placental lesions are not, of course, equally lethal to the fœtus, and I have noted cases of cysts on the fœtal aspect and of calcareous deposits on the uterine along with perfectly healthy infants; but, as a general rule, disease of the placenta means death of the fœtus, or, what comes to the same thing, premature expulsion of it from the uterus. It is of great importance, in studying the causes of abortion and premature labour, to remember that the placenta is an organ of the fœtus. During the last few years I have been frequently asked to state the cause of fœtal death and of premature delivery from the examination of the fœtus alone. It is scarcely ever possible to do so, for the cause of the fatal result is most often in the very structure that is not available for examination. I cannot too strongly insist upon the fact that a fœtus without the placenta and membranes is an incomplete specimen. To attempt to give an opinion from it alone resembles trying to find out the cause of death in a case of head injury from the dissection of the thorax and abdomen. A conclusion of some kind may be reached by a process of exclusion, but its value cannot be very great. The placental filter, then, may save the fœtus sometimes from disease, but it may do so at the cost of fœtal life. It may prove a barrier to the disease germs, but, inasmuch as the barrier is the most essential organ that the fœtus possesses, this protective influence may be very dearly bought. The placenta, in saving the fœtus from disease, becomes pathological itself, and so condemns it more certainly to

death. There may exist some doubt as to the exact nature of the morbid changes in the fœtus which alcoholism in the mother tends to produce (J. Matthews Duncan, *Trans. Edinb. Obstet. Soc.*, xiii. 105, 1888); but there can be no doubt at all about the frequency with which abortion and premature labour from placental lesions occur under these circumstances. When it is borne in mind that the placenta is lungs, stomach, and kidneys to the fœtus, it is easy to understand how pathological changes in it soon lead to fatal results in the latter.

From yet a *fifth* standpoint the placenta may be regarded in connection with its effect upon fœtal morbid processes. By reason of its highly differentiated tissue and its active metabolism, it may act upon pathogenic substances in other and more subtle ways than by simply opposing a barrier to their passage from mother to fœtus. It is possible that it may secrete products which may act as antitoxines; it is also possible that under certain circumstances it may by a disordered metabolism produce materials which increase the virulence of attacking germs or weaken the natural defences of the placental tissues. Again, it is possible that too much speculation may retard rather than advance our knowledge of this whole subject of the influence of the placenta in fœtal pathology.

There is, however, one other point to which some reference must here be made, although it must be conceded that it also is largely speculative. Thus far I have dealt only with the transmission of disease from mother to fœtus; but it may be asked whether the current is not sometimes reversed or capable of being reversed, and morbid influences pass from fœtus to mother? From what has been stated in the preceding chapter regarding the excretory functions of the placenta and the experimental evidence associated with them, there is a presumption at any rate in favour of the reverse current as regards disease. I have referred also to the fact that Charrin (*Compt. rend. hebd. de l'Acad. des Sc.*, Paris, cxxvii. 332, 1898) has, in the case of animals, succeeded in killing the mother by injecting the toxine of Löffler's bacillus into the fœtuses in utero; it may be found to be possible by making progressive injections, thus to render the mother immune against the poison of diphtheria. We are tempted to ask ourselves whether the fact that the bacillus, toxine, or poison reaches the mother by the placental route will in any way modify the results produced thereby in the maternal organism? Again, will the physiological condition of the woman in pregnancy (anæmia, hyposiderosis) increase or diminish her susceptibility to the morbid influences coming to her from the fœtus? Does the placenta by its metabolic activities or its internal secretion (not yet demonstrated) intensify or reduce the virulence of the germs or toxines? The whole question of the effect of fœtal morbid processes upon maternal predisposition and immunity can hardly be regarded as more than touched at present, and much remains to be done before any conclusions can be drawn with security. Certainly the problem of a mother with an acquired immunity against smallpox, scarlet fever, measles, etc., carrying in her womb a fœtus with an almost certain

predisposition to take any or all of these very diseases, is most interesting and complicated. As complicated and as interesting is the state of a mother who has not got syphilis and who is yet in physiological contact through the placenta with a fœtus who is syphilitic because of the syphilis of the father. It seems necessary to grant the existence of this reverse current of pathological influence proceeding from fœtus to mother, if we are to offer any explanation of the occurrence of telegony, the wireless telegraphy of antenatal pathology; without such a mechanism it is impossible to understand how characters of a previous sire can be transmitted to the progeny of a later one by the mother; of course, in cases of telegony it would also be necessary to predicate the possibility of the ova in the ovaries becoming imbued with paternal characteristics apart from actual impregnation. Many and difficult are the problems which present themselves to those who are courageous enough to attempt to study the laws of the phenomena of generation.

The Embryonic Factor in Fœtal Pathology.

While the placenta and the intrauterine environment serve to account for some of the peculiarities of fœtal maladies, they leave unexplained not a few. The occurrence which complicates fœtal pathology so greatly is the projection into it of the results of embryonic pathology. It is an error to suppose that every morbid condition found in the infant at the moment of birth must have arisen during parturition or in the fœtal period. It is common to speak of "fœtal" monstrosities, but if by this it is meant that the monstrosities in question are the result of fœtal pathological processes the notion is probably erroneous. There is good reason for believing that malformations and monstrosities are the product of morbid agents acting during the embryonic period. The fœtus is born, as it were, into fœtal life with all the results of embryonic pathology in it; so long as these are not incompatible with the continuance of fœtal life, it goes on growing, and may reach the full term and be transferred into extrauterine life, still bearing the evident traces of its embryonic troubles. It is probable that the original malformations do not during the fœtal period greatly alter in their appearances; they grow with the general growth of the body, and may, according to circumstances, become more or less marked, but they retain their essential characters. They may, however, have a very important bearing upon the development of fœtal diseases, and their coexistence with them certainly makes their pathology very difficult to understand. The difficulty is still further increased by the fact to which allusion has already been made, that the whole organism does not at once pass out of the embryonic into the fœtal period. It comes about, therefore, that the fœtal bone diseases are specially difficult to understand, for they are really *deformities* originating during the period which as a whole is characterised by the production of *diseases*.

Some years ago it was a very commonly accepted theory that

monstrosities were caused by the occurrence of diseases in the fœtus, and Sir James Simpson (among others) gave the weight of his authority to the view. Modern research has not supported this theory. Duval ("Pathogénie générale de l'embryon," in Bouchard's *Traité de pathologie générale*, i. 159, 1895), especially, decides against it, and distinctly states that it is not to be thought that a malformation of any part is the result of a disease from which the malformed part has suffered. With this I in part concur; but I think that just as a pre-existing malformation may influence the progress of a fœtal disease, so a fœtal disease supervening upon a malformation may, during the seven months of fœtal life, very considerably alter its manifestations as seen at birth. Further, the cause of the malformation may not cease to act with the close of the embryonic period; it may continue to act in the fœtal; in this way it may be the cause of both the deformity and the disease. For instance, a malformation of the intestine and fœtal peritonitis often coexist; both may be the result of one and the same cause; but it may also quite well be that the existence of the disease has influenced the nature of the malformation, and that the malformation has made the disease more or less active. Exomphalos is a manifestly teratological condition, and there often exists along with it a great amount of peritonitic fixation of the abdominal viscera, a fact upon which stress has been laid by A. Rischpler (*Archiv f. Entwickelungs-mechanik der Organismen*, vi. 556, 1898), but it seems to me that all this association shows is that some common cause acting specially on the abdominal region has been at work during the embryonic and the fœtal period. Peritonitis coming on during the fœtal epoch may exaggerate or alter the appearance of the exomphalic condition, but it is doubtful whether it is in any sense either the cause or the result of the exomphalos. The consideration of the embryonic factor takes into account, therefore, (*a*) the modification of fœtal diseases by pre-existing malformations, and (*b*) the modification of malformations by coexisting diseases.

In the preceding pages I have attempted to describe three possible factors which play a part in modifying the diseases which affect the fœtus and give to them their peculiar characters. Doubtless there are other factors, but the existence of these three—environment, the placental influence, and the embryonic complication—must be recognised. In order to make the matter somewhat simpler, I may compare the fœtus to a traveller coming from a tropical climate to our country. He finds himself in a new environment which in many details differs much from that which he has left, and which gives new characters to the diseases which he now develops. Further, through his dress and modes of life, he lays himself open to taking certain maladies more often and in more serious forms than previously, while from others he may perhaps be protected. In the third place, he comes to our country with the results of the diseases from which he has already suffered in his own land in him and part of him; and these earlier pathological experiences also influence the course of the morbid states which he acquires later.

Fœtal pathology, then, presents many difficult problems for solution. It asks how pathological processes are altered by the presence of the liquor amnii and by the absence of atmospheric air and light; it calls for a definition of the action of the placenta in the preservation of health or the production of disease in the fœtus; and it places prominently before us the extraordinarily complicated question of the inter-action and inter-relation of embryonic malformations and fœtal diseases in the fœtal period of the existence of the organism. Pathologists of the future have no light task before them in the solving of these problems.

CHAPTER XII

Types of Transmitted Fœtal Diseases. Fœtal Variola: Pathogenetic Possibilities; Clinical Peculiarities; Diagnosis, Prognosis, and Treatment. Fœtal Vaccinia; Antenatal Immunity. Fœtal Measles, Scarlet Fever, Erysipelas, Parotitis, Influenza, Pertussis, Relapsing Fever, Yellow Fever, and Cholera. Fœtal Typhoid; Pathogenetic Possibilities; Widal Test in the Fœtus. Fœtal Malaria; Observations; Pathogenetic Possibilities.

THE transmitted diseases of the fœtus constitute the most interesting group of antenatal morbid states. Their interest depends, in the first place, upon the varied and intricate relations which are or may be established between the maternal and fœtal organisms through them and as a result of them: in no physiological or pathological laboratory could more elaborate or instructive experiments be devised and carried through than are to be witnessed in the uterus, when the mother is the subject of a malady which is known to be transmissible. In the second place, their interest depends upon the possibilities of successful therapeutics which they present; when the cause of a disease is known, and when the diagnosis of its occurrence is not outside the bounds of possibility, the chances of successful treatment, preventive and curative, are much increased. To some extent it may be said that the etiology of the transmitted fœtal diseases is within our knowledge, and their diagnosis not altogether outside our grasp; with perseverance and skill their treatment will yet be hopefully undertaken by the well-informed physician. There are other reasons why the transmitted fœtal diseases appeal more directly to us than the idiopathic maladies; some of these will emerge, as the consideration of the subject is proceeded with; in the meantime let us take, as the first type of this group, *fœtal variola.*

Variola in the Fœtus.

In the first separate work on diseases of the fœtus (66), the author, Düttel, writes: "Primum, autem, deprehendimus morbum variolum, quo gravida corripitur saepius transire in ipsum fœtum," and proceeds to gather together the cases of fœtal variola which had up to that time (1702) been reported. There were not many of them; but in the number, it is interesting to note, were instances of fœtuses with smallpox, the offspring of women who had themselves escaped the malady, but had been in contact with cases of it. Thus early was it observed that the infection might pass through the

maternal organism to the fœtal without manifesting itself in the former. Reference was also made to the case of a variolous mother whose infant was born with no signs of smallpox; but in this instance the infant died before the malady had time to develop. It may be concluded that, prior to 1600, the occurrence of variola in the fœtus was hardly suspected, and was even denied, as is seen from the statement, "Dum fœtus est in utero, non ei accedere variolos nec morbillos"; but with the seventeenth century came the records of undoubted cases, and, as has been seen, at the beginning of the eighteenth, Düttel was able to enumerate quite a number of them. As late, however, as the close of the eighteenth century, the birth of such a fœtus was regarded as somewhat of the nature of a wonder, for Lynn's paper read at the Royal Society (London) in 1786 was entitled, "The singular case of a Lady who had the Smallpox during pregnancy, and who communicated the same disease to the Fœtus." I have met with traces of a belief in the immunity of the fœtus from smallpox among the laity even at the present time. From the now very large number of published cases of fœtal variola it is easy to obtain some idea of the pathogenetic possibilities, when a pregnant woman develops smallpox or comes into contact with a case of it. Let me state some of these possibilities.

When a pregnant woman is attacked by smallpox, it does not necessarily follow that her infant will be born showing the eruption on its skin. It may be born alive with no sign of variola, and may die soon afterwards, or may live and not develop the disease; in the latter case, it would appear that it is possessed of an antenatal immunity from variola, which persists in postnatal life. It may also be born dead, having died in utero, from the high temperature or some other cause, before the disease had time to show itself in the form of the distinctive eruption. In fact, it must be regarded as the exception and not as the rule to meet with variola in the stage of eruption at the time of birth. There is great need for further and more accurate investigation of the infants, alive and dead, that are the offspring of variolous mothers, and yet show no external signs of variola. It may be found that, although they have not the pustules and other external indications of smallpox, yet they may have suffered in other ways: for instance, there may be traces of the eruption on mucous surfaces; or the nutrition may have been interfered with, and an atrophic state produced which persists after birth and predisposes to infantile diarrhœa, etc.; or there may have been secondary infection with streptococci and staphylococci (Auché, *Bull. Soc. d'anat. et physiol. de Bordeaux*, xiii. 278, 1892); or the placental tissues may have become diseased, and fœtal death occurred. From our knowledge of other transmissible maladies, we are justified in believing that the poison of variola, entering the fœtus by the umbilicus, may cause lesions in the organs along the placental route of invasion without affecting the skin.

When, however, the fœtus shows marked external signs of smallpox, several clinical types may be met with. Thus, the mother may pass through a slight attack of modified variola, her pregnancy may

go on to the full term, and a living infant be born covered with a great or a small number of pustules, or with scars, or with simple papules which have not yet suppurated. Again, the pregnancy may be interrupted, and the fœtus be born prematurely, showing the eruption in one or other of its stages, or developing the exanthem within a few hours or days of birth. Yet again, the mother may die from confluent or hæmorrhagic smallpox, and the fœtus be removed post-mortem from her uterus and be found bearing the evident signs of the malady. Apparently the fœtus is susceptible to variola at any stage, for a case at the third month has been reported, and there are observations at almost all ages after that up to the full term. An interesting complication is introduced into the clinical types, when the uterus contains not one but two fœtuses; in one of the recorded cases both the twins suffered from variola; in another case, one was affected while the other had evidently escaped; and in a third case, although both fœtuses showed the eruption, one exhibited many pustules (sixty-five in all) while the other had only a few (six). In these plural pregnancies both the fœtal membranes and the placenta were generally double, but in one remarkable instance, reported by Chantreuil (*Gaz. d'hôp.*, xliii. 173, 1870) the placenta was composed of a single mass, although there were two chorions and amnions. Chantreuil's case was also noteworthy, for the reason that, while one twin evidently had variola, neither the other twin nor the mother suffered from it, a striking example of the pathological independence of the unborn infant, both as regards his mother and his brother or sister in utero. It is possible to account for such a case as that just referred to; but what is to be said about the explanation which Legros (*Gaz. méd. de Par.*, 3. s., xx. 493, 1865) offers in connection with the following record? A woman gave birth to a five months fœtus showing the eruption of smallpox; she had not herself had smallpox; but the father of the child was in the stage of convalescence from variola when conception took place. Could the infection have remained latent in the embryo and then in the fœtus until nearly five months of intrauterine life had elapsed? This possibility has been affirmed for syphilis and malaria, but in this case one is tempted to ask whether the fœtus was really suffering from variola? At the same time, it may be that the incubation period in the fœtus is different from that in the adult, for in the case reported by Laurens (*Bull. Soc. anat. de Par.*, xliii. 184, 1868) the mother had smallpox early in her pregnancy, and two and a half months later aborted of a fœtus with the eruption well marked. In order to complete this survey of the chief clinical possibilities of fœtal variola, it may be added that the disease may perhaps be acquired by the infant during his transit through the maternal passages, or very soon thereafter; but this can hardly be described as true *fœtal* smallpox.

Reference has already been made in the previous chapter to the symptomatological peculiarities of variola as it occurs in the unborn infant; but certain details may profitably be repeated here, and some new points added.

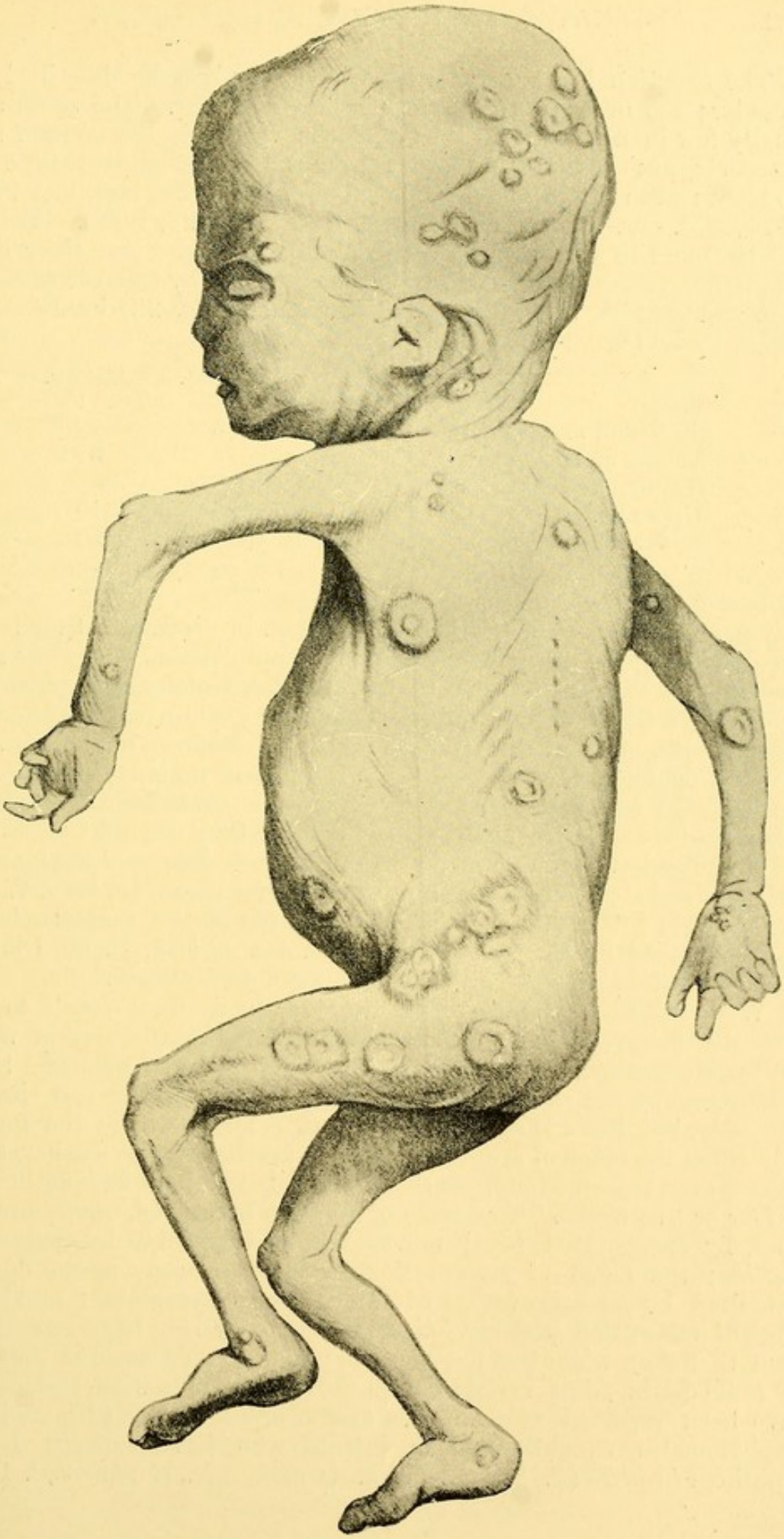


Fig. 28.—Laurens' Case of Smallpox in the Fœtus.

The eruption has a distribution which may best be described as irregular; the order of appearance is also irregular. The spots are usually few in number (12–100), and the variola is therefore of the discrete type; rarely they are many, and the confluent type is produced; even the hæmorrhagic form of eruption has been met with (Cless, *Med. Cor.-Bl. d. württemb. ärztl. Ver.*, xxxvi. 23, 1866). Below will be found in a tabular form the number of spots and their distribution in two cases of fœtal variola, one reported by Charcot (*Compt. rend. Soc. de biol.*, v. 88, 1853) and the other (Fig. 28) by Laurens (*Thèse*, Paris, 1870):—

	Charcot.	Laurens.
Face	15	1
Scalp and back of neck	23	22
Thorax and abdomen	19	30
Scrotum and buttocks	8	—
Upper limbs	16	15
Lower limbs	12	20
	93	88

The pustules vary in size from 1 to 9 mm. in diameter; they have the same shape as in the adult, and show umbilication, and they run through the same stages of macules, papules, vesicles, and pustules. They have a white or pale yellow colour, and contain clear yellow or slightly opaque fluid, and sometimes pus. Suppuration, however, is not a common feature, and there is little or no crust formation; the eruption resembles that seen on mucous surfaces in the adult. The pustules are surrounded by a red areola; they are not limited to the skin, but have been found on the mucous membranes of the mouth, pharynx, and stomach, and even on the visceral pleura (E. Huc, *Thèse*, Paris, 1862). The microscopical appearances of the eruption have been described by Charcot (*Compt. rend. Soc. de biol.*, iii. 39, 1851): "Une altération cavitaire du corps muqueux de Malpighi."

With regard to the stages of the fever in utero, it seems to be generally believed that the incubation period varies within wide limits (Margoulieff, *Thèse*, Paris, 1889); there is some evidence that it may occupy the same time in mother and fœtus and run simultaneously, but there is also evidence that it may begin in the fœtus only when the stage of eruption has been reached in the mother, and there is even reason to suppose that the incubation may be lengthened to four or five weeks. The stage of invasion is marked, sometimes at least, by exaggerated fœtal movements, and possibly by maternal malaise; the stage of suppuration, when it occurs, is no doubt signalised by an aggravation of the mother's symptoms; and the stage of desiccation possibly follows a course differing in some details from that seen when the pustules are under the influence of the air. In fœtal as in adult variola complications are met with, and cases have been reported of periostitis and necrosis of the tibia and of staphylomatic exophthalmia in infants who have suffered from exanthem *in utero* (T. Mejan, *Journ. de méd., chir., et pharm.*, i. 145, 1803).

It need hardly be added that smallpox as it occurs in the fœtus is the same disease as that met with in the adult; but, as a matter of fact, it has been proved to be so by the occurrence of infection, and by the possibility of inoculating another individual with the malady by means of the matter from the pustules of the new-born infant (E. Jenner, *Med.-Chir. Trans. Lond.*, i. 271, 1815). Further, infants who have suffered from the disease in utero have been found to be refractory both to inoculation and to vaccination.

The antenatal diagnosis of fœtal variola has not been made; but there is no reason why it should not be provisionally made when smallpox is met with in a pregnant woman, and when there is the distinct history of exaggerated fœtal movements corresponding in time with the stage of invasion in the mother. After the infant is born there ought to be no difficulty in recognising the disease, save perhaps in the cases in which the mother has escaped, but even in these the history of exposure to infection and the umbilication of the pustules ought to suffice. Neonatal pemphigus and ecthymatous syphilis neonatorum present resemblances, but not so great as to mislead the careful observer who is aware of the possibility of smallpox attacking the fœtus in utero without at the same time affecting the mother. It is impossible to state what is the intra-uterine death-rate for fœtal variola. Possibly the fate of the fœtus is determined chiefly by the degree of severity of the maternal malady, and by the occurrence or non-occurrence of premature labour, and not so much by the type of the fever by which it is affected. Mauriceau, who by his writings made conspicuous additions to the knowledge of fœtal pathology, was himself an instance of a good recovery from fœtal smallpox. That the fœtus recovers from intrauterine variola need not cause much surprise, when it is remembered that its surroundings are the very ones that the physician would choose for his variolous patients, including as they do, protection from light and the continual bathing of the whole body in a warm fluid medium of practically constant temperature. But, on the other hand, the presence of smallpox in the unborn infant may increase the gravity of the maternal prognosis, for it is probable that the mother's organs, and especially her kidneys, may receive from the morbid fœtus such a flood of pathological products as to be most prejudicially affected thereby.

The treatment of variola in postnatal life is or ought to be prevention, and nothing else ought to be necessary. In vaccination we have a sure means of preventing this malady, and this means ought always to be used. Is there any reason why a different standard of treatment should be applied to the unborn infant? It has been stated that, supposing the fœtus has taken smallpox in utero, we may with some degree of confidence leave it to Nature to effect a cure, our chief duty being to prevent premature expulsion of the little patient from his hospital; but are there any means that can be adopted to lessen the risk of his developing variola in utero? In other words, is intrauterine vaccination possible? The answer to this question demands a separate paragraph.

Vaccinia in the Fœtus.

The infant of a woman who has had smallpox in her pregnancy may be insusceptible to vaccination. A case of this kind occurred in my dispensary practice some years ago: a woman who had during her gestation a mild attack of variola, gave birth ten weeks after her recovery to a child, who was vaccinated on several occasions but always without success; she herself had good vaccination marks, which no doubt accounted for the mildness of her attack. There seemed to be no evidence that the child had had variola in utero; if he had, the recovery must have been absolutely perfect, for no traces were visible. It may be supposed, perhaps, that he was immune against both smallpox and vaccination as an idiosyncrasy. It seems, however, to be more reasonable to believe that he had been protected by the placental barrier, or some other means, from the maternal disease, but had at the same time got minimum doses of the toxine and been rendered immune against variola, and therefore refractory to vaccination. Whether this be the correct explanation of the occurrence or not, the case raises the question of the possibility of protecting the fœtus by vaccinating the mother. If a mother suffering from smallpox can confer immunity on her infant in utero, without the latter showing any external signs of variola, can she by undergoing vaccination also give this immunity without the child exhibiting vaccination marks? In a sentence, can we give the unborn infant immunity against smallpox by vaccinating the mother during her pregnancy, and if so, is the result brought about by the vaccination of the fœtus or by the transmission to it of an acquired property by the mother?

Many observations have been made upon the vaccination of the pregnant woman. During an epidemic of smallpox, pregnant women, like the other members of the community, are revaccinated, to save them from the disease; and there are therefore many opportunities of testing whether their infants are afterwards refractory to vaccination or not. It must at once be admitted that they are not invariably refractory to subsequent vaccination; but it may also be claimed as clearly proven by statistics, that many of them are insusceptible, and that the immune percentage, so to speak, is larger than can be accounted for by idiosyncrasy or accidental causes. According to some observers, the percentage of refractory infants is 32; according to others it is as high as 80 per cent.; and among recent authorities, Piéry (*Lyon méd.*, xciv. p. 37, 1900), from his own results and those of others, gives 58 per cent. as the average. Hermann Palm (*Arch. f. Gynaek.*, lxii. 348, 1901), however, gives a much lower proportion of refractories. It will, I think, be safe to accept one fœtus in three as the proportion protected by vaccination of the mother in the second half of pregnancy. From what we know of the laws of placental transmission, this is what was to be expected. If we compare the transmission of smallpox with that of vaccinia, we are not entitled to expect that the latter

will pass from mother to fœtus oftener than the former. But, it may be asked, are they comparable? I think they are; but it is necessary to remember that there are details in which they differ. An infant has never been born carrying a vaccination pustule upon its skin, as the result of the vaccination of the mother; but, similarly, an infant has never been born with the primary sore of syphilis upon its genital organs. The point of contact of mother and fœtus is in the placenta and not on the fœtal cutaneous surface. If a vaccination mark or a primary sore occur in antenatal life at all, it is to be looked for in all probability in the placenta. To return, now, to the original question with which this paragraph began, How does maternal vaccination in pregnancy protect the fœtus? It may be that there is a direct transmission of the antitoxine which is elaborated in the maternal tissues to the fœtus; but it is more probable that the immunising agent, whatever it may be, passes to the fœtus and acts upon its tissues and fluids, and that these then elaborate the antitoxine. This, at any rate, is the view advanced by Lop (*Thèse*, Paris, 1893), and it has much to commend it.

There is reason to believe that the protection against smallpox which a fœtus gets from the vaccination of the mother during her pregnancy does not last long; six months has been stated as the probable period of protection. In this respect it is comparable, as has been pointed out by Bar, Béclère, and others, to the immunity given by immunising serums rather than to that conferred upon the infant after birth by arm vaccination. The practical consequence of this conclusion is, that it is necessary to vaccinate all new-born infants whether their mothers have been vaccinated in pregnancy or not.

It must, in conclusion, be pointed out that it is possible that an infant may obtain immunity against smallpox (as shown by refractoriness to vaccination), in another way than that referred to above: it may be rendered immune while still in the mother's ovary. Thus, there is reason to believe that sometimes the vaccination of the mother during her childhood may confer immunity upon her future infants: Piéry (*loc. cit.*) found that of forty-four women who were vaccinated without success in their pregnancies, presumably on account of earlier successful vaccination, thirty-one gave birth to infants that were refractory to vaccination; while of five women vaccinated successfully in the last month of pregnancy, on account of absence of pre-existing immunity, only one transmitted immunity to her infant. This "hereditary" mode of transmission of immunity from mother to infant is more closely related to the experimentally induced immunity against such microbic conditions as the pyocyanic disease (*vide* Charrin and Gley, *Arch. de physiol. norm. et path.*, 5 s., viii. 225, 1896) than to the matters at present under discussion; it will be referred to later. The practical conclusion is, that it is wise in the presence of an epidemic of smallpox to revaccinate a pregnant woman for the sake of her unborn infant, even if not for her own.

Fœtal Measles, Scarlet Fever, Erysipelas, etc.

I have chosen fœtal variola as the type of the exanthemata that may be met with in intrauterine life, for many cases have been recorded, and therefore most of the clinical and pathological varieties have been observed. The other eruptive fevers, however, if not so well known, are at any rate not unknown in the fœtus; and the investigation of some of them has brought out new facts with regard to the pathological intertwining of the maternal and fœtal lives.

Of fœtal measles I have met with and published a case (56). The mother developed an attack of measles for the first time at the sixth month of her first pregnancy; the disease ran its ordinary course, but during the stage of decline of the eruption the fœtus was prematurely expelled and soon died; and the mother made a good recovery. The fœtus, a male, showed a large number of spots of morbilli on the back, a few on the lower limbs near the ankles, and one or two on the face; some stringy mucus was adherent to the nose and mouth. He was somewhat poorly nourished. At the time when I published this case (1893), I gathered together from literature some twenty recorded examples of fœtal measles. Among these was the case quoted by Squire (*Trans. Obst. Soc. Lond.*, xvii. 146, 1876) from the "Sydney Papers": "Lady Sydney was sickening for measles, when, on third day, with severe cough and full rash, she was brought to bed of a goodly fat son; the child was also full of the measles, mostly in the face, yet it sucked the nurse as well as any child could." So far as could be judged from the clinical details given in the twenty cases, it seemed that the infection of mother and fœtus must have been simultaneous, for the eruption on the latter at the time of birth corresponded in character with that then exhibited by the mother. No instance has been placed on record of a fœtus suffering from measles, the mother escaping, although having been subject to infection; but the small number of known cases does not permit us to draw conclusions regarding this and other pathogenetic possibilities.

Of fœtal scarlet fever I have also met with one case, that reported by Dr. Milligan and myself (59). The mother was a primipara, 21 years of age, who began to suffer from symptoms suggesting scarlet fever about the seventh month of her pregnancy; from the state of the tongue, the appearance of the rash, and the high temperature, as well as from the distinct history of exposure to contagion, the diagnosis was fully made; the infant was born prematurely and with considerable hæmorrhage in the third stage. Within twenty-four hours of its birth it was noticed that the child was covered with a red rash and that some of the glands of the neck were enlarged; the skin was hot to the touch, and the tongue was bright red, although not coated as in scarlet fever in later childhood. The diagnosis of scarlet fever developed in intrauterine life was made, and in about a week afterwards both mother and infant passed through the stage of desquamation. Not more than twenty well-authenticated cases

of scarlet fever in the fœtus have been recorded; but it may occur oftener than is supposed, for the diagnosis is not easy, and the eruption is apt to be confounded with the physiological erythema and desquamation of the new-born. In the instances which have been noted, the infection in mother and fœtus would seem to have been practically simultaneous. Leale's case was a very clearly established and typical one (*Med. News*, xliv. 635, 1884).

Although the intrauterine transmission of erysipelas is to be regarded as possible and even probable, it is a striking fact that so few cases have been reported in which that malady was noted in the

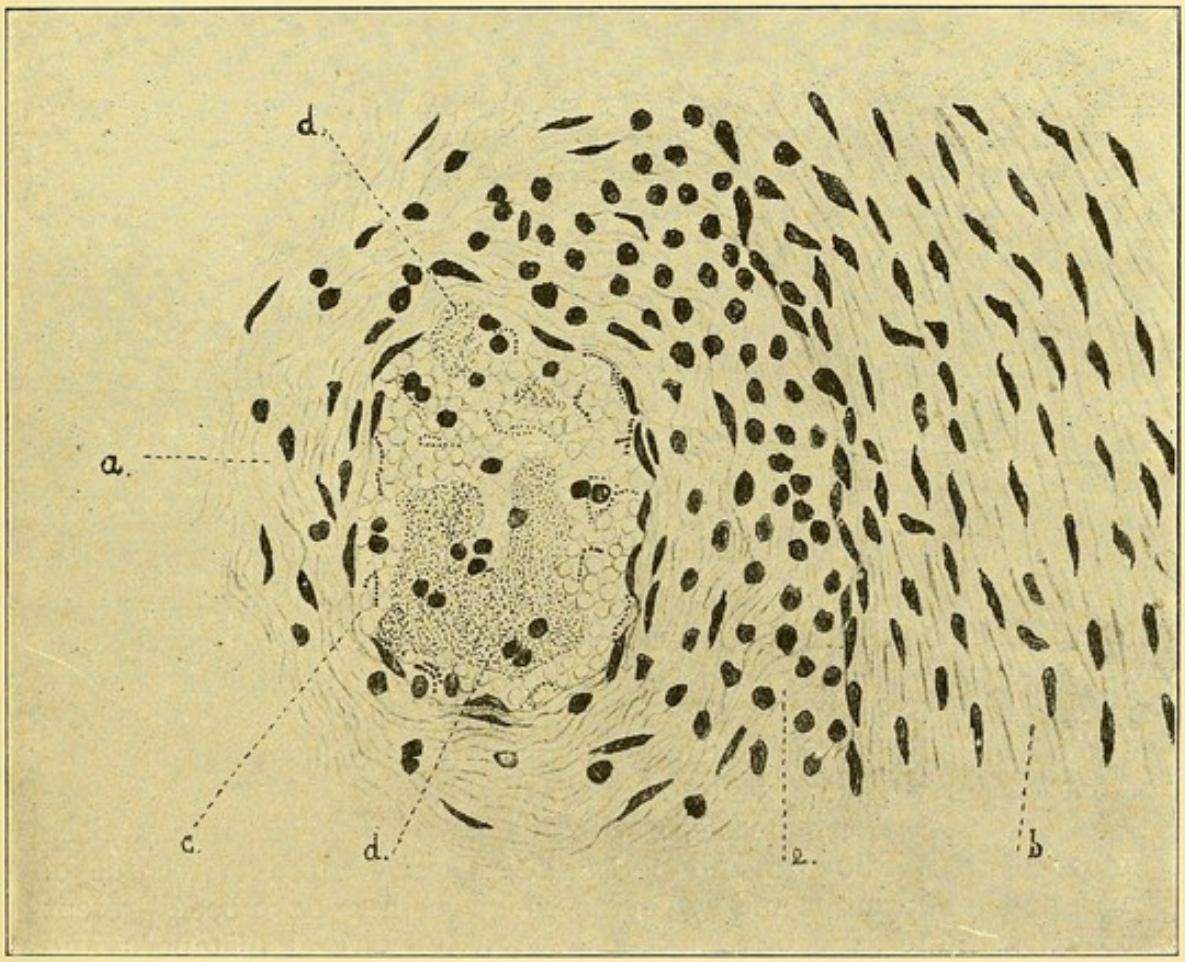


FIG. 29.—Section of Tricuspid Valve of Heart: *a*, vegetation upon valve; *b*, tricuspid valve; *c*, newly formed vessel, indicated by micro-organism; *d*, mycotic thrombi; *e*, infiltration of leucocytes.

infant at birth. Even in R. Kaltenbach's observation (*Centrlbl. f. Gynäk.*, viii. 689, 1884) and in Stratz's (*ibid.*, ix. 213, 1885) the diagnosis could not be regarded as certain, for the bacteriological confirmation was wanting. Lebedeff's case (*Ejened. klin. gaz.*, St. Petersb., vi. 285, 1886) was more completely demonstrated. It may be, however, that the fœtal environment and the peculiarities of fœtal physiology prevent the development of the characteristic cutaneous and subcutaneous manifestations of erysipelas; it may also be that fœtal erysipelas, when it has occurred, has been classified simply as a well-marked instance of neonatal erythema and desquamation.

Recent investigations on this subject seem to show that erysipelas can be and probably often is transmitted from mother to fœtus, but takes on pathological characters in the latter which differ from those seen in the former. The streptococci apparently sometimes pass the placental barrier and invade the fœtal tissues by the umbilical avenue of entrance; they must then reach first the organs, such as the liver and heart, which lie directly in their path; and there is evidence to show that they may set up morbid changes in these parts without affecting the skin or subcutaneous tissue at all. The interesting and important observation made by E. Bidone (*Teratologia*, i. 182, 1894) has been incidentally referred to in the preceding chapter. It was that of a pregnant woman, a primipara, who was attacked by facial erysipelas about the beginning of the ninth month; after having given birth to a male infant, she died in the puerperium from septic peritonitis and endometritis. The infant died about nineteen hours after birth, and at the autopsy vegetations were found on both the tricuspid and mitral valves, but specially on the former, along with incipient glomerulo-nephritis; numerous streptococci were found in the spleen, lungs, kidneys, but more particularly in the vegetations on the cardiac valves (Fig. 29); and cultures and inoculations showed that the micro-organism was the streptococcus of erysipelas. In this case the streptococcic endocarditis on the auriculo-ventricular valves seems to have taken the place of the skin lesions of erysipelas, for it is apparently clear that the infection passed through the placenta from mother to fœtus. The maternal disease, then, led to the development of a pathological condition in the fœtus, which was the same in its microbic nature but differed in its manifestations. It may be that what has been found in relation to erysipelas may apply to other transmissible diseases; the mother may show the typical manifestations, while the fœtus suffers from a modified malady. Moncorvo's suggestion relating to congenital elephantiasis and the streptococcus will be considered later.

Along with fœtal measles, scarlatina, and erysipelas, I may place fœtal parotitis, influenza, and pertussis. There are scanty records of cases in which mumps and whooping-cough seem to have been present at birth; and of congenital influenza there are several instances, and I have myself noted at least three (20). Cases of relapsing fever (R. Albrecht, *Wien. med. Bl.*, vii. 738, 1884; *St. Petersb. med. Wchnschr.*, i. 129, 1894; Mamuroffski, *ibid.*, *Beilage*, p. 10, 1896); and of yellow fever (J. Jones, *Med. Times and Gaz.*, i. for 1874, p. 5; C. Finlay, *Edin. Med. Journ.*, xl. 416, 1894), have been reported; and cholera in the new-born infant has been met with (J. C. Lucas, *Trans. Obst. Soc. Lond.*, xxi. 250, 1880; Tizzoni and Cattani, *Centrlbl. f. d. med. Wissensch.*, xxv. 131, 1887; R. Vitanza, *Riforma med.*, vi. 272, 278, 284, 290, 1890). Varicella in utero is not unknown; J. Grindon (*Journ. Cutan. and Gen.-Urin. Dis.*, xix. 237, 1901) has recorded an apparent case, although the cutaneous lesions in the infant were not typically vesicular. Fœtal typhoid is a morbid entity which has only recently been recognised; and, since it presents several features of special interest, deserves a more detailed description.

Fœtal Typhoid Fever.

Before the recognition of the bacillus of typhoid fever, few cases had been met with in the fœtus; the reasons were obvious, for the external appearances of the disease were such as might easily pass unobserved, and the internal pathological conditions were seldom looked for. Further, it was almost to be expected that the intestinal appearances which are so diagnostic in typhoid in the adult, would be little if at all marked in the fœtus. Nevertheless, two or three cases of fœtal typhoid ending fatally soon after birth were reported prior to the discovery of the causal bacillus (Charcellay, *Arch. gén. de méd.*, 3 s., ix. 65, 1840); in these the ulceration of the Peyerian patches in the intestine was observed, as was enlargement of Brunner's glands. When we remember the characters of the distribution of pathological lesions in the fœtus, due to physiological peculiarities and the avenue of entrance of the infection, it need not be a source of wonder that so few cases of typhoid fever with intestinal lesions have been met with; such cases must be very rare. There is good reason to believe that fœtal typhoid is commonly unaccompanied by intestinal ulceration; and it must not be forgotten that even adult typhoid sometimes shows the same peculiarity. The discovery of the pathogenic organism of typhoid made it possible to diagnose with some degree of confidence cases of enteritis without intestinal lesions; and the result of this bacteriological discovery was immediately manifest in the publication of a considerable number of instances of fœtal typhoid fever. One of the first, if not the very first certain case, was that reported by C. J. Eberth (*Fortschr. d. Med.*, vii. 161, 1889), for the evidence in the observations of H. Reher (*Arch. f. exper. Path. u. Pharmakol.*, xix. 420, 1885), of R. Neuhauss (*Berl. klin. Wchnschr.*, xxiii. 389, 1886), and of A. Chantemesse and F. Widal (*Arch. de physiol. norm. et path.*, 3 s., ix. 217, 1887) was not conclusive. In Eberth's case the bacillus was found in the blood, the spleen, and the placenta; the fœtus, however, was born dead, as it was also in Hildebrandt's case (*Fortschr. d. Med.*, vii. 889, 1889). The bacteriological recognition of typhoid fever in the living fœtus was carried out by P. Ernst (*Beitr. z. path. Anat. u. z. allg. Path.*, viii. 188, 1890); in the instance reported by him the infant lived for over ninety-three hours, and the bacillus was found in the spleen, the brain, and the marrow of the femur; the mother, in addition to her typhoid fever, had suffered from a traumatism, which it was thought may have caused hæmorrhages into the placenta and facilitated the passage of the micro-organism. J. Giglio's observation (*Centrlbl. f. Gynäk.*, xiv. 819, 1890) was interesting on account of the early period in antenatal life that the fœtus had reached—three months. V. Frascani (*Riv. gen. ital. di clin. med.*, iv. 282, 348, 1892) made careful microscopic examinations of three fœtuses from women suffering from typhoid; in one of these it is interesting to take note that the bacilli were found in the placenta but not in the fœtal organs. The infant with congenital typhoid seen by T. Janiszewski (*München. med. Wchnschr.*, xl. 705, 1893) lived for fifteen days. In

these cases, as also in that reported by Freund and Levy (*Berl. klin. Wchnschr.*, xxxii. 539, 1895), there was no special localisation of pathological processes, but rather a general blood infection with the typhoid bacilli. Negative bacteriological results were obtained by G. Resinelli (*Ann. di ostet. e ginec.*, xviii. 695, 1896), all the cultures from the fœtus of a mother with typhoid remaining sterile. It should be noted that sometimes there seems to have been a mixed infection as in H. Dürk's observation (*München. med. Wchnschr.*, xliii. 842, 1896), in which Eberth's bacillus of typhoid as well as the *Staphylococcus pyogenes albus* were discovered in the spleen; further, in Fraenkel and Kiderlen's report (*Fortschr. d. Med.*, vii. 641, 1889) the typical bacilli of typhoid were not found at all but only the *Staphylococcus pyogenes albus et flavus.* Mixed infection and infection with secondarily developed microbes are pathological possibilities which have to be kept in mind in the consideration of all the maladies that may be transmitted from mother to fœtus.

With the year 1896 came the discovery of the Widal serum test for typhoid fever, and it was not long before this new diagnostic means was applied to the recognition of fœtal typhoid, with most interesting developments. G. Etienne (*Presse méd.*, p. 465, 1896) noted the absence of any agglutinative action on the part of the blood of the fœtus from a mother who had died from a severe attack of typhoid fever; and negative results have also been obtained by A. Dogliotti (*Gazz. med. di Torino*, xlviii. 801, 821, 1897), Charrier and Apert (*Presse méd.*, p. cii., 1896), and Plauchu and Gallavardin (*Lyon méd.*, lxxxviii. 479, 1898). On the other hand, the five months fœtus which I saw in 1897, and which was examined and fully described by W. Fordyce (*Trans. Edinb. Obst. Soc.*, xxiii. 90, 1898), gave very marked positive results. It was the offspring of a woman who died from typhoid fever soon after delivery, and serum taken from the peritoneal cavity of the fœtus, as well as blood from the heart, showed very distinctly the agglutinative action; growths of the typhoid bacillus were obtained from the kidney, spleen, and intestinal contents, but not from the blood. The Widal reaction was also got by Chambrelent (*Journ. d. méd. de Bordeaux*, xxvii. 245, 257, 1897), J. P. Crozer Griffith (*Med. News*, lxx. 626, 1897), and A. Mossé and Daunic (*Compt. rend. Soc. de biol.*, 10 s., iv. 238, 1897). In Crozer Griffith's case the infant was, save for slight jaundice, healthy at birth, and continued to be so; nevertheless, when seven weeks old, its blood gave the Widal reaction. Griffith thinks that the child may have had typhoid fever in utero and recovered after a very short attack, or that the agglutinating principle may have passed through the placenta from mother to fœtus without the latter contracting the disease at all. Zängerle's observation supports the second supposition (*München. med. Wchnschr.*, xlvii. 890, 1900), although Crozer Griffith is himself inclined to favour the first. The whole question of the method and meaning of the transmission of the agglutinating principle without the passage of the disease itself must still be regarded as unsettled (C. Achard, *Compt. rend. Soc. de biol.*, 10 s., iv. 255, 1897; Mossé and Frenkel, *Bull. et mém. Soc. méd. d. hôp. de Par.*, 3 s.,

xvi. 49, 1899; G. Etienne, *Compt. rend. Soc. de biol.*, 11 s., i. 860, 1899).

Maternal typhoid fever, in addition to the effects that have been referred to above, may have yet another influence upon the fœtus in utero. Not only may the unborn infant take the fever and show the typical manifestations of it, not only may the pathogenic bacteria of typhoid be found in the fœtal tissues or be grown in cultures from the fœtal organs, not only may the agglutinating principle be transmitted through the placenta and be discovered in the serum of the fœtus, but there may be also met with certain little understood but vastly important pathological changes in the fœtal viscera, more particularly in the liver, thyroid, brain, and suprarenal capsules, which have a far-reaching effect upon the postnatal life of the offspring. To these changes the attention of the profession has been specially directed by A. Charrin (*Compt. rend. Soc. de biol.*, 2 s., i. 550, 1899), by Charrin and Nattan-Larrier (*Journ. de physiol. et de path. gén.*, i. 292, 1899), and by Charrin, Guillemonat, and Levaditi (*Soc. de biol.*, January 6, 1900); they consist in degenerative and sclerotic alterations unaccompanied by the presence of microbes, but productive of a slackening of body metabolism and lowering of body temperature, along with a tendency to develop broncho-pneumonia, gastro-enteritis, and infantile atrophy. The same results are produced, as we shall see, by other infectious maternal conditions, and are probably due to the transmission of toxic principles through the placenta. It would seem also, from some observations that have been made, that these transmitted toxines may produce still more profound alterations in antenatal health, taking the form of malformations and structural anomalies; to this matter, however, I shall again return. Finally, it has been thought that typhoid fever of the mother in pregnancy may be the cause of intellectual peculiarities in her offspring, developed many years afterwards (J. E. Corbin, *Thèse*, Paris, 1890). In this connection, the case reported by W. Osler (*Teratologia*, ii. 13, 1895) is peculiarly suggestive: the fœtus of a woman who died from typhoid fever in its late stage was removed from the uterus post-mortem; in the left cerebral hemisphere there was a large recent clot which had broken through the ganglia into the lateral ventricle; the mother was also the subject of inherited syphilis. It is possible that the fœtal cerebral hæmorrhage was due to the maternal typhoid; and, had the infant lived, it would undoubtedly have shown phenomena caused by the intracranial condition.

Fœtal Malaria.

Typhoid fever in the fœtus is a discovery of modern medicine; the existence of fœtal malaria was known to Hippocrates. There is at any rate an obscure reference to it in the treatise on *Airs, Waters, and Places*, in which it is stated that women who drink unwholesome water from marshes have difficult labours, that their infants are large and swelled, and that during nursing they become wasted and sickly (83). Several reported instances are to be found in medical literature

prior to the nineteenth century. Thus C. F. Paullini in his *Observationes medico-physicæ selectæ et curiosæ* (published as an appendix to the *Miscellanea curiosa*, Dec. ii., Ann. v., 1687), under the title "Quartana infantis in utero," relates, without the professional secrecy of the present day, how Anna Dorothea Meisenthurm, a soldier's wife, suffered from a quartan ague in which her fœtus participated. Here is the description: "Ultimis mensibus in et ante paroxysmum embryonem maxime inquietum, tremulum, et ab uno in aliud latus sese volutantem manifeste sensit, ut tristem sibimetipsa prædiceret eventum. Tandem, superato eodem die terribili paroxysmo, circa decimam vespertinam peperit filiolam, quæ una eademque hora, una cum matre, febri ista misere affligebatur." The infant, he goes on to tell us, succumbed in about seven weeks. "Mater tandem, Dei misericordia, convaluit." That in those days as now was something to be thankful for. A good many other cases of a similar nature are to be found in the older authors, and most of these were gathered together by Grætzer (*Die Krankheiten des Fotus*, p. 22, 1837). One of them I reproduce here in full, as a type of antenatal pathology and diagnosis in the close of the eighteenth century, for it is well worth reproducing. It is "The Account of a Case of Ague in a Child in Utero," by Dr. P. Russel (*Trans. Soc. Improve. Med. and Chir. Knowl.*, ii. 96, 1800). Here it is in Dr. Russel's own words:—

"In the month of June, 1767, a young healthy woman, at Aleppo, already the mother of two children, and then in the seventh month of her third pregnancy, was attacked with a tertian fever. The fits returned regularly about noon, and terminated in less than ten hours by a profuse sweat; but it was remarkable in this case, that the fœtus seemed to suffer a paroxysm perceptibly distinct from that of the mother. About eight in the morning of the odd days, the woman felt the child (as she expressed it) tremble with great violence; and she was sensible at the same time of a sudden weight and coldness in the womb. The coldness went off in less than fifteen minutes, and was succeeded for more than an hour by a glowing heat, during which the child was at intervals somewhat restless, though its motions then, she said, were not tremulous, but like what she had felt at other times when in health. While this happened to the child, the mother to all appearance remained well; her pulse was not altered, and she only complained of lassitude and a dull pain in the forehead, the usual forerunners of the paroxysm. On the access of the fever at noon the child again became unquiet. It stirred but little while the cold fit lasted, and throughout the hot fit was alternately quiet and restless. The mother constantly insisted that the struggles of the child at noon were totally of a different kind from the tremulous motion of which she was sensible in the morning. The same circumstances invariably attended every fit until the eleventh day of the disease. The peruvian bark was administered on the termination of the fifth paroxysm. On the eleventh day, the child remained quiet all the morning, and the mother, feeling less of her usual headache and lassitude, was in hopes of being cured as well as the child. Her fit, however, returned at noon as violent as ever, and the child, who till that time had been

perfectly quiet, became disturbed as usual during the mother's paroxysm. The bark was repeated in the succeeding intermission, and the fever did not return. I have met with a few instances somewhat similar," adds Dr. Russel, "but in all of them more might be ascribed to the power of the mother's imagination than in the present case, the patient being a woman of remarkable good sense, of a chearful (*sic*) disposition, and who had never been subject to hysteric ailments."

Unfortunately, the author does not record the state of the infant at birth, but even in the absence of information on this point the case is both curious and interesting. If we accept the conclusion that the fœtus suffered from malaria in utero, then it would appear that its seizures did not occur simultaneously with those of the mother. The occurrence of fœtal malaria of a different type from that of the mother has, however, been noted by other writers. Further, the diagnosis of the fœtal malady is an interesting feature of the case, and a still more interesting one is the success of antenatal treatment, a success gained apparently more quickly for the fœtus than for the mother.

Notwithstanding the publication of Russel's case, and others of a somewhat similar kind, Leroux found it necessary in 1882 (*Rev. de méd.*, ii. 561, 1882) to collect together all the available evidence in order to establish the probability even of the occurrence of fœtal malaria. He put on one side the evidence founded solely upon the history of intrauterine shivering fits noted by the mother as unreliable, and gave more weight to the discovery of hypertrophy of the spleen discovered at birth. The cases of G. R. Playfair (*Edinb. Med. Journ.*, ii. 901, 1856–7), of Bouchut (*Gaz. d. hôp.*, xxxi. 221, 1858; xxxv. 245, 1862), of Brunzlow (*Med. Ztg.*, x. 57, 1841), of Schupmann (*Journ. f. Geburtsh.*, xvii. 318, 1838), of P. Aubinais (*Journ. de la Sect. de med. Soc. acad. Loire-inf.*, xxvi. 15, 1850), of Lepidi (*Morgagni*, xii. 923, 1870), of Bohn (*Jahrb. d. Kinderh.*, n. F., vi. 115, 1873), of Bazin (*Gaz. d. hôp.*, xliv. 286, 1871), and of Bureau (*Rev. mens. de méd. et chir.*, iv. 214, 1880) have all some value; but in the end Leroux comes to the conclusion that "les observations ne sont ni assez nombreuses ni assez probantes." His sceptical position would seem to be largely due to the discovery, made about the time his communication was published, of the hæmatozoon malariæ of Laveran, and to the belief then current that formed bodies, such as hæmatozoa, could not pass the placental barrier.

Since the time of the recognition of the causal hæmatozoon or plasmodium of malaria, the number of reported cases of fœtal malaria has increased, as is shown by the publication of observations by Verneuil (*Rev. de méd.*, ii. 641, 1882), by W. T. Taylor (*Amer. Journ. Obst.*, xvii. 538, 1884), by F. Cima (*Pediatria*, i. 231, 1893), by F. M. Crandall (*N. York Polyclin.*, i. 38, 1893), by Moncorvo (*Méd. inf.*, ii. 363, 1895), and by K. Winslow (*Boston Med. and Surg. Journ.*, cxxxvi. 514, 1897). Felkin's two cases (*Trans. Edinb. Obst. Soc.*, xiv. 71, 1889) are chiefly noteworthy for the reason that in both instances the mothers were free from malaria, and that apparently the disease had been transmitted from the fathers to the fœtuses without the

mothers being affected. Attempts to discover the hæmatozoon in the fœtal tissues have not been crowned with success, for V. Caccini (*Bull. d. Soc. Lancisiana d. osp. di Roma*, xvi. 12, 1895–6) and Bastianelli (*ibid.*, xii. 48, 1892) both obtained negative results. This failure, however, cannot be used as conclusive evidence against the possibility of transmission of malaria from mother to fœtus, for in typhoid as we have seen, and in tubercle as we shall see, it is exceptional to find the causative organism in the fœtal tissues. It may also be urged that the peculiarities of malarial infection and the necessity of the presence of the mosquito, *Anopheles*, may prevent or make very difficult the intrauterine transmission of the disease; but it must be remembered that the passage of malaria from mother to fœtus is not to be compared to the infection of one individual by another; there may be no need for the intermediate developmental phases of the malaria parasite when the fœtus is to be the host, the mother and fœtus being co-hosts as it were. At any rate, there is good reason to believe that the parasite (*Hæmamœba*, *Hæmatozoon*) can pass the placental barrier, more especially if, as Varaldo (*loc. cit.*) maintains, white blood corpuscles habitually do so. There may be some doubt whether the red corpuscles of the fœtal blood may be so easily invaded by the parasite as are those of adult blood. The question must be left unsettled.

To summarise: It would appear that the fœtus may be affected with malaria in utero and be born with the hypertrophied spleen of that malady; it may receive from the maternal organism toxic products which interfere with its nutrition and cause it to be born delicate and little able to resist postnatal infections; and it may possibly sometimes be expelled from the uterus with a partial immunity against malaria (P. Pennato, *Riforma med.*, xiii. 1, 4, 206, 1897). The fear of inducing abortion or premature labour by administering quinine to a pregnant woman who is suffering from ague seems to be largely imaginary; to give that drug would rather appear to be good treatment both for mother and fœtus.

The types of transmitted fœtal disease which have been chosen for description in the present chapter offer some interesting contrasts as well as some evident resemblances. Their consideration leads us to the inevitable conclusion that the manifestations and mechanism of intrauterine transmission are much more complicated than might at first thought have been anticipated. It is evident that a disease such as measles or smallpox may pass from mother to fœtus, and show itself in the latter in the same form, or in nearly the same form, as in the former. It is evident also, from what is known of fœtal typhoid and erysipelas, that in the unborn infant the disease may take on characters which are unknown or at least seldom met with in the adult; these characters are in great measure due to the route by which the infection reaches the fœtus, and to the peculiarities of fœtal physiology. Further, it is clear that the fœtus in utero may suffer not only from the attacks of the causative micro-organism of the maternal disease, but also from those of secondary infections (streptococcic or staphylococcic); in some instances the effect of the

latter may be more prejudicial than that of the former. Apparently the fœtus is sometimes immunised in utero by a process other than by suffering from the disease itself. This is a complicated and involved question, but may possibly be explained by the action of the placental tissues upon the toxines or antitoxines. There is some evidence that a disease may pass from the paternal to the fœtal organism *viâ* the maternal body without the last-named showing signs of infection. These are some of the considerations suggested by the fœtal maladies above reviewed. They throw light upon some problems of intra-uterine transmission, but they apparently darken others—apparently only, for it cannot be doubted that in time and with further knowledge will come elucidation. There remains unsolved the large problem stated thus by Mademoiselle Margoulieff, "Par quel caprice pathologique le placenta laisse-t-il passer le même micro-organisme qu'il arrêtera dans un autre cas?" (*Thèse*, Paris, 1889). At present we can only repeat, "par quel caprice?" *but we know that it is no caprice.*

CHAPTER XIII

Types of Transmitted Fœtal Diseases; Fœtal Tubercle; Evidence of its Existence; Causes of its Rarity; Characters; Baumgarten's Theory of Latency; Non-tubercular Manifestations of Antenatal Tubercle; Prophylaxis; Fœtal Sepsis; Fœtal Epidemic Cerebro-spinal Meningitis; Fœtal Purpura; Fœtal Pneumonia; Fœtal Anthrax; Fœtal Rheumatic Fever.

FŒTAL TUBERCULOSIS, which is the subject to the consideration of which I shall devote the greater part of this chapter, is a morbid entity whose existence has been insisted upon by one school of pathologists and as stoutly denied by another. It has given rise to numberless discussions, which have served this useful purpose, if no other:—they have for a while focussed the minds of pathologists and physicians upon the vexed question of intrauterine and intraovular transmission of disease, of the paternal influence in heredity, and of the difference between hereditary predisposition to tubercle and fœtal infection with tubercle. These are questions which the profession cannot afford to pass by. At this time, when a campaign is going on against tuberculosis, it is manifestly a matter of no little importance to consider well all the aspects of the subject. It would be bad generalship in such a campaign not to reconnoitre every part of the enemy's position; were precautions of this kind neglected, masked batteries might open fire at a critical stage in the great battle, and lead to irretrievable disaster. It is therefore incumbent upon us, in our struggle against tuberculosis, to make a reconnaissance in force with a view to discover what may be the strength of the antenatal section of the hostile attacking forces. In other words, it is necessary to take into account antenatal as well as postnatal tuberculosis. Tubercle, "cette maladie de tous les peuples, de tous les milieux, on pourrait presque dire de toutes les familles," is, in a certain sense and to a certain extent, a preventable disease; for it may be possible greatly to diminish the risks of the entrance of tubercle bacilli into the human body, even if it can scarcely be hoped that the chances of such a microbic invasion will be altogether abolished. If it were found possible to exterminate absolutely the immediate cause (microbic or toxinic) of tubercle, it might then be permissible, perhaps, to neglect the question of the receptivity or unreceptivity of the body-cells with regard to that microbic or toxinic cause. If there were no seed being sown, it would not matter much about the soil; but there is seed in abundance, and hence it does matter about the soil. Therefore, in any attempt to prevent tubercle, the

problem resolves itself into the prevention of the incidence of tubercle bacilli upon the tissues of the body, and (since this cannot be carried out with absolute success) into the preparation of the tissues to resist the morbid action of the bacillary invaders. Now, this is not a problem of postnatal life only; it is also a problem of antenatal life, for the organism before birth is liable to the attacks of tubercle bacilli and toxines, and its tissues may likewise be more or less able to repel such attacks. Further, the antenatal side of the problem has an important bearing upon the postnatal. For this reason, therefore, if for no other, the subject is well worthy of study.

In the present chapter I am concerned with *fœtal* tuberculosis, but it must not be forgotten that possibly the organism may fall under the influence of the tubercular poison during one or other of the two earlier epochs of antenatal life. It may be infected during the embryonic or during the germinal period as well as during the fœtal. Of the possibility of the ovum being invaded by a tubercle bacillus when in the ovary, or when passing down the Fallopian tube, and of the possibility of it being penetrated by a spermatozoon which has a bacillus in its interior, I shall have something to say under the head of Germinal Pathology. The effect of the tubercular poison upon the organism in the embryonic or developmental period of its antenatal existence will, as I shall afterwards show, probably take the form of interference with development, *i.e.* of malformation. In the meantime, however, let us focus our attention upon fœtal tuberculosis, upon the cases in which there is reason to believe that the morbid processes in the fœtus are set up between the second and the ninth months of intrauterine life.

Evidence of the Existence of Fœtal Tuberculosis.

The evidence which may be and has been adduced in support of a belief in the existence of fœtal tuberculosis may be direct or indirect. The direct evidence is founded upon the discovery of tubercular lesions in the fœtus, upon the recognition of the tubercle bacillus in its tissues, and upon the fact that its blood and organs when injected into animals lead to the development of tubercular processes. The indirect evidence, of much less value, rests upon the discovery of signs of tubercle in the placenta, umbilical cord, and liquor amnii, and upon the tuberculinisation of the new-born infant of a tubercular mother.

I shall here describe three typical cases of fœtal tuberculosis: the first of them occurred before the discovery of the tubercle bacillus, and its diagnosis rests, therefore, upon the lesions present in the fœtus; the second is a fully established case according to the exacting requirements of the modern definition of tuberculosis; and the third is an instance of tubercle without evident lesions, in which the proof depended upon experimental inoculations.

The first case of fœtal tuberculosis which I select as a type is that reported in 1873 by Charrin (*Mém. et Compt. rend. Soc. de sc. méd. de Lyon* (for 1873), xiii., pt. 2, 65, 1874). There were cases put on record before this date, but most of them were incompletely stated

and unconvincing; Charrin's case was fairly complete in its clinical and pathological details, and as convincing as it could be in the absence of modern bacteriological tests. The mother was a tripara, 29 years of age, who, at the fourth month of her pregnancy, developed a pleurisy; at the seventh she had all the signs and symptoms of phthisis. At this time labour came on prematurely, and she died ten days later; at the autopsy, tubercles were found in the lungs and pleura and in the spleen and kidneys, the bronchial glands were caseous, and the liver was much enlarged and fatty. The genital organs were normal. The placenta, unfortunately, was not available for examination. The fœtus, a female, weighed only 1100 grms. at birth, and had a greatly distended abdomen; it was very feeble, and died in three days, after having developed a general œdema. At the necropsy, miliary tubercles were found in the kidneys, suprarenal capsules, great omentum, spleen, and liver; the abdominal cavity contained much clear yellow serum with flakes of lymph in it; the mesenteric glands were much enlarged, and were nearly all caseous; the bronchial glands, also, were caseous; and there were some scattered grey granulations in the lungs. Charrin draws attention to the localisation of the lesions in the fœtus as compared with the mother, abdominal in the former, thoracic in the latter; and he rightly emphasises the apparent rapidity of transmission of the tubercular process from mother to fœtus. Several of the circumstances which struck the author as peculiar and difficult to explain are now well known and easily understood by all who have studied Antenatal Pathology: there is nothing in this recorded case to make us doubt that it was really tubercle of the fœtus; no doubt it was a very rare instance of it (for it will be shown that it is extremely rare to meet with such marked and widespread lesions), but yet indubitably fœtal tubercle.

The recently observed case of Auché and Chambrelent (*Arch. de méd. exper. et d'anat. path.*, xi. 521, 1899) will serve excellently as a type of a fully established instance of fœtal tuberculosis. It was that of a prematurely born but living female infant, the product of the fourth pregnancy of a tubercular woman, forty years of age, who died three days after her confinement. It was found at the autopsy that she (the mother) had been the subject, not only of far advanced pulmonary phthisis, but also of tubercular disease of the liver, spleen, intestines, mesenteric glands, and kidneys. The ovaries, Fallopian tubes, and uterus were healthy, and there were no signs of peritonitis. The other children of this woman were alive and well, but in her family history there was the record of the death of one sister from phthisis. There was no history of alcoholism. The infant, which was born between the sixth and seventh months of intrauterine life, survived in the couveuse for twenty-six days, and then died without having exhibited any marked symptoms. It had, however, lost weight continuously. At the autopsy no peritonitis was found, and the intestinal canal showed no tubercular lesions. In the liver, however, were numerous yellow granulations; in the spleen there were crowds of the same confluent, punctiform granulations; while in the lungs were grey, transparent, round granulations in much smaller

numbers. The bronchial glands were tubercular, but the other organs had a normal appearance as seen by the naked eye. Microscopic examination revealed an excessive number of tubercles in the liver, some caseated in the centre, along with an enormous quantity of Koch's bacilli. The same condition was found in the spleen. There were no giant cells. Many bacilli were found in the pulmonary alveoli. Further, tubercular endocarditis in the right ventricle was discovered by means of the microscope. It remains to be noted that the placenta showed many tubercular granulations, some caseous at the centre and others not; the chorionic villi were in some places little altered, in others they were lost in the caseous portions; some giant cells were seen, and bacilli were present, although they were not so enormously numerous as in the fœtal organs. Three rabbits were inoculated with fragments of the liver, spleen, and lung from the infant, and these all died of generalised tubercle, with numerous bacilli in the lesions. A piece of placenta was inserted under the skin of a guinea-pig; two months later the animal was examined, when it was found that tubercular infection had occurred. Finally, two cubic centimetres of blood from the umbilical cord were injected into the peritoneal cavity of another guinea-pig without any apparent results; but the animal died nearly a year later, when it was discovered that there was tubercle of the peritoneum, mesenteric glands, liver, spleen, and lungs, with bacilli in all the lesions.

Some five or six further cases, in which the evidence in favour of the existence of fœtal tuberculosis was as clearly or nearly as clearly established, have been reported during the past ten or twelve years; but it is freely confessed by all who have investigated the subject, that such instances are extremely rare. It would seem, also, from G. Küss's masterly exposition of the whole question of antenatal tuberculosis (*De l'hérédité parasitaire de la tuberculose humaine*, Paris, 1898), that well-established cases in the fœtal calf are almost as uncommon as in the human subject. The reasons which have been advanced to explain this great rarity will be referred to later; in the meantime, the fact that at birth evident tubercular lesions are most exceptional in the offspring of tubercular mothers, must be accepted as fully proven. In order, however, that the case for congenital tuberculosis may be quite fairly stated, some reference must be made to the third type of the malady, that in which, although evident tubercular lesions were not met with, yet the bacilli were found in the fœtal tissues, and inoculation of animals with pieces of organs or blood from the fœtus led to the development of tubercle. About twelve instances of tuberculosis without lesions have been put on record, including those of Schmorl and Birch-Hirschfeld (*Beitr. z. path. Anat. u. z. allg. Path.*, ix. 428, 1890), of Aviragnet (*Thèse*, Paris, 1892), of Londe and Thiercelin (*Gaz. d. hôp.*, lxvi. 189, 1893), of Schmorl and Kockel (*Beitr. z. path. Anat. u. z. allg. Path.*, xvi. 312, 1894), of Bar and Rénon (*Compt. rend. Soc. de biol.*, 10 s., ii. 505, 1895), and of Jens Bugge (*Beitr. z. path. Anat. u. z. allg. Path.*, xix. 433, 1896). The case described by Bugge may

be given as a good example of this type of antenatal tuberculosis. It was that of a woman, 39 years of age, the daughter of a phthisical mother, who had had thirteen children, of whom ten had died of tubercle and one was ill with the disease. Two years previous to the birth of her fifteenth infant, she began to show signs of phthisis, and she died four days after being delivered of a female infant. The necropsy discovered tubercular changes in the lungs, liver, bronchial glands, kidneys, and intestinal canal. The placenta was not examined. The infant lived for thirty hours; it was prematurely born (second half of the eighth month), and weighed 1820 grms. With the naked eye no tubercular lesions were discoverable in the organs of the infant; but microscopically, bacilli were found in the blood of the umbilical vein, and, to the number of four, in the lumen of one of the small vessels of the liver. Further, blood from the umbilical vein, and a piece of the liver, were inoculated into three guinea-pigs, all of which succumbed from tubercle in two and a half, four and a half, and five and a half months respectively. In this case it is probable that fœtal infection occurred late in pregnancy, possibly even in the course of labour.

Of indirect evidence bearing upon the occurrence of fœtal tuberculosis it is unnecessary to say much. The histological and bacteriological examination of the placenta and membranes in all cases, but especially in those in which the infant survives birth, ought to be carried out; but the discovery of tubercular lesions or bacilli in the fœtal annexa does not of necessity indicate tuberculosis of the fœtus itself, as was shown some years ago by Schmorl and Kockel (*Beitr. z. path. Anat. u. z. allg. Path.*, xvi. 312, 1894). With regard to the examination of the blood of the umbilical cord, and the inoculation of animals with it, Küss (*op. cit.*) has pointed out that, while positive results may have a certain value, negative ones have very little, for the bacilli of tubercle are rarely found in the blood. Inoculations of animals with liquor amnii from cases in which the mother was tubercular have been little practised; Herrgott (*Ann. de gynéc. et d'obst.*, xxxvi. 1, 100, 1891) obtained positive results in one case; but tubercle bacilli in the liquor amnii do not necessarily mean tubercle of the fœtus. A more useful means of investigation may be found to be the testing of new-born infants, the offspring of tubercular mothers, with tuberculin; but in the meantime it is doubtful whether the medical man would be justified in using this method, even if the parents were ready to give their consent. After all, it is unnecessary to have recourse to indirect evidence to prove the occasional but rare occurrence of fœtal tuberculosis; that fact is sufficiently proved by the direct evidence. Fœtal tubercle occurs, but it occurs with almost extraordinary rarity. Let us inquire whether there is any explanation of this great rarity.

Causes of Rarity of Fœtal Tuberculosis.

It must, in the first place, be borne in mind that the transplacental passage of diseases, and even of the most transmissible

diseases, is far from constant. Already, in describing fœtal smallpox, measles, scarlet fever, etc., I have pointed out the rarity of these maladies. Not every woman who suffers from one or other of the infectious fevers transmits the same to her unborn infant; she may transmit some morbid influence which may show itself in weakened fœtal metabolism of one kind or another, but it is exceptional for her to pass on the disease itself. The reasons for this rarity of transmission have been considered under the head of the Placental Factor in Fœtal Pathology, and need not be reconsidered; suffice it that the placenta sometimes acts as a prophylactic barrier. In the case of tubercle, however, there are also special reasons why the fœtus is so rarely affected. In order that the tubercle bacilli may reach the fœtus in utero, they must be present in the blood of the mother and pass through the placenta, for there is practically no other avenue of entrance. The ordinary mode of infection (viz. pulmonary and aerial) is out of the question for the fœtus. Now, it is an uncommon occurrence for the bacilli of tubercle to be present in the blood-stream; they can live in it, and do so in advanced cases of general tuberculosis, but they constantly show a tendency to escape from it and to become localised in special organs. In a sentence, an intense blood-infection is quite rare in tubercle. It is not often that women showing marked and generalised tuberculosis, with numerous bacilli in the blood-stream, come to the full term, or even to the seventh month, of pregnancy; therefore it is rare for tubercle bacilli to arrive in the placenta. Even in ordinary phthisis, however, it is possible that bacilli reach the placenta; but then there is some evidence that the placenta is not a good culture medium for them, and even if that be not so, there is the natural tendency of the organ to act as a barrier to microbic invasion. So that it is easy enough to believe that few germs actually arrive in the fœtal tissues. Further, it may be hazarded that the fœtal liver may act as a second barrier in the way of a successful bacillary invasion; and that, being the potent organ in fœtal life, which it undoubtedly is, it may act in concert with or as a substitute for the placenta, and thus save many a fœtus from tubercular contamination. Some additional causes of the rarity of fœtal tubercle may be referred to briefly. There is the rarity of primary tubercular lesions of the genital organs (uterus, ovaries, and Fallopian tubes) of the mother. J. D. Williams and I met with and reported a case of primary tuberculosis of the Fallopian tubes some years ago (19), but such cases, as also examples of primary tubercle of the ovaries (Loeffler, *Wien. med. Wchnschr.*, August 26, 1899), are exceedingly uncommon. No doubt, if tubercular changes in the tubes, ovaries, and mucous membrane of the uterus were more often met with, placental tubercle would be more common, and cases of fœtal infection would be less rare than they are. Finally, it is possible that if fœtal tubercle were more often and more carefully looked for in the still-born fœtuses of tubercular women, it would be more often found. At any rate, enough evidence has been led to demonstrate the causation of its apparent rarity.

Characters of Fœtal Tubercle.

Fœtal tubercle differs from infantile and adult tubercle in its characters; but the differences are such as can be explained by the general laws of antenatal as distinguished from postnatal pathology. In other words, fœtal tuberculosis has peculiarities, not because it is *tuberculosis*, but because it is *fœtal*. It is unnecessary to do more than enumerate the peculiarities. In the *first* place, fœtal tubercle is not pulmonary tubercle. In the cases in which definite tubercular lesions are present they are rarely found in the lungs, and even when they are met with in these organs they are quite discrete. Evidently this is just what was to be expected, for the lungs are not in the direct line of bacillary invasion of the fœtal body, neither is the circulation in the lungs at all active. On the other hand, the liver is in direct communication with the umbilical avenue of approach, and therefore it is to be expected that in it and in the neighbouring glands there will be tubercular lesions. As a matter of fact, the liver is frequently affected; but it has to be noted that there are not a few exceptions. Possibly this is to be explained by the fact that the invading germs may pass direct to the heart by the ductus venosus without traversing the liver. From a study of the recorded cases, it would appear that tubercle germs may reach the fœtus in large numbers; when they do so the lesions are generally widespread: they may, on the other hand, be few in number, and then the lesions are commonly localised, in the suprarenals, in the cerebellum, in the liver, spleen, and indeed in all the glands, and rarely in the bones and serous membranes. In the *second* place, such cases as that of Auché and Chambrelent (*loc. cit.*) seem to prove that the fœtal tissues, far from being unsuitable soil for the growth of tubercle bacilli, are peculiarly fitted for their reception and development. In the liver and spleen they have been found in such numbers as to rival the lesions of "avian tuberculosis." This conclusion, if warranted by further research, has a most important bearing upon the theory of Baumgarten. In the *third* place, it may turn out that in fœtal tubercular lesions giant cells are wanting; but, in the absence of a large number of observations, it is not safe to make this generalisation. In the *fourth* place, tubercle bacilli may be present in the fœtal organs in large numbers without the development of the characteristic lesions of postnatal tubercle; this is the so-called bacillosis without lesions, and it may be due to the termination of antenatal life before the lesions have had time to form. Infants who show bacillosis may be apparently perfectly viable and well developed; on the other hand, the experimental work of A. Charrin (*Journ. de physiol. et de path. gén.*, i. 82, 1899) and others would seem to prove that the offspring of guinea-pigs which have been inoculated with tubercle grow slowly, have a low temperature, and suffer from lesions in the liver, thyroid, and sometimes in the kidneys. In the latter case, however, the fœtuses do not necessarily contain tubercle bacilli. It is quite possible that these hepatic, renal, and other

changes are the result of the transmission of toxines, and not of the bacilli themselves; a similar supposition has been made with regard to typhoid fever occurring in pregnancy. It may therefore be said that, in the *fifth* place, fœtal tubercle may take on characters not at first recognisable as in any way tubercular.

Baumgarten's Theory.

Any discussion of fœtal tubercle would manifestly be incomplete without a reference to the views advanced by Baumgarten (*Centrlbl. f. d. med. Wissensch.*, xix. 274, 1881; *Samml. klin. Vortr.*, No. 218, 1882; *Ztschr. f. klin. Med.*, vi. 61, 1883). This author was struck by the fact, which has engaged many other workers in this field of study, that while tuberculosis is evidently and very frequently transmitted from parents to children, it is commonly not till late childhood or early adult life that distinct signs and symptoms begin to appear. In order to retain the idea that the tubercle of the ascendants was transmitted to their descendants, and to bring it into harmony with the long period of apparent immunity which intervenes between birth and the appearance of the disease, Baumgarten was led to formulate the theory of the latency of the germ. He believed that germs are carried to the unborn infant either through the placenta or by the ovum or spermatozoon (at the time of conception); that these sometimes, possibly when very numerous, set up distinct tubercular lesions in the fœtus, or lead to the development of the rare infantile form of tuberculosis; that most often they are few in number, and remain in the fœtal tissues and organs in a sort of larval state till birth, and for a short time thereafter; that the larval stage is succeeded by one of semi-activity, in which tubercular foci are formed; and that these foci may long remain latent, existing simply in the anatomical and not in the clinical sense, but may at some time or another give rise to active tubercular manifestations. It was thought that the tubercular foci were most often to be found, if looked for, in the bones and glandular system. Now, modern research has revealed some facts which lend support and some which go to discredit this theory of latency of the germ as stated by Baumgarten. For instance, it is now known that tubercle bacilli may, in small numbers at any rate, gain access to the fœtus through the placenta, and that at the time of birth they may have produced no recognisable tubercular lesions. On the other hand, there is little or no evidence to support the conclusion to which Baumgarten was driven, that the tissues of the fœtus, on account of their great vitality, restrain or altogether prevent the growth of the germs of tubercle. Such cases as that reported by Auché and Chambrelent (*loc. cit.*), and such experiments as those of Sanchez-Toledo (*Arch. de méd. expér. et d'anat. path.*, i. 503, 1889) and A. Gärtner (*Ztschr. f. Hyg. u. Infectionskrankh.*, xiii. 101, 1893), show no special resistance of the fœtal tissues; indeed, it has already been stated that, when tubercle bacilli reach the fœtal organs, they apparently have found a soil very suitable for their growth, and may soon be as numerous as they are

in "avian tuberculosis." There are other difficulties in the way of an acceptance of Baumgarten's theory; and it must, I think, be fully conceded that the great number of cases of tuberculosis, both in children and adults, are caused by the invasion of the organism by germs in postnatal and not in antenatal life. The cases of true congenital tubercle, with or without lesions, are rare; and there is no good reason to believe that germs enter the fœtus, and after a period of latency lead to auto-infection in adult life.

Non-Tubercular Manifestations of Antenatal Tubercle.

I have already referred to the occurrence of pathological conditions in the offspring of tubercular women, conditions which are not tubercular in the usual sense of the word; these I have, for want of a better name, called the non-tubercular manifestations of antenatal tubercle. I do not defend the nomenclature; but I draw the reader's attention to the phenomena, for they are, to my mind, of a very special importance.

I have at various times met with the following cases. There was the instance of fœtal ascites and distension of the bladder in the offspring of a tubercular woman, which I recorded (197) in the *Edinburgh Obstetrical Society's Transactions* in 1897. Into this case and its meaning I do not propose to enter, for unfortunately no examination for the tubercle bacillus was made. It, however, directed my attention towards the occurrence of fœtal diseases, not necessarily of a tubercular type, in the offspring of tubercular parents. The second case was more immediately important and striking. It was as follows:—

On January 2, 1899, I saw with my friend, Dr. John Stevens, an interesting case of congenital anomaly of the knee-joint. The patient was a male child, eleven months old, the offspring of the third pregnancy of a woman whose two earlier gestations had also ended in the birth of males, but well-formed and healthy males. There was one fact, however, about the third pregnancy which calls for immediate notice; it was that the mother during it was in an advanced stage of pulmonary tuberculosis. Obstetrically, it pursued a normal course; the infant was carried to the full term and born without artificial assistance. Soon after birth it was noticed that the infant, who was healthy in appearance and not malformed, had the power of causing a curious change in his right knee-joint. When the right foot was pressed against the left leg, and more particularly during struggling and crying, a slight creaking sound was heard, and it was then evident that a dislocation outwards of the right knee had occurred. This phenomenon happened frequently, sometimes very many times in succession, and as the infant grew older it seemed as if he derived a certain amount of satisfaction from this voluntary and transitory dislocation. When I saw him he was eleven months old, and was beginning to stand, and could bear his whole weight upon the right foot. Notwithstanding this, he was still able to dislocate the knee, without apparently causing any inconvenience to himself.

By seizing the right leg and pressing the head of the tibia outwards, I found I could cause the luxation, and reduce it again quite easily and without distressing the child. The two knees did not appear to be dissimilar, but the dimple over the external condyle of the femur in extension of the joint seemed to be more marked on the right side. All the movements of the knee took place quite naturally. Careful palpation during the production of the dislocation discovered that the head of the tibia passed outwards to a slight extent at the same time as the distinct click was heard. There was no clubfoot; indeed, the boy was normal in every way, save for the recurrent dislocation of the knee. This was the state of things in January, and it was my wish that as soon as he was able to walk the child should be fitted with a retentive apparatus to fix the joint and allow of retraction of the ligaments, for it was evident that there was some relaxation of the ligamentous structures, and especially of the crucial ligaments. But as the weeks passed it was noticed that as he began to stand and walk the dislocation occurred with diminishing frequency. At the age of sixteen months there was power of walking, and the dislocation no longer happened, and even considerable pressure did not produce it, and manifestly there was no need to make excessive pressure. The mother, however, had succumbed to the phthisical condition from which she was suffering, her infant remaining well and healthy.

This case suggests the question whether the state of the infant's knee-joint was in any way the result of the mother's tuberculosis. Unfortunately the placenta was not available for microscopic examination. It is only right to state that the father of the child was the subject of nævoid swellings of the eyelids and of nævi upon the scalp and back; these were congenital in their nature. The case was fully reported in 1899 (105–107).

So much was I impressed with the association of fœtal malformation and disease with tubercle in the parents, that when, in the September of 1900, I had charge of the Royal Maternity Hospital, Edinburgh, I had under my care a parturient woman with phthisis of both lungs, I caused careful search to be made for malformations or anomalies in the infant to which she gave birth. It was found that the child had webbed toes.

These observations do not of course stand alone. The occurrence of malformations and structural peculiarities in the children of phthisical parents has been known for years, and V. Hanot (*Gaz. hebd. de méd. et chir.*, xliii. 265, 1896) has called it heteromorphic tubercular heredity. Various dystrophies have been noted, such as minor malformations of the cranium, hernias, ectopia of the testicle, malformations of the heart and great vessels, lobulation of the liver, congenital dilatation of the oesophagus, infantilism, congenital dislocation of the hip, hare-lip and palatal defects, deaf-mutism, and even actual monstrosities (pseudencephaly, anencephaly). In these cases it would almost seem as if the malformation or anomaly had taken the place of the truly tubercular lesion. Hanot (*loc. cit.*), for instance, suggests that congenital atresia of the pulmonary artery, which he has noted in the descendants of tubercular parents, may

represent the whole of the transmitted tendency; the cardiac malformation of the offspring of tubercular parents may then indicate not a proneness to become tubercular, but an immunity against tuberculosis! Without going so far as Hanot does, it may be conceded that there is in all probability the relation of cause and effect between the tubercle in the parents and the malformations and dystrophies in the children. It may also be said, and in this respect the evidence is against Hanot's view, that sometimes fœtal tubercle may co-exist with a malformation; Sarwey's case (*Arch. f. Gynaek.*, xliii. 162, 1892), was that of a fœtus which had a large meningocele and cleft palate, and at the same time showed distinct tubercular lesions in the bodies of the cervical vertebræ. Too much must not, however, be concluded from Sarwey's observation, for in it the father alone was tubercular, and the tubercular nature of the fœtal lesions was not established beyond all doubt. G. Keim (*l'Obstétrique*, iv. 473, 1899), has recently reported a remarkable case in which the twins of a tubercular mother were of the same sex, and yet, while one was normal in appearance, the other showed malformations of the lower limbs. This whole question of the non-tubercular manifestations of antenatal tubercle must be for the meantime left in a chaotic state. Its meaning is not clear ("bleibt unklar"), although it may be conjectured that the malformations are due to tubercular toxinic products reaching the embryo (bacillary toxæmia), and disturbing normal embryogenesis. Possibly such experiments as those made by G. Carrière (*Arch. de méd. exper. et d'anat. path.*, xii. 782, 1900), in which the young of tubercular guinea-pigs showed various morbid states, and were more easily tuberculisable, may yet throw light upon the matter. They show, apparently, that when the disease itself is not transmitted from parent to child, a sort of weakened state may be passed on, which both before and after birth may lead to morbid developments, arrests of formation, and arrests of function.

The Antenatal Factor in the Prophylaxis of Tubercle.

From what has been written, it is evident that the antenatal side of the problem of the prevention of tubercle cannot be neglected. While it is clear that fœtal tubercle with lesions is very rare, and while, therefore, the danger of an infant being born already affected with tubercle is slight, yet there are associated dangers which are not slight, and which we cannot afford to neglect. There is evidence that the offspring of tubercular women are born not infrequently with diminished powers of resistance, and even with various malformations, some of which, such as cardiac anomalies, act as veritable disabilities. These may be due to the transmission to the fœtus in utero, of bacilli or of their toxinic products. No doubt, in such weakened organisms the advent of tubercle bacilli from the outside in postnatal life will be less likely to be effectually resisted; in this sense it may be said that the tendency to become tubercular is transmitted; it is not, however, a tendency specially to become

tubercular, but a tendency to yield to the onslaughts of all forms of pathogenic organisms and their associated toxines. It may then be concluded that it is a danger to the unborn to have a tubercular mother; but the danger is much lessened if there be a healthy placenta.

Fœtal Sepsis.

As yet comparatively little is known of the transmission from mother to fœtus of the specific organisms of sepsis; but it cannot be doubted that a most important part of antenatal pathology, that dealing with fœtal sepsis, yet remains to be investigated. Reference has already been made to the discovery of streptococci in the fœtus of a woman suffering from erysipelas (Bidone's case), and indications are not wanting of other instances of a similar or allied kind. Thus G. Ricker (*Centrlbl. f. allg. Path. u. path. Anat.*, vi. 49, 1895) records two cases in which the streptococcus pyogenes was found in the human fœtus; in one, the mother died of diphtheria at the sixth month of pregnancy, and the micro-organism was found in her body, in the placenta, and in the liver of the fœtus, although the fœtus and placenta showed nothing abnormal otherwise; in the second case the mother suffered from an abscess of the arm, which proved fatal after the delivery of a dead-born infant, which showed the streptococcus in the blood of the umbilical vein. Cases of true fœtal sepsis must not of course be confounded with the comparatively much commoner instances of intranatal infection of the fœtus; when septic germs are present in the mother's vagina, they may, during labour, and especially during prolonged labour, gain access to skin wounds, or to the eyes, or to the mouth and lungs of the infant passing through the canals; they may set up ophthalmia, or pneumonia, or septic cutaneous conditions, but these are not truly fœtal in origin. Even the cases in which, on account of premature rupture of the membranes, germs gain access to the fœtus while it is in the uterus (Queirel, *Marseille-méd.*, p. 124, July 15, 1895), ought to be separated from those in which the infection takes place by the placental route, the uterus being still a closed cavity. In addition to Ricker's cases, which have been referred to above, Bonnaire (*l'Obstétrique*, iv. 473, 1899) has recorded three instances in which streptococci seem to have passed from mother to fœtus by the placental route; in one of these the mother died of eclampsia after having expelled a dead fœtus; the maternal blood and meningeal pus gave a pure culture of streptococcus pyogenes, and the cerebro-spinal fluid of the infant gave a culture rich in streptococci. The article by Widal and Wallich (*Compt. rend. Soc. de biol.*, 10 s., v. 266, 1898) is also of interest in this connection. The staphylococcus also sometimes passes to the fœtus, as has been shown by Fraenkel and Kiderlen in their case already referred to (*vide* p. 200); and two or three cases are on record in which the bacterium coli seems to have been transmitted. The passage of the diplococcus of pneumonia will be considered in a separate paragraph.

It must be freely admitted that true fœtal sepsis occurs; but it is

probably comparatively rare. It may, as has been stated in the description of fœtal typhoid, be met with as a secondary and associated infection in antenatal life. An interesting part of this subject has yet been hardly at all investigated, namely, the character of septic lesions in the fœtus. In some of the older works we read of purulent collections in the fœtal tissues (P. Ollivier, *Arch. gén. de méd.*, 2 s., v. 70, 1834), and it is possible that these may have been the result of fœtal sepsis. More recently Palazzi (*Ann. di ostet. e ginec.*, xxiii. 558, 1901) has met with two cases of abscess in the fœtus, but in each instance the mother was quite healthy. Fœtal endocarditis, also, and hepatitis may be consequences of the invasion of the fœtal body by the umbilical avenue. It may be surmised, in addition, that septic conditions of the mother may produce morbid states in the fœtus which are not themselves evidently septic, such as delayed developments, congenital weakness, and tendencies to defective body metabolism of various kinds. At any rate, the experience which has been gained from the study of the dystrophies of fœtal tuberculosis and syphilis would almost warrant us in concluding that sepsis also has similar effects. It must be freely confessed, however, that much remains to be done to elucidate the problems of fœtal sepsis. It may be hazarded, from what is known of allied conditions in the new-born infant, that suppuration is a comparatively rare result of the entrance of septic bacilli into the fœtus.

I may close this chapter with a few notes of some diseases which have only rarely been observed in the fœtus, namely, epidemic cerebro-spinal meningitis, purpura, pneumonia, anthrax, and rheumatic fever.

Epidemic Cerebro-spinal Meningitis in the Fœtus.

In October 1899, I received a letter from Dr. R. B. H. Gradwohl, bacteriologist to the St. Louis City Hospital, U.S.A., containing a reference to "a case of epidemic cerebro-spinal meningitis transmitted in utero." As the case is probably unique, I give the details somewhat fully.

The patient was a woman, aged 31, seven months pregnant, who two days before coming into hospital had begun to suffer from pain in the left ear. Some drug had been injected into the ear by a medical man but without relief, and she soon became comatose. No fœtal heart sounds could be heard, and the fœtus could easily be pushed from side to side. Vaginal examination revealed a soft undilated os. Respirations were somewhat laborious, and the pulse was rapid (120) and weak; temperature 102° F., pupils unequal, Kernig's sign present. The head was drawn back, there was hyperæsthesia and photophobia, and on touching the spine or back of the neck the patient would come out of her coma for a moment or two and mutter deliriously. *Tache cérébrale* was manifest, and there was instability of the pupil. She died undelivered, and at the necropsy the kidneys showed acute parenchymatous nephritis, and inside the cranium was a typical meningitis (an abundant purulent exudation

was scattered here and there over the entire meningeal surface, especially at the base), while the same condition was found upon the cord. A seven months fœtus was removed from the uterus, and in it there was an exact counterpart of the condition of the maternal meninges, with perhaps more of a sero-purulent exudation than a purely purulent one. Bacteriological examination of fluid from both the maternal and fœtal meninges revealed the presence of the diplococcus intracellularis meningitidis. The same micro-organism was also separated in pure culture from the left ear of the mother. Dogs inoculated with cultures from the maternal and fœtal meninges died in convulsions.

This case occurred during an epidemic in which thirty-four persons were affected, and details both of the epidemic and of the special case were communicated by Dr. Gradwohl to the *Philadelphia Monthly Medical Journal* (vol. i., July and September, 1899). In the absence of further information about epidemic cerebro-spinal meningitis in the fœtus, the case must stand alone, and it would be rash in the extreme to draw any deductions from it.

Fœtal Purpura.

Fœtal purpura, like fœtal cerebro-spinal meningitis, would seem to be one of the rarest of the diseases which may be transmitted from the mother to her unborn infant. Some of the cases which have been reported would seem to have been the results of the traumatism of labour, and not true instances of the purpuric disease; others appear to have been examples of hæmorrhages into the skin developed after birth, as in Dr. Elizabeth Stow Brown's case (*Amer. Journ. Obst.*, xviii. 1048, 1885), in which there was melæna neonatorum and omphalorrhagia, and in which, also, there was a family history of hæmophilia. I have recently met with a case, which occurred in the practice of Dr. W. H. Miller of Edinburgh, in which the fœtus showed numerous purpuric spots over the head, chest, and abdomen. There was, however, no history of any abnormality in pregnancy, and the mother was quite healthy; there was no reason to regard it as true purpura hæmorrhagica. It may be added that the fœtus showed also complete hypospadias, with non-descent of the testicles, making the diagnosis of the sex doubtful; and there were various internal anomalies. Some reported instances of purpura neonatorum, such as that described by J. H. Glenn at a meeting of the Royal Academy of Medicine in Ireland (*Med. Press and Circ.*, i., for 1893, p. 587), are evidently cases of congenital syphilis. If the above-named morbid states be excluded, very few genuine examples of fœtal purpura remain in medical literature. Possibly the cases of Petit (*Bull méd. du nord*, 2 s., xii. 363, 1872) and of Dalziel (*Glasgow Med. Journ.*, 5 s., xxxii., 65, 1889) may be regarded as such; certainly the instances reported by Dohrn (*Arch. f. Gynaek.*, vi. 486, 1873–4) and by J. C. Diehl (*Ztschr. f. Geburtsh. u. Gynäk.*, xli. 218, 1899) have strong claims to be accepted as true instances of the transmission of purpura hæmorrhagica from mother to fœtus.

Diehl's case is reported with considerable fulness. The mother was 36 years of age, and had six normal confinements, but no abortions, and was pregnant for the seventh time. Having reached the fifth month, she was attacked by pains and stiffness in the lower limbs, and had to keep her bed. She gave birth to a male fœtus, the confinement not being accompanied by marked bleeding. Soon afterwards she was found to be suffering from purpura in the skin of the chest and abdomen, arranged in a somewhat symmetrical manner. The urine contained blood, and the pulse was small, soft, and quick. She died on the third day of the puerperium. The fœtus, like the mother, showed cutaneous hæmorrhages, with a symmetrical distribution, but affecting only the head and back; they were punctiform. Post-mortem examination revealed, in the case of the mother, numerous internal hæmorrhages in the dura mater, under the periosteum of the anterior wall of the spinal canal, in the peri-aortic tissues, in the left crus of the diaphragm, in the tissue round the urethra, and in the bladder wall, and elsewhere. The fœtus showed irregularly distributed hæmorrhages in the dura mater, in the spinal canal, in the visceral layer of the pericardium, in the peritoneum, and on the palate; there were no signs of syphilis. It is unnecessary to refer to the microscopical appearances of the maternal and fœtal organs; but it may be noted that in none of the organs (maternal or fœtal) were micro-organisms discovered, although they were very carefully looked for. Dohrn's case (*loc. cit.*) resembled the above in certain details, but differed in the fact that both mother and infant recovered; the evidence, therefore, in favour of the diagnosis of fœtal purpura rested entirely upon clinical observation.

The case reported by V. Hanot and Ch. Luzet (*Arch. de méd. expér. et d'anat. path.*, 1 s., ii. 772, 1890) may be referred to here, as it is apparently related to purpura, to cerebro-spinal meningitis, and to sepsis. Briefly stated, the case was as follows:—The mother had had a normal pregnancy, which ended in the expulsion of a dead full-time fœtus. On the day before labour supervened, however, she had become comatose, and a number of purpuric spots had appeared upon the abdomen and on the upper and lower limbs. She died two days after her confinement, and at the post-mortem examination a state of sub-acute purulent cerebro-spinal meningitis was discovered, with the streptococcus pyogenes in the meningeal exudation, in the spleen, liver, and uterus. The fœtus, which had evidently not been long dead, showed no purpuric spots on the skin, but there were some hæmorrhages in the pericardial and pleural membranes. In these petechiæ on the pericardium and in the liver, the streptococcus pyogenes was found. The authors are of opinion that the maternal cerebro-spinal meningitis was the primary source of the bacterial infection, whence it spread to the rest of the body and through the placenta to the fœtus, causing its infection and death in utero. It would seem that the case is more nearly allied to fœtal sepsis than to fœtal purpura; but, after all, the question may be reasonably asked, What is purpura?

Fœtal Pneumonia.

Scattered throughout medical literature are reports of cases in which the fœtus in utero apparently suffered from pneumonia. Thus, in B. C. Hirst's observation (*Amer. Journ. Obst.* xx. 1195, 1887), a prematurely born infant, who only lived twenty-two hours, showed marked double catarrhal pneumonia, which the author was inclined to regard as due to the drawing of meconium into the lungs by the making of intrauterine inspiratory efforts; the mother in this instance did not suffer from pneumonia, but from a large lumbar abscess, so that it is probable that the fœtal pneumonia was truly septic in origin. In two cases of epidemic cerebro-spinal meningitis in pregnancy observed by P. Foa and G. Bordoni-Uffreduzzi (*Deutsche med. Wchnschr.*, xii. 249, 1886), the mothers suffered from pneumonia in the stage of red hepatisation, and the fœtuses, expelled at the fourth and sixth month respectively, showed in their blood and in the liver the characteristic diplococcus of pneumonia; the micro-organism was discovered also in the uterine sinuses and in the fœtal portion of the placenta. These authors also demonstrated the passage of the diplococcus pneumoniæ in animals. As was noted with other transmissible diseases, so with this, it occurs now and again that the causal microbe is not found in the fœtus: thus, in one of E. Levy's cases (*Arch. f. exper. Path. u. Pharmakol.*, xxvi. 155, 1889), there was croupous pneumonia in the mother, but the diplococcus was not found either in the blood or in the spleen of the fœtus expelled at the fifth month of antenatal life. Several cases are on record in which both mother and infant developed pneumonia (M. Thorner, *Diss. München*, 1884; Netter, *Compt. rend. Soc. de biol.*, 9 s., i. 187, 1889; A. Viti, *Riforma med.*, vi. 578, 584, 1890; and M. Delestre, *Compt. rend. Soc. de biol.*, 10 s., v. 150, 1898); but the fœtus sometimes had lesions of other parts as well as the lungs, *e.g.* of the pleura, pericardium, and peritoneum. G. Carbonelli's case (*Riv. di ostet. e ginec.*, ii. 281, 1891) was peculiar in that, while the fœtus showed the diplococcus of pneumonia in the peritoneal exudation, in the spleen and in the blood, the mother had suffered from no infectious disease during her pregnancy.

It is evident that these cases of fœtal pneumonia have close connections with septic conditions; indeed, it may be found desirable in the future to group them with fœtal sepsis rather than in a division by themselves. A reference to the general principles which have been laid down with regard to fœtal diseases will make it plain why the lungs are neither often nor exclusively affected in these cases; the organs are not in the direct line of the circulation, and are not supplied with a large amount of blood. Of course, it is not always possible to exclude infection of the fœtal lungs, which has occurred during the progress of labour, for, when early rupture of the membranes takes place, infected liquor amnii or vaginal secretion may be sucked into the mouth of the infant, and reach the pulmonary tissues, setting up inflammatory processes in them. Instances of this intranatal

mode of infection have been recorded by Legry and Dubrisay (*Arch. de tocol.*, xxi. 599, 1894).

Fœtal Anthrax.

Although the bacillus anthracis was one of the first microbes whose passage through the placenta from mother to fœtus was experimentally determined in animals, clinical proof of its transmission in the case of the human subject has only been forthcoming during recent years. D. Morisani (*Morgagni*, xxviii. 523, 1886) recorded an instance of anthrax in a pregnant woman, but the fœtus was dead-born, and no cultures of the bacillus anthracis could be got from its tissues; on the other hand, the pregnant woman suffering from malignant pustule who was seen by S. Romano (*Morgagni*, xxx. 458, 1888) gave birth to a living and healthy infant. With regard to the case observed by F. Marchand (*Arch. f. path. Anat.*, cix. 86, 1887), the mother was found at the autopsy to have been suffering from anthrax, and the infant developed the same malady; but the evidence of intrauterine transmission was defective, for the infection might have occurred in the act of birth, and, further, the avenue of entrance of the maternal infection could not be determined. In the placenta, bacilli were found only in the intervillous spaces. Over against these negative or practically negative results must be placed, the three remarkable cases reported by M. J. Rostowzew (*Ztschr. f. Geburtsh. u. Gynäk.*, xxxvii. 542, 1897). These were instances of malignant pustule attacking pregnant women at the eighth, seventh, and fourth months respectively, and proving fatal a few days after the expulsion of the uterine contents. The bacilli of anthrax were found not only in the placental intervillous spaces, but also in the fœtal villi; and in one case there were hæmorrhages into the placental substance, while in another there was some necrosis either of the syncytium alone or affecting all the component parts of the villus; and in the necrotic areas were the bacilli, Rostowzew also found the characteristic microbes in the liquor amnii. With regard to the fœtal tissues (apart from the chorionic villi), it was noted that some bacilli of anthrax were to be recognised in the blood and organs, but they were few in number, and did not stain well with reagents; possibly they were in a more or less inactive state, although, as we have seen in respect to fœtal tuberculosis, there is no reason to believe that the fœtal structures have any bactericidal effect upon germs. From the study of Rostowzew's cases, it may be considered that, while the germs of anthrax had made their way to the fœtus, they had not yet produced the disease in it; possibly they had not had sufficient time. There is a considerable literature dealing with the transmission of anthrax from mother to fœtus in the case of animals (E. Perroncito, *Arch. ital. de biol.*, iii. 58, 1883; G. Sangalli, *R. Ist. Lomb. d. sc. e lett. Rendic.*, Milan, 2 s., xv. 668, 1882; I. Straus and C. Chamberland, *Gaz. hebd. de méd.*, 2 s., xx. 167, 1883; V. Carità, *Gior. d. r. Accad. di med. di Torino*, 3 s., xxxi. 349, 1883; M. Simon, *Ztschr. f. Geburtsh. u. Gynäk.*, xvii. 126, 1889; W. Rosenblath, *Arch. f. path. Anat.*, cxv. 371, 1889;

M. R. Latis, *Riforma med.*, v. 842, 1889; M. R. Latis, *Beitr. z. path. Anat. u. z. allg. Path.*, x. 148, 1891; and C. Massa, *Riforma med.*, xii., pt. 2, 531, 1896); but, as has been stated, the cases in which a pregnant woman has transmitted the malady to her unborn infant are few in number.

No instance has yet been reported in the human subject in which a mother has transmitted hydrophobia to her fœtus; but in the presence of the necessary conditions the occurrence is not to be regarded as impossible. Further, the transmission has actually occurred in the lower animals; E. Perroncito and Carità (*Gior. d. r. Accad. di med. di Torino*, 3 s., xxxv. 122, 1887) inoculated a pregnant rabbit with rabies in the neighbourhood of the fourth ventricle; some days later the contents of the uterus were expelled, and the animal died of rabies; with the medulla oblongata of two of the living fœtuses which had been expelled, two guinea-pigs were inoculated; one of these remained healthy, but the other died, and two other guinea-pigs and a rabbit were inoculated from its medulla; all the three died with the symptoms of rabies. The disease had therefore been transmitted in the case of some but not of all the fœtuses. G. Zagari's experiments (*Gior. internaz. d. sc. med.*, n.s., x. 54, 1888), however, gave negative results; but Palazzi (*Ann. di ostet. e. ginec.* xxiii. 570, 1901) refers to Lisi's possible case of the placental transmission of hydrophobia in a bitch, and gives details of a somewhat doubtful instance in a cow which had been under his own observation. There seems to be no reason to doubt that, as with other transmissible maladies, so with hydrophobia, its intrauterine and transplacental transference from mother to fœtus may occasionally occur.

In a case of maternal diabetes mellitus, H. Ludwig (*Centrlbl. f. Gynäk.*, xix. 281, 1895) found an excessive quantity of liquor amnii, and in that amniotic fluid were very distinct traces of sugar; he hazarded the suggestion that possibly this might be an instance of fœtal diabetes. As, however, the infant was born dead, there was no opportunity of testing the suggestion by the results. Further, E. Rossa (*Centrlbl. f. Gynäk.*, xx. 657, 1896), in the following year met with a somewhat similar case; in it the infant survived birth long enough to give an opportunity of urine analysis; the urine contained no sugar, although the liquor amnii and the maternal urine did.

Fœtal Rheumatic Fever.

Sometimes, although very rarely, a pregnant woman suffering from acute rheumatism gives birth to an infant whose joints are enlarged and tender; the presumption then is that rheumatic fever has been transmitted from mother to fœtus in utero. The case reported by J. Haig Ferguson (*Edinb. Hosp. Rep.*, i. 608, 1893) was apparently a well-established example of this transmission. The mother had twice suffered from rheumatic fever, and was attacked for the third time at the second month of pregnancy; she was ill

for four months, and thereafter had rheumatic pains till the full term; the child at birth was plump, but cried when handled, and the knees and wrists and fingers were swollen; after birth it rapidly became emaciated, the swelling of the joints increased, and redness and tenderness developed; the infant died when ten days old. At the autopsy the elbows, wrists, and knees were found enlarged, there was fluid in the knee-joint and in the pericardium; the bones were not, however, diseased. A somewhat similar case was that seen by F. E. Pocock (*Lancet*, ii., for 1882, p. 804); less than twelve hours after birth the child's temperature was found to be raised, the right shoulder and elbow were swollen, and the skin covering them was red; since, also, these parts were evidently tender to touch, the diagnosis of congenital rheumatism was made, and salicylate of soda was administered; the infant made a good recovery. Schæfer's observation (*Berl. klin. Wchnschr.*, xxiii. 79, 1886) closely resembles the foregoing; in it, also, the infant recovered under salicylate of soda. Possibly some of the cases which have been reported as instances of rheumatism in the new-born have been truly antenatal in their origin; but even if they be admitted, the total number of observations remains very small. It must also be borne in mind that septic and gonorrhœal conditions in the new-born may closely simulate acute rheumatism. It remains as an undoubted fact that, for some reason, acute rheumatism is rarely present at birth.

The types of fœtal disease which have been considered in this chapter, and more especially tuberculosis, will have suggested and illustrated several new pathological possibilities which arise when a pregnant woman is the subject of a malady which may be transmitted to her unborn infant. In particular, the reader will have learned that sometimes the disease itself may not be transmitted, and yet the pathological state of the mother may produce its effect upon the fœtus, and set up in it morbid conditions which, for want of a better word, we call dystrophies. This special peculiarity of fœtal pathology will be more fully dealt with in the following chapter, for it is well demonstrated in connection with fœtal syphilis, and with that important malady the chapter has to do.

CHAPTER XIV

Types of Transmitted Fœtal Diseases: Fœtal Syphilis; Limitation of the Subject; Definitions of Infantile, Neonatal, and Fœtal Syphilis; Morbid Anatomy, General and Special; Dystrophies of Antenatal Syphilis; Pathogenesis; Nature of the Morbid Agent; Modes of Transmission of the Syphilitic Virus; Effects of Fœtal Syphilis; Modifying Influences; Treatment.

FŒTAL syphilis is the malady that most medical men think of when reference is made to fœtal disease. It has been studied in all its aspects and at very considerable length by a multitude of careful observers. It has been taken as the type of antenatal maladies, as the typical disease of the fœtus; it may almost be said that, to some investigators, fœtal pathology and fœtal syphilis have been synonymous terms. It has comparatively seldom been contrasted with the other known transmitted maladies of the unborn infant; and it has scarcely at all been studied in the light of recent generalisations regarding the phenomena and laws of Antenatal Pathology. The description of fœtal syphilis given in this chapter is not to be looked upon as in any sense an attempt to equal, far less to surpass, the many accurate and exhaustive accounts of the morbid anatomy and pathogenesis of the disease which have been set forth by such noted specialists as Colles, Diday, Hutchinson, F. von Baerensprung, Fürth, Fournier, Kassowitz, Heubner, Parrot, and Hochsinger. I intend simply to consider syphilis as one of the many morbid states which may be transmitted to the fœtus in utero, albeit one of the most important of these; to point out in what respects it agrees with or differs from these other transmitted states; and to essay to show and illustrate the manner in which the malady obeys the laws which govern Antenatal Pathology. To do more than this would be to expand this chapter into a volume, and so destroy the symmetry of this *Manual of Antenatal Pathology;* to do less, would be to give inadequate consideration to a fœtal disease of great importance and with far-reaching consequences.

Limitation of the Subject.

I do not intend, save in an indirect fashion, to describe the syphilitic manifestations which first appear during the second month of life. To them the name of *infantile* syphilis is correctly enough given. They are due in the great majority of cases to infection which has occurred before birth; but in a small minority of instances they

take their origin in the intranatal or in the neonatal period, and are, therefore, sometimes of the nature of "acquired" syphilis, albeit the acquirement is entirely involuntary and "innocent." The possibility of the acquirement of syphilis during the act of parturition has been doubted; but some few cases have been put upon record (*vide* L. D. Bulkley's *Syphilis in the Innocent*, p. 170, 1894), in which a chancre ("at the root of the nose," "at the inner angle of the eye," etc.) appeared four weeks after birth, and could apparently be traced to recently developed syphilitic lesions of the mother's genitals (Thiry, *Presse méd. belge*, xxxvi. 241, 1884). Cases, also, have been reported in which syphilis was acquired during the neonatal period, either from the nurse in lactation or from an infected infant. As a rule, however, syphilis showing itself for the first time in the second month of life has been transmitted to the infant before birth; in its clinical manifestations it differs from the acquired forms in the absence of the primary sore and initial glandular enlargement, and in other minor details such as the rarity of roseola. It is syphilis occurring in and being modified by the infantile organism; it has characters which are impressed upon it by the peculiarities of the physiology of the infant (*e.g.* its fatality, the nature of the cutaneous lesions); and for it, in my opinion, the name *infantile syphilis* ought to be rigidly reserved. Like syphilis in the adult it has the power, in a very remarkable degree, of simulating or imitating many non-syphilitic morbid processes; there is scarcely a cutaneous malady that may not thus be simulated, and even affections of the respiratory, circulatory, gastro-intestinal, and nervous systems may be copied more or less closely by syphilis. The well-known symptoms and signs of the disease, as it occurs in infants, it is not my purpose to consider, they are fully described in countless text-books and monographs; but I may draw the attention of the reader to the striking fact that, although the infant is undoubtedly syphilitic at birth, the clinical manifestations of the taint have their appearance delayed until six weeks or two months have elapsed. What may be the meaning of this period of freedom from the external signs of the disease it is not yet possible to determine; all explanations must be more or less of the nature of guesses. It is possible, of course, that the extrauterine environment differs so essentially from the intra-uterine that it takes some time for the disease to become evident along the new lines of development which are imposed upon it by the new conditions which surround it. It may be that fœtal conditions favour the occurrence of visceral lesions, while the infantile environment predisposes to cutaneous and respiratory changes; some time is necessary before the new pathological departure makes itself felt. It is possible, also, that anti-syphilitic treatment of the mother before her confinement may have beneficially affected her fœtus in utero, and that this good effect persists for four or five weeks after birth; but this explanation utterly fails to meet the cases in which no mercury has been given to the mother in her pregnancy.

Neither do I intend to discuss fully the syphilitic manifestations which occasionally occur during the first month of life. For them the

term *neonatal syphilis* ought to be reserved, and they ought to be distinguished from the signs which are actually present at birth and to which alone the name *fœtal syphilis* should be applied. Neonatal syphilis is comparatively rare, that is to say, the offspring of syphilitic parents, showing no external indications of the taint at birth, do not often develop unmistakable manifestations of it during the first two or three weeks of life. When, however, the disease is met with at this period of infancy, it has characters which are to some extent peculiar to it and which are possibly the result of the peculiar physiological conditions which then prevail. I have already in Chapter IV. dealt in some detail with the physiology of the neonatal period, and have emphasised and exemplified the fact that it is essentially a period of transition, of readjustment, and alteration of structure and more especially of function to suit the new environment; there is no need for me to enter again into details at this stage. Syphilis, like other maladies which may attack the new-born infant, has characters impressed upon it which are the result of the special physiology of the neonatal period of life. For instance, it is very fatal and very rapidly fatal, a fact which is no doubt partly to be explained by the transitional nature of the neonatal economy. Death is then due in all probability to visceral lesions, for such infants come into the world already carrying in their internal organs the structural changes due to fœtal syphilis; these changes were to some extent compatible with intrauterine life, but they seriously interfere with prolonged extrauterine existence. The only sign of neonatal syphilis may therefore be rapid death, apparently brought about by a trifling cause but really due to antenatal visceral lesions which become lethal under the changed circumstances which follow birth. There may also, however, be special signs of the syphilis of the new-born. Of these perhaps the most distinctive is pemphigus. The bullæ of this cutaneous affection may be present at birth and the disease be therefore truly fœtal; but very often they do not appear until a few days have elapsed. It is a striking fact that the most marked cutaneous manifestation of neonatal syphilis should be pemphigus, but it finds an explanation in the loose attachment of the epidermis to the underlying skin at this period of life and in the resulting tendency to desquamation. Pemphigus occurs also in the new-born as a sign of diseases other than syphilis (*e.g.* sepsis), and is then no doubt due to the same keratolytic state of the integument; but the form to which I now specially refer has peculiarities of its own due to its syphilitic nature. The bullæ contain a blood-stained or purulent fluid; they are large and numerous; they have a special tendency to affect the palms and soles; and after rupture they tend to leave irregular ulcers covered sometimes with a brownish or blood-stained crust. In syphilis neonatorum, then, pemphigus is apt to occur because the subject affected is the *new-born* infant, and syphilitic pemphigus of the new-born has special characters which distinguish it from the non-syphilitic variety. Another peculiarity of neonatal syphilis is its hæmorrhagic tendency. So marked is this tendency in some cases, that the name *Syphilis hæmorrhagica neonatorum* has been introduced

(G. Behrend, *Deutsche Ztschr. f. prakt. Med.*, v. 289, 301, 1878; E. Petersen, *Vrtljschr. f. Dermat.*, x. 509, 1883 R. Fischl, *Arch. f. Kinderk.*, viii. 10, 1886–7; F. Mraček, *Vrtljschr. f. Dermat.*, xiv. 117, 1887; etc.), to give expression to it. It would seem (from Mraček's statistics) that the bleeding most commonly occurs in the skin, subcutaneous tissue, lungs, and pleura, and less frequently in the heart and vessels (adventitia), brain, kidneys, scalp, liver, etc.; but it may apparently take place in any organ or tissue in the body. It may be ascribed in part to the direct effect of syphilis upon the tissues, and in part to the transitional state of the blood and circulation immediately after birth. Syphilis attacking the new-born child may also, like that malady in infancy and later life, simulate or imitate the diseases which are to some extent peculiar to the neonatal state. Thus, there is a syphilitic neonatal omphalorrhagia, a syphilitic œdema neonatorum, a syphilitic jaundice of the new-born, a syphilitic melæna neonatorum, and so on. These morbid states are all full of interest, and they are, moreover, in a sense congenital, being due to a specific infection which has occurred before birth; but, as has been stated above, they do not fall to be considered under the heading of *fœtal syphilis* properly so called.

The name *fœtal syphilis* ought, in my opinion, to be limited to the pathological changes which are produced in the organs and tissues of the unborn infant during the fœtal period of antenatal life, a period which lasts, as will be remembered, from the sixth to the fortieth week. As will be seen immediately, most of these changes are of the nature of diseases, but some few of them are more correctly to be regarded as deformities. The latter find an explanation in the fact, to which reference has already been made elsewhere (p. 10), that all the fœtal organs have not completed their development when they reach the beginning of the fœtal period; the syphilitic virus acting upon them in their embryonic state will, it may be supposed, produce in them malformations rather than diseases. It is in this way that some of the so-called dystrophies of fœtal syphilis are produced. Theoretically, fœtal syphilis ought to be separated from what may be called embryonic and germinal syphilis. It is very probable that syphilis acting upon the organism in its embryonic period of antenatal life produces changes of a very different kind from those met with in the fœtal period. It may ultimately be found that the former are of the nature of monstrosities and malformations rather than of diseases in the strict sense of the word. It is not, however, in the meantime possible to carry out in practice this separation of the phenomena of fœtal from the phenomena of embryonic and germinal syphilis; with fuller knowledge it may yet be accomplished.

I have thus indicated certain limitations of the subject to be considered in this chapter; but it must not be forgotten that there is another aspect of the matter. It is necessary to bear in mind that when syphilis attacks the organism in the fœtal period, it attacks not only the fœtus but also the so-called fœtal appendages, namely, the placenta, membranes, cord, and liquor amnii. There is, therefore, in

this direction an expansion of the meaning of the term fœtal syphilis. Although, in my classification of fœtal morbid states (p. 175), I have placed diseases and morbid conditions of the fœtal annexa in a group by themselves, it is not wise to insist too strictly upon this separation; and, as a matter of expedience, it will be best in the case of fœtal syphilis to neglect it altogether.

Morbid Anatomy of Fœtal Syphilis.

Of the vexed question of the channels by which the syphilitic virus reaches the fœtus in utero something will be said ere long; but, in the meantime, I proceed upon the assumption that fœtal infection with syphilis is generally transplacental. I do not doubt that syphilis in the father may produce certain effects upon the fœtus through the fertilising spermatozoon and that syphilis in the mother may act upon the ovum in the ovary and the embryo in the uterus; I do not deny the possibility of sperminal and germinal infection leading to syphilitic manifestations in the fœtus, but, on theoretical grounds, I regard it as unlikely; the consideration of these matters, however, can be more properly taken up after the morbid changes met with in the fœtus have been dealt with. It is provisionally understood, then, that the fœtus takes syphilis from the mother through its vascular placental connections, and rarely, perhaps, through the medium of the liquor amnii. What, now, are the pathological changes which may be found in the fœtus at the time when it is expelled from the uterus?

General statement.—Fœtal syphilis, being a fœtal disease, will be subject to the laws that govern fœtal pathology. What these laws are, a reference to Chapter XI. will show. For instance, the intra-uterine environment will modify the morbid changes which occur as the result of syphilitic infection; the cutaneous changes will be slightly marked or absent altogether, and the post-mortem alterations (when fœtal death occurs) will be those due to syphilis associated with those due to the aseptic surroundings. Again, the placental factor will have its influence; if we may judge by analogy, it may be said that the placenta will in some instances keep back the syphilitic poison (microbic or toxinic) and so save the fœtus from syphilis; in other cases, possibly on account of placental lesions, it will allow it to pass, and then the fœtal tissues will be attached in the manner and order which are peculiar to infections arriving by the umbilical avenue; in yet other cases, the placenta will itself become seriously pathological, and this will entail not fœtal disease so much as fœtal death; and finally, the fœtus may become infected through the placenta and then die on account of lesions in the placenta. From the great frequency of intrauterine death in cases of maternal syphilis, it may be concluded that the placenta acts most often in the two last-named ways. It must, also, be borne in mind, in considering the morbid anatomy of fœtal syphilis, that some of the changes present may be the results of the action of syphilis upon the organism in the embryonic or germinal epochs of antenatal life; all that is seen in the fœtus at

birth is not necessarily the result of causes acting in the fœtal period; this statement applies with special force to what are called the syphilitic dystrophies.

Special morbid anatomy.—Our knowledge of the morbid anatomy of the various organs and tissues in fœtal syphilis has been derived from the study of fœtuses born either dead or alive, at or (more frequently) before the full term of intrauterine existence. In many details it is unsatisfactory, for next to nothing is known of the initial stages, and the changes due solely to intrauterine death have been persistently confounded with those caused purely by the disease. Nay more, histological conditions of the organs which are normal in the fœtus have been described as due to the syphilitic poison. I shall begin my consideration of these changes with the description of them as they are found in the placenta and umbilical cord, for the former is the most important organ that the fœtus has, and by its pathological state no doubt much is determined.

The placenta.—Alterations in the structure of the placenta in syphilis are very frequent although not constant; when they occur they are very often of the kind to be now described, but they are not invariably so. If, therefore, we give the name "syphilis of the placenta" to these morbid changes, it must be with the reservation that, while they are highly suggestive of syphilitic infection, they are not absolutely pathognomonic thereof. The pathology of the syphilitic placenta has been carefully investigated by a considerable number of workers, including E. Fränkel (*Arch. f. Gynaek.*, v. 1, 1873); C. Hennig (*Ibid.*, vi. 141, 1873-4); E. Hervieux *Arch. de tocol.*, vi. 513, 1879); G. B. Ercolani (*Bull. d. sc. med. di Bologna*, 6 s., xi. 217, 1883); R. Zilles (*Mitth. a. d. geburtsh.-gynäk. Klin., zu Tübing.*, i. Hft. 2, p. 1, 1884); A. Gascard (*Thèse*, Paris, 1885); M. Pedicini (*Progresso med.*, Naples, i. 67, etc., 1887); Thiel (*Dissert.*, Würzburg, 1889); Rosinski (*Dissert.*, Königsberg, 1889); G. R. d'Aulnay (*Arch. de tocol.*, xxi. 910, 1894); Eckardt (*Verhandl. d. deutsch. Gesellsch f. Gynäk.*, vi. 627, 1895); Schwab (*Presse méd.*, p. 494, 1895); J. D. Bissell (*Amer. J. Gyn. and Obst.*, xi. 147, 1897); Audebert (*Journ. de méd. de Bordeaux*, xxviii. 82, 1898); and V. Wallich (*Rev. prat. d'obst. et de pædiat.*, xi. 33, 1898). By the naked eye the placenta is seen to be larger than normal and paler in colour —it is of a pale red with yellowish-white patches. When handled it is to be noted that it is softer than usual and may even be friable. In the case of a dead syphilitic fœtus the weight of the placenta is to that of the body as 1 : 4, whereas in the absence of syphilis it is as 1 : 6 (C. Ruge, *Ztschr. f. Geburtsh. u. Gynäk.*, i. 57, 1877). Under the microscope the most important change is found to be a diffuse and gradual inflammation affecting specially the blood vessels. There is well-marked endarteritis and very often a thrombus is to be seen in the lumen of the vessel along with indications of periarteritis outside. These changes are specially developed in the vessels of the villi, in which also inflammatory proliferation is to be noted in the stroma and in the epithelial covering, so that there is considerable hypertrophy of the villi with fibrous degeneration of their tissues.

The quantity of blood circulating in the fœtal part of the placenta is thus diminished, and the organ becomes more or less anæmic, with results to the fœtus which can readily be understood. But the maternal part of the placenta may also suffer; here and there hæmorrhages may be found in it showing various stages of resorption, and these, partly by their effect on the maternal blood spaces, and partly by separating the placenta from the uterine wall, tend still further to diminish the circulation passing through the organ, and so render fœtal death, which is already probable, almost inevitable. The so-called "gummata" of the placenta are probably hæmorrhagic in their origin, or are due to fibrous patches which have become more or less caseous; possibly, however, true gummata may in exceptional circumstances be met with. An attempt has been made to separate into two groups the morbid alterations which are met with in the placenta —in one group are placed the changes in the villi and in their vessels, and when these alone are found it is supposed that the disease has originated in paternal infection; in the other are the changes in the decidual tissues and the parts arising from them, and when these alone are found a maternal source is predicated—but it can hardly be safely concluded that any such grouping is warranted by the facts. It has also been stated that the placental pathology differs with the date in pregnancy when the infection took place—another statement which is easily made but with difficulty substantiated or disproved.

The umbilical cord.—The commonly occurring change in the funis in cases of fœtal syphilis would appear to be a thickening of the vessel walls so great as almost to produce obliteration, along with the formation of thrombi in these narrowed vessels. The vascular changes in the cord, taken along with the morbid alterations in the placenta, play no doubt a very important part in diminishing fœtal vitality and leading to intrauterine death. Forming as they do the first lines of defence, the placenta and cord bear the brunt of the attack, and being also as it were the key of the position, their failure to resist is immediately disastrous. In neofœtal life it may indeed be doubted whether the syphilitic poison very often reaches the organism at all; it attacks the decidual membranes and leads rapidly to abortion by the changes produced in them. Among other changes in the cord in cases of syphilis, absence of the jelly of Wharton causing dissociation of the vessels has also been observed (Macé and Durante, *Ann. de gynéc*, xliv. 221, 1895).

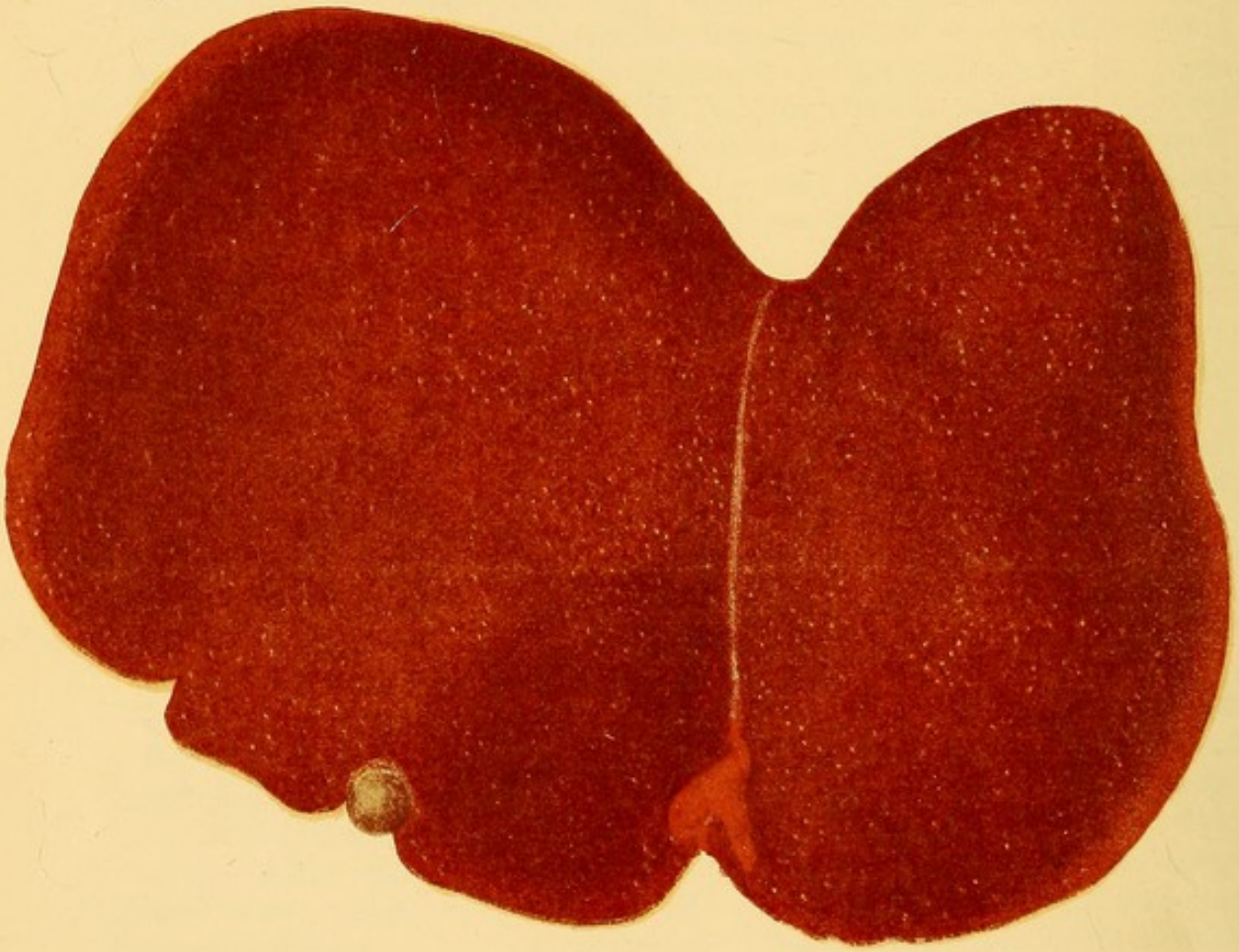
The liquor amnii.—There can be no reasonable doubt that a quantitative change in the amniotic fluid is a very frequent result of fœtal syphilis. Hydramnios is so common in connection with this malady, that some have been tempted to regard excess of the liquor amnii as pathognomonic of syphilis. This conclusion, however, is not warranted, indeed it must be conceded that hydramnios is very common in all pathological states of the fœtus; it is pathognomonic rather of fœtal disease and deformity than of any one fœtal disease or deformity. At the same time, this generalisation does not in any way lessen the value of the well-established fact that hydramnios is common in fœtal syphilis, it only prevents us from ascribing too

great a diagnostic importance to it. The association of hydramnios with syphilis does not aid very materially in clearing up the vexed question of the origin of the liquor amnii; it does not even enable us to affirm its maternal or fœtal origin. Apparently there may be hydramnios, not only when the fœtus is distinctly syphilitic but also when the fœtus is free and the mother alone affected. It is, however, a fair working hypothesis to regard the hydramnios as largely due to increased pressure in the umbilical vein, caused by lesions in the placenta, in the cord itself, or in the fœtal liver; it may be compared with postnatal ascites due to circulatory troubles in the portal system, and it may even be regarded as taking the place of portal ascites in the fœtal economy (*v.* P. Bar, *L'hydramnios, Thèse*, Paris, 1881). Cardiac and pulmonary lesions in syphilitic fœtuses may also impede the circulation and lead to hydramnios. Possibly, then, it may be safe to regard the presence of hydramnios as of grave import in cases of syphilis, for the reason that it indicates visceral lesions in the fœtal economy (placental, funic, hepatic, pulmonary, or cardiac); but it is wise to be slow, very slow to formulate views on these matters, the antenatal pathologist being like a storm-tossed mariner with a continual lee-shore largely unknown to him but dangerously near. Meanwhile, let the reader keep in mind the association of hydramnios and fœtal syphilis. Much might be learned from carefully made analyses of the composition of the liquor amnii in cases of fœtal syphilis in which the fœtus is alive at birth; but alas! such analyses are sadly wanting. Quantitative alteration in the amniotic fluid in this fœtal malady then is undoubted; qualitative changes probably almost certainly exist, but are of unknown nature.

The liver.—Next in importance to the changes in the placenta must be ranked those of the liver, for the fœtus is largely dependent upon the state of its placental and hepatic tissues. The occurrence of birth excludes the placental factor, and thereafter the liver shares with the lungs the first place in pathogenesis; in the new-born infant, therefore, syphilitic alterations in the lungs and liver are of great moment. Yet with regard at least to the hepatic alterations, little or nothing was known till 1849, when A. Gubler published his article on syphilitic jaundice (*Bull. Soc. Anat. de Paris*, xxiv. 66, 1849); since then many monographs dealing with the same subject have appeared, among which that by Lucien Hudelo (*Contribution à l'étude des lésions du foie dans la syphilis héréditaire*, Paris, 1890) may be singled out for special mention; but Gubler it was who broke fresh ground in this direction—a memorable name and date therefore—*Gubler 1849.* To be quite exact it was in 1847 that Gubler first noted special changes in the liver of the syphilitic new-born infant, but the publication of the fact was in 1849. What, then, are the changes met with in the fœtal liver in syphilis?

In the *first* place, lest I by any chance omit to make the statement, the liver may show no alterations whatever, exhibiting only the naked-eye and microscopic characters common to all new-born infants; in other cases in which the fœtus has died in utero, the organ will reveal the appearances due to macerative change, and these may

PLATE X.



entirely obscure any specific peculiarities. This statement is true not only of the liver but also of all the organs in fœtal syphilis.

In the *second* place, the liver may be the seat of very special changes, macroscopic and microscopic. To the liver thus altered by syphilis the French writers have given the names "foie silex" (flint liver) and "foie silex avec grains de semoule" (flint liver with semolina grains); the two names to some extent indicate two different alterations, for the "flint liver" may show none of the "semolina grains"; but it is common to find the two groups of lesions combined in the same liver, the semolina change being the usual concomitant of the flinty ("c'est la satellite habituelle de la lésion silex," *Hudelo*). Some years ago I obtained from an undoubtedly syphilitic fœtus the liver which is produced in Plate X., it exhibits very clearly the "semolina grain" appearance. The flint liver ("foie silex") is larger and heavier than normal and its margins are rounded; its surface is smooth, and the consistence of the organ is much increased and at the same time is elastic; the colour has been compared to that of flint (hence the name "silex"), and on sections this coloration is very evident, along with a semi-transparency and a loss of the outlines of the lobules. Sometimes the flint appearance is generalised ("foie silex généralisé"); at other times there are two colours to be recognised, the flint tint and a rather deep brownish-red ("foie silex partiel"). Most commonly, as has already been hinted, the curious semolina-grain aspect is found in association with the yellow flint change (Plate X.). When a section of the organ is carefully examined, it can be noted that scattered here and there are little opaque, white spots not unlike grains of flour or semolina; many of them have a diameter not greater than one millimeter; they are commonly arranged in groups with the larger ones at the centre; and they are most numerous and of greater size in the partial form of the flint liver. Under the microscope several changes can be recognised, which are doubtless stages in the process which results in the production of the flint liver with semolina grains. There may be simply a generalised infiltration with embryonic cells, a change which Hudelo (*loc. cit.*) found only in fœtuses born prematurely; the infiltration may be the result of diapedesis or of proliferation of connective-tissue cells or even possibly of the hepatic cells themselves. In other cases there may exist small patches of fibrous tissue, which probably precede the diffuse sclerotic change which is characteristic of the typical flint liver of fœtal syphilis. This diffuse interstitial sclerosis was called fibro-plastic induration by Gubler, and infiltrating syphiloma by Wagner; it may be generalised or partial in extent. Some of the liver cells remain unaltered, but many of them in the neighbourhood of the chief tracts of sclerotic tissue show various stages of atrophy. The portal spaces are enlarged on account of the presence of much fibrous tissue in them; the bile-ducts in these spaces are usually quite unaltered, but the veins and sometimes the arteries also show thickened walls and a diminished calibre. The capsule of the organ shows little change. It has been stated that there are histological signs of an exaggeration of the hæmatopoietic function of the liver in

fœtal syphilis. Under the microscope the semolina grains ("miliary syphilomata" of Wagner, "miliary gummata" of Virchow) present themselves as rounded collections (circular, oval, elliptical) of nuclei, varying in number from twenty to one hundred in each grain, and situated both in the hepatic lobules and in the portal spaces. They vary in size from quite microscopical structures to bodies having the diameter of a portal space. They would appear to originate in the neighbourhood of the vessels, and may arise from diapedesis or from proliferation of the endothelium of the capillaries.

In the *third* place, the liver in the syphilitic fœtus may occasionally show changes of a gummatous kind which are more commonly associated with the manifestations of postnatal syphilis. For instance, nodular gummatous hepatitis has, in a few cases, been met with in premature fœtuses; the viscus is brownish-red or normal in colour, slightly increased or normal in size, and of an unaltered consistence; in it are the gummatous nodules, size of a pin-head to that of a pea or bean, lying on the surface or embedded in the substance of the organ, circular or less regular in form, greyish-white or yellow in colour, firm in consistence, and not to be enucleated from the surrounding hepatic tissue. Doubtless they represent a later stage than the miliary syphilomata (semolina grains). Under the microscope they show degeneration at the centre, and sometimes giant cells are found. The presence of recognisable gummata like those of postnatal syphilis is very uncommon in the fœtal liver, but some few cases have been reported (*e.g.* Hervey, *Bull. Soc. anat. de Par.* (1870), xlv. 262, 1874).

In the *fourth* place, changes which are not in any way distinctive of syphilis may be met with in the liver. For instance, waxy degeneration of the hepatic tissue has been found in patches and usually in association with gummatous nodules; but it is rare in the fœtus or new-born infant.

Such, then, are the structural lesions met with in the liver of the syphilitic fœtus; but it may be added that the capsule may show thickening (perihepatitis), that the portal vein and hepatic artery in their course outside the liver may exhibit hyperplastic changes in their walls, and that the bile-ducts may be obliterated. That the hepatic changes taken as a whole represent for the fœtus the chancre of syphilis acquired postnatally, can hardly be considered as probable; the early appearance of gummatous nodules must be regarded as due to the factors which come into play in *fœtal* syphilis and which are common to all fœtal maladies. There is a hypertrophic cirrhosis arising probably in the neighbourhood of the vessels which by it are compressed and obliterated; and although such changes may not develop till late in postnatal syphilis, in the antenatal malady there are circumstances which permit their precocious evolution.

The lungs.—It has been maintained that pulmonary lesions are more frequent in fœtal syphilis than hepatic lesions (P. Bar, *loc. cit.*), but there are special reasons why the pulmonary changes are more often observed (*e.g.* greater resistance offered by the lungs to macerative changes, earlier postnatal death from pulmonary than from hepatic alterations, etc.), and possibly they are not really more

common. Like the changes in the liver to which reference has been made, they are no doubt largely instrumental in leading to the production of hydramnios through obstruction of the circulation. The morbid anatomy of the lungs resembles in many points that of the liver, and the pathological appearances fall into four categories. There may be (1) a generalised, diffuse gelatinous infiltration—pneumonia gelatinosa specifica; (2) a form in which there exist thickened patches, white in colour, and consisting of air vesicles crowded with epithelial cells in a state of fatty degeneration—pneumonia alba syphilitica; (3) a variety in which there are scattered miliary syphilomata (gummatous growths) with signs of interstitial pneumonia in their neighbourhood; and (4) clearly marked interstitial fibroid pneumonia due to hyperplasia of the pulmonary connective-tissue—pneumonia interstitialis fibrosa chronica congenita. Much remains to be done to clear up the pathology of the pulmonary changes in fœtal syphilis and to differentiate between the syphilitic lesions and those caused by *e.g.* fœtal tubercle and fœtal or intranatal sepsis.

The heart, blood vessels, and blood.—Changes in the heart have not been often noted, but miliary syphilomata and rarely gummata may be met with in its substance. The vessels, as will doubtless have been already gathered, show, as a rule, widespread and almost constant alterations, consisting for the most part in endarteritis and periarteritis with resulting diminution in calibre. According to Helmut Scharfe (Hegar's *Beitr. z. Geburtsh. u. Gynaek.*, iii. 368, 1900), the antenatal death of the syphilitic fœtus is often due to narrowing of the ductus arteriosus through changes of the above kind ("durch kolossale Intimawucherung"). Bar and Tissier (*Ann. de dermat. et syph.*, 3 s., vi. 1156, 1895) also deal with this generalised periarteritis of fœtal syphilis. Observations on the blood of the syphilitic fœtus are sadly lacking, even in the case of the new-born infant they are few; but it seems reasonable to expect that some changes are present in both the fluid and corpuscular elements of the blood. After birth, at any rate, a pseudo-leukæmic anæmia has been described; and F. Cima (*Pediatria*, vi. No. 12, 1898) found marked diminution in the amount of hæmoglobin, some poikilocytosis of the red cells, but no leucocytosis other than that commonly present during the first weeks of life. There is a fruitful field for investigation in the examination of blood from the umbilical cord in the case of syphilitic fœtuses; information is also lacking as to the value of the Justus blood-test in the new-born, and the bacillus of syphilis (when isolated) will have to be carefully looked for in the blood of the cord and placenta.

The thymus.—Morbid alterations in the thymus gland have long been described in connection with fœtal syphilis, and it has been customary to regard them as of the nature of small abscesses or degenerated patches of syphilomata; but there is some reason to look upon them as cystic formations in developmental epithelial and glandular relics embedded in the thymus (Otto Eberle, *Ueber congenitale Lues der Thymus. Diss.*, Zürich, 1894). Their precise pathological significance and relation to syphilis are unsettled. The gland may

be normal in size and weight; it may also exhibit induration (E. Schlesinger, *Arch. f. Kinderhlk.*, xxvi. 205, 1899.).

The suprarenal capsules.—The adrenals are usually somewhat enlarged, and histologically they may exhibit an infiltration with embryonic cells, or a hyperplasia of the connective-tissue with atrophy of the cells peculiar to the organs. In some cases hypertrophy of the epithelial cells has been noted, constituting what may be looked upon as small adenomata; hæmorrhages are not uncommon, but are probably in no way characteristic of syphilis. (L. Petit, *Lésions des capsules surrénales dans la syphilis congénitale, Thèse*, Lyon, 1900–1901.)

The spleen.—This organ is practically always enlarged in the syphilitic fœtus (R. Hecker, *Deutsches Arch. f. klin. Med.*, lxi. 1, 1898). There is a *splenitis luetica*, although Bar (*loc. cit.*) did not meet with it in the cases examined by him, and regarded the hypertrophy as purely the result of circulatory disturbances in the portal system. There is a small-celled infiltration of the large and medium-sized blood vessels.

The pancreas.—In the pancreas, lesions similar to those in the liver may be encountered; there is a small-celled infiltration, with fibrous tissue formation, induration, and consequent hypertrophy of the organ. The vascular walls are thickened, while the proper epithelial tissue of the gland is in a more or less atrophic state. The weight is increased.

The kidneys.—The kidneys, like the other organs in the syphilitic fœtus, show an increase in weight so that they become one eighty-sixth instead of about one hundred and twenty-third of the total body weight (Hecker, *Jahrb. f. Kinderhlk.*, n. F., i. 375, 1900). Of late their histology has been accurately studied by Hecker (*loc. cit.*), and in a very complete fashion by J. J. Karvonen (*Die Nierensyphilis, Akad. Abhandl.*, Helsingfors, 1898). The latter writer states that renal lesions are rarely met with in the syphilitic fœtus, possibly because it perishes before they have time to develop; but the former found them in every one of ten dead-born syphilitic fœtuses. At first there is a small-celled infiltration of the small vessels of the cortex and sometimes of the larger vessels of the medulla; frequently also there co-exist a proliferation of the interstitial connective-tissue and an endo- and peri-arteritis of the small vessels of the cortex. In full-time fœtuses the vascular and perivascular infiltration is less marked, but degeneration, more or less marked, of the epithelium is quite recognisable. It is rare to find parenchymatous lesions unless the fœtus has survived birth. A most interesting histological peculiarity —the presence in the kidney substance of fœtal epithelial relics—is discussed at length by Carl Hochsinger (*Studien über die hereditäre Syphilis*, p. 415, 1898); it was pointed out by Stroebe some ten years ago (*Centrlbl. f. allg. Path. u. path. Anat.*, ii. 1009, 1891).

The intestines and peritoneum.—Intestinal lesions in fœtal syphilis (*e.g.* atrophy of small intestine) have not been often described, but for many years antenatal peritonitis has been regarded as syphilitic in nature. As long ago as 1838, J. Y. Simpson pointed out this association of peritonitis and syphilis, and stated that "a great proportion of those children that die in the latter months of pregnancy may yet be shown to have perished under attacks of peritoneal inflammation"

(*Obstetric Works*, vol. ii. p. 152, 1856). No doubt peritonitis, often accompanied by effusion (fœtal ascites), is frequently met with in syphilis; but it is not, of course, pathognomonic, and it may arise from quite other causes. The presence of fluid in the peritoneal cavity, in the absence of other changes, cannot be regarded as peritonitis; there must be not only serum but also flakes of lymph, and the intestinal coils must be more or less adherent to each other and to the abdominal viscera. In the case of syphilitic fœtuses that have succumbed in utero and undergone a certain degree of maceration, the presence or absence of peritonitis is most difficult to determine. The other serous cavities may likewise contain fluid effusions (*e.g.* hydrocephalus, hydropericardium, and hydrothorax).

The testicles.—The changes in the testicles resemble those in the other viscera. There is a small-celled infiltration of the connective-tissue in the neighbourhood of the vessels, and at a later stage the special tissue of the organ becomes affected by the surrounding sclerosis, and atrophy of the seminiferous tubules follows.

The nervous system.—That the nervous tissues suffer in fœtal syphilis cannot be doubted; but the morbid alterations that are found in them are better described as malformations or dystrophies than as diseases. The reason is probably to be found in the fact that the brain is, even at the end of the fœtal period, still in a state of incomplete development, and that peccant matters acting upon it will therefore determine anomalies of construction rather than diseases in the strict sense of the word. To these dystrophic states I shall return immediately. The spinal cord, however, which is almost fully developed at birth, may show signs of fœtal syphilis; these take the form of diffuse meningo-myelitis with an infiltration of small cells, and lead to a pathological state resembling in nature the interstitial hepatitis which has been described above (Gilles de la Tourette, *Nouv. iconog. de la Salpetrière*, ix. 80, 1896).

The skeleton.—The osseous system, like the nervous, is in a state of development even at the time of birth, and is therefore like it also the seat of malformations; but in addition to these, to which reference will again be made, it shows frequently some very characteristic changes which fall into the category of diseases. To these changes the name of *Wegner's sign* has been given, for G. Wegner was the first to draw special attention to their diagnostic importance (*Arch. f. path. Anat.*, l. 305, 1870). At the dividing line between the diaphysis and the epiphysis of a long bone such as the tibia, there is a jagged, broad yellow line separating the bone of the shaft from the cartilage of the extremity. In non-syphilitic fœtuses there is no such line, there being simply a sharply defined boundary where cartilage ceases and osseous tissue begins. To ascertain the presence of this yellow line of fœtal syphilis, the head of one of the long bones (*e.g.* of the femur) is cut down upon, and, having been exposed, is split vertically by means of a strong cartilage knife. The condition may be found in various stages or degrees from a slight thickening of the normal thin white dividing line to the marked, broad, irregular yellow tract described above. In the major degrees there may be

also some thickening of the periosteum and perichondrium. The process which leads to these changes has been called syphilitic osteochondritis; the newly-formed cells between the cartilage and the bone are of low vitality, and undergo degenerative changes of a fatty or caseous kind. During or after birth, separation of the head from the shaft of a long bone may take place; possibly this may also occur in utero with subsequent healing of the separation and the formation of much callus (osteophyte). Other conditions of the bones (both long and flat) have been described in connection with syphilis; and J. Parrot (*La syphilis héréditaire et le rachitis*, Paris, 1886) has gone so far as to state that rachitic changes are always the results of the action of the syphilitic virus, a statement, however, which has not been confirmed by others.

Such are the visceral and skeletal changes which may be met with in the syphilitic fœtus; it cannot be affirmed that any one of them must be present in order to prove the existence of fœtal syphilis, but the presence of several of them in combination may be held to fulfil all the requirements of even an exacting diagnosis. It may even be found that the presence of the peculiar osteochondritis of the long bones is sufficient in itself to constitute a post-mortem diagnosis of the malady, but it is not invariably present. The association of increase in weight of the viscera, along with the bone changes and those in the liver, kidneys, lungs, and thymus, ought to enable the pathologist to be certain that he is dealing with fœtal syphilis; and there need to be no doubt at all if there exist also placental changes and hydramnios.

In order, however, to complete our survey of the morbid anatomy of fœtal syphilis, we must pass in review the alterations met with in the skin and subcutaneous tissue at the moment of birth.

The skin.—The syphilitic fœtus may come into the world with the bullæ of pemphigus in full eruption; the characters of this syphilitic form of pemphigus have been already described, and need not be dealt with further, but it may be remarked in passing, that this cutaneous manifestation of the disease is (*when it happens to be present*) of very great diagnostic value. Besides pemphigus, however, the skin may show an alteration to which the name of ichthyosis has sometimes been applied. Let it be at once noted that this condition is not the same as that called fœtal ichthyosis; that is a malady which will be described as one of the types of the idiopathic diseases of antenatal life; it has very clearly marked characters, and is nearly always associated with an absence of all indications of syphilis in the parents. The condition referred to here, as occurring in the syphilitic fœtus, is more of the nature of an excessive cuticular desquamation, a pseudo-ichthyosis. It shades off by degrees into the macerative states of the skin found in the syphilitic fœtus which has died in utero. It must, however, be borne in mind that, although the syphilitic infant often dies in utero, and is expelled showing all the alterations due to post-mortem maceration, yet a macerated fœtus is not necessarily a syphilitic fœtus. It is doubtful, indeed, whether

there are any peculiarities about the macerative changes in fœtal syphilis which will enable the pathologist to differentiate them from the alterations which follow upon intrauterine death due to non-syphilitic causes. If death have not preceded birth too long, it may be possible from the discovery of the characteristic osseous, hepatic, renal, and pulmonary changes, to state definitely that here was a case of death from syphilis; but in many instances no such conclusion can be safely drawn. Certainly the condition known as *hydrops sanguinolentus*, which is simply well-marked maceration, is not of necessity syphilitic. General fœtal dropsy or general anasarca of the infant born alive may sometimes be syphilitic in origin, but assuredly it is not always so, being, in fact, a symptom of various morbid states rather than itself a distinct morbid entity. Finally, in describing the cutaneous manifestations of fœtal syphilis, it has to be noted that the eruptions (erythematous, papular, and the like) which are so characteristic of the malady in infants are seldom present at birth, at least have seldom been noticed then; this immunity may perhaps be due to the intrauterine environment (as has already been suggested).

It may be added that fissures, ulcerations, and condylomata about the mouth and anus, as well as other syphilitic affections of the mucous membranes, would appear to be rarely observed in the syphilitic infant at the moment of birth.

It must be borne in mind, that of the pathological conditions which have been described, many are rarely met with, while sometimes hardly any of them will be markedly present. On the other hand, the pathologist occasionally, although perhaps very rarely, meets with a case in which nearly all of them can be recognised in the same fœtus. Thus G. Mathewson (*Prag. med. Wchnschr.*, xx. 113, 1895) has described a seven-months' fœtus in which there were the following morbid states: pemphigus; encephalitis; gummata of the meninges, thymus, lungs, myocardium, liver, kidneys, and right femur; hypertrophy of the spleen; osteo-chondritis in the long bones; multiple ecchymoses; hydrothorax and ascites; and placental infarcts.

Dystrophies of Antenatal Syphilis.

Now, in order to complete the picture of the morbid anatomy of fœtal syphilis, it is necessary to mention what have been called the *dystrophies*. A reference to what has been written on page 185 concerning the embryonic factor in fœtal pathology, will enable the reader better to understand the relation of the dystrophies to the ordinary pathological changes of antenatal syphilis. It has already been pointed out in the description of fœtal typhoid and fœtal tubercle (pp. 201, 214), that sometimes the infant of a woman suffering from one of these maladies showed not the ordinary manifestations of typhoid or tubercle, but slight anomalies of structure, or actual malformations, or abnormal tissue reactions leading to early postnatal debility and death. In the case of tubercle, I called these

the non-tubercular manifestations of antenatal tubercle; similarly in the case of syphilis they might be called the non-syphilitic manifestations of antenatal syphilis. At the same time this nomenclature, although in one sense convenient, is probably the expression of an erroneous conception of the real nature of the malformations and anomalous tissue reactions which are met with in the offspring of tubercular or syphilitic parents. Perhaps it is best (in the case of fœtal syphilis, at any rate) to retain the name "dystrophies." What then are these dystrophies which are found sometimes in the fœtuses of syphilitic parents, and what is the probable explanation of their mode of origin?

Edmond Fournier has written a large work (*Stigmates dystrophiques de l'hérédo-syphilis*, Paris, 1898), into which he has condensed most of the information which has been accumulated regarding fœtal dystrophic states. Fournier points out that syphilis has two sorts of hereditary consequences, namely, (1) the transmission of syphilis itself, in nature and in substance, from the ascendant to the descendant; and (2) the transmission of various pathological characters, having nothing syphilic in them, and consisting either in innate inferiorities of constitution, of temperament, or of vital resistance, or in arrests and imperfections, as shown in deviations of physical and intellectual development, in organic malformations, and even in monstrosities. The first of these groups of pathological consequences constitutes syphilitic heredity proper, and the second may be called the dystrophic, parasyphilitic, or toxinic results of syphilitic heredity. I may interpolate here my objection to the use of the word "heredity" in the above senses; to my mind, it is less likely to confuse, if one speaks of two sets of consequences of the transmission of the syphilitic poison from parents to offspring: (1) the ordinary pathological manifestations of syphilis, *e.g.* small-celled infiltration, thickening of vessel-walls, syphilomata; and (2) the syphilitic dystrophies or anomalies of structure and of tissue reaction, which differ from the patently syphilitic manifestations of the first group.

It is impossible to give in detail the description of the various dystrophies that Fournier has found in the progeny of syphilitics; but I have cast some of them into the following tabular statement:—

A. General Dystrophies—

1. Simian or senile physiognomy.
2. Infantilism and "dwarf-fœtus."
3. Rachitis (?).
4. Osteogenic exostoses.

B. Partial Dystrophies—

1. Cranial dystrophies, including cranial malformations, asymmetry, synostoses, microcephaly, and hydrocephaly.
2. Dental and maxillary dystrophies, including microdontism, absence of certain teeth, dental vulnerability, and malformations of the jaws.

3. Hare-lip, cleft palate, and occlusion of nares.
4. Ocular and aural dystrophies, including coloboma, strabismus, and various malformations of the external ear.
5. Spinal malformations, *e.g.* spina bifida and scoliosis.
6. Dystrophies of the limbs, including partial giantism, micromely, polydactyly, syndactyly, ectrodactyly, ectromely, congenital dislocation of the hip, and club-foot.
7. Cerebral dystrophies and anomalies of the spinal cord, deaf-mutism.
8. Cardiac and vascular anomalies, congenital cyanosis, Raynaud's disease.
9. Anomalies of the digestive system, *e.g.* anal imperforation, hernia.
10. Genito-urinary malformations, *e.g.* vesical and testicular ectopia, epispadias, cryptorchidy, uterine and vulvar anomalies.
11. Cutaneous dystrophies, including ichthyosis, alopecia, nævi, scleroderma, and dermoid cysts.
12. Anomalies of the fœtal annexa, *e.g.* tightness of amnion, hydatid mole.
13. Monstrosities, *e.g.* exomphalos, anencephalus, pseudencephaly, meningocele, etc. etc.

C. Dystrophies of Intellectual Development—

1. Retarded development, *e.g.* backwardness.
2. Arrested development, *e.g.* idiocy.

D. Dystrophies of Predisposition—

1. Hæmorrhagic diathesis, general or local obesity, and paroxysmal hæmoglobinuria.
2. Tubercle.
3. Nervous diseases, *e.g.* convulsions, Little's disease, epilepsy, hysteria, neurasthenia, etc.

Truly the dystrophies of syphilis, as enumerated by Fournier, constitute a lengthy and imposing list. Of course, it is not claimed that in all the individual cases narrated in Fournier's work (*op. cit.*), syphilis was the cause of the dystrophy; in some instances the malformation and the syphilitic taint were no doubt accidentally associated; but the important conclusion remains that *we cannot regard the co-existence of anomalies of structure (and more especially of malformations) and a syphilitic parentage as accidental.* In isolated cases the association may be a coincidence, but the coincidences are numerous enough to enable us to affirm a relation of cause and effect. Numerous as are the recorded dystrophic states which have been found in syphilitic offspring, I would add to their number the instances of the presence of embryonic relics in the thymus gland and kidneys, to which reference has already been made.

It may be insinuated that the very variety of the dystrophies is proof that they cannot be of syphilitic origin; but it may be said in answer that the polymorphism of syphilitic manifestations

(*e.g.* the cutaneous affections of infantile syphilis) is proverbial. A more important objection is found in the remark that many of the dystrophic states named in connection with antenatal syphilis may be found also in the progeny of tubercular and alcoholic parents. That is quite true; but, as will be shown immediately, when the probable explanation of these parasyphilitic signs is considered, this is just what might be expected.

If the reader will now turn back to pages 7–12 and 185, he will be the better able to understand the explanation of the dystrophies which is here set forth. He will find it pointed out in these passages that before the fœtal period of antenatal life there is a formative or embryonic epoch during which the organs are being constructed. It may be taken as a good working hypothesis that morbid agents, such as the virus of syphilis, acting upon the organism in this organ-forming period, will produce results of the nature of malformations (*i.e.* malforming of organs). It may be supposed, therefore, that some of the dystrophies are due to the action of the syphilitic poison or toxin upon the organism in its embryonic state, *i.e.* in the first six weeks of pregnancy. The dystrophies so produced will be of a grave character, *e.g.* monstrosities, and such malformations as hare-lip, exstrophy of the bladder, and anal imperforation; for it is very improbable that any morbid agent could produce these changes after the embryonic period is past. But, further, it will be remembered that I pointed out in my corrected scheme of antenatal life (*vide* p. 10), that all organ-formation is not finished in the embryonic period; some embryonic developments occur during the fœtal period, among which may be mentioned the complete formation of the skin and its appendages, of the genital organs, of the limbs, of the eye and ear, of the face, of the brain, and of the skeleton (*vide* "Scheme of Development of Organs," on p. 97). Let us suppose, then, that the morbid agent (*e.g.* syphilis) continues to act upon the organism in its fœtal epoch of intrauterine life, it will interfere with the proper formation of the organs which are now in the formative phase, those, namely, that have been mentioned above. So here again a series of dystrophies will arise of a less grave type, and affecting the skeleton, the limbs, the face, and sense organs, the skin, the genitals, and the brain. If the reader will glance at Fournier's list of dystrophies, he will find just these very organs holding a foremost place. But it will no doubt have been already noted that some of the dystrophies therein enumerated are the dental anomalies and infantilism, that is to say, malformations which cannot well be supposed to have originated in the fœtal period. But, as I pointed out in the scheme already referred to (*vide* p. 10), some small amount of organ-formation takes place in postnatal life, *e.g.* the teeth, and it is also after birth that there is a continuance of the growth of all the tissues and organs. It must, then, be seen that dystrophies due to the continued (post-natal) influence of the syphilitic or other virus will take the form of dental and growth anomalies, that is, they will find expression in the special pathological possibilities of the epoch. It thus comes about that one morbid cause can yet produce such diverse anomalies

and malformations as are enumerated in Fournier's list of dystrophies. The dystrophies, let it be also noted, may occur in combination with the ordinary pathological changes of syphilis, or (rarely perhaps) alone. The ordinary manifestations of syphilis, I take it, are those due to the action of the virus upon the organs or tissues whose development is so to say complete, which have in other words passed out of the embryonic stage and entered the epoch of growth and functional activity. It is quite possible, therefore, that both the dystrophies and the ordinary morbid changes of syphilis may be met with in the same infant at birth; in syphilis acquired late in pregnancy, the grave dystrophies are practically certain to be absent, and indeed nothing may then be found save the ordinary results or syphilitic lesions in the strict sense of the word. To sum up, therefore, it may be said that the dystrophies are the result of the action of the syphilitic poison upon the organism during the embryonic stage of antenatal life, or upon such of its organs and tissues which during the fœtal (and even the postnatal) period are still in the embryonic or formative condition.

An interesting question may be referred to briefly at this stage: How far do other morbid agents (apart from syphilis) produce dystrophies? There is good reason to believe that tubercle often does (*vide* pp. 214–216), so also does alcohol; and there is some evidence that sepsis and the enteric poison may occasionally produce dystrophic effects. It may ultimately be found that all the agents which produce disease in formed organs and tissues produce malformations or dystrophies in developing or forming structures.

Another question remains to be answered under this heading: Can the dystrophies of syphilis be regarded as in any way special and to be distinguished from (let us say) those of alcohol or tubercle? Fournier is of opinion that to some extent they can be, and refers especially to infantilism (a group of dystrophies), cranio-facial malformations, and dental anomalies, as characteristic (especially when all co-existing in one subject) of the dystrophies of syphilis; but it may be doubted whether there is sufficient evidence to warrant this conclusion. I believe that it can hardly be affirmed that any of the dystrophies are peculiar to any one of the morbid causes (syphilis, tubercle, alcohol); indeed, the dystrophies may be met with apart from any of these states. Possibly the dystrophies of syphilis may be special, in the sense that they are very numerous and very various. The whole question of the nature of malformations and monstrosities will, of course, receive full consideration in a future volume dealing with the pathology of the embryo and germ. The reference to it here is due to that projection of embryonic into fœtal life which I have already several times alluded to (*vide* pp. 9, 12, 185).

Pathogenesis.

I have now to deal with a very complex and difficult part of the subject of fœtal syphilis, namely, its pathogenesis. In considering the mode of origin and of transmission of this malady, it is, in the present

state of our knowledge, impossible to separate fœtal from embryonic and germinal syphilis. We must of necessity to some extent consider them together; and we are thus led into a veritable maze of theories, views, opinions, and hypotheses, with here and there a stray fact or pseudo-fact turning out on closer inspection to be far otherwise. We must abbreviate as far as is possible this wandering about among innumerable theories and apparent facts.

With regard, in the *first* place, to the *nature of the causal agent* in syphilis, it may be taken as a working hypothesis and as a probable conclusion that it is microbic or parasitic. It is more than likely that before long it will be found that syphilis will take its place alongside of tubercle, typhoid fever, and malaria as due to the action of a microbe or parasitic organism upon the tissues of the body. As long ago as 1841, Vanoye published a note upon an animalcule found in syphilitic pus (*Ann. Soc. d. sc. nat. de Bruges*, ii. 39, 1841); and in 1868, J. H. Salisbury gave "a description of two new algoid vegetations, one of which appears to be the specific cause of syphilis and the other of gonorrhœa" (*Amer. Journ. Med. Sc.*, n. s., lv. 17, 1868); but it was not till 1880 that the search for the causal organism of syphilis became really prolific in results. From that date (1880), when Bermann published his article on "The Fungus of Syphilis" (*Arch. Med.*, New York, iv. 263, 1880), up to the present time there has been a steady output of articles dealing with the "bacteria," "microbes," "bacilli," "streptococci" and "micrococci" and "fungi" of syphilis. The subject has been dealt with by such authorities as Doutrelepont, Finger, Kassowitz, Hochsinger, Lustgarten, Doehle, and Neisser; and on several occasions it has been declared with more or less confidence that at last the *causa causans* was found. Recently it has been affirmed with more than usual confidence that the bacillus of syphilis had been isolated by Justin de Lisle and Jullien (*Acad. de méd.*, Paris, 3 s., xlvi. p. 50, 1896); it is described as polymorphic (short, threadlike, etc.), it is said to produce (in the guinea-pig) an indurated ulcer with swelling of the nearest lymphatic glands, and the blood of syphilitic patients added to a three days' old culture of the bacillus causes agglutination of the latter. For culture purposes de Lisle and Jullien used blood plasma separated from the serum, and also fluid from blisters, for they hold that the negative results previously obtained were due to the presence in the coagulated blood of a bactericidal alexin, and they regard the above media as alexin-free. Whether this polymorphic micro-organism be at last the real bacillus of syphilis or not, does not, from the present standpoint, matter very much; it is sufficient to accept as a good working hypothesis the idea that syphilis is due to a microbe.

In the *second* place, we have to consider the *mode of transmission* of syphilis to the unborn infant. As this matter is most complicated, I give here a tabular statement of the manner in which I propose to discuss it, to serve as a sort of *memoria technica*. It will be noted that I take the *periods* of antenatal life as my primary divisions:—

1. Fœtal Period.

   (*a*) Transmitter.
   (*b*) Mechanism of transmission.
   (*c*) Results of transmission.
   (*d*) Reverse current.

2. Embryonic Period.

   (*a*) Transmitter.
   (*b*) Mechanism of transmission.
   (*c*) Results of transmission.

3. Germinal Period.

   (1) Unified Epoch.
      (*a*) Transmitter.
      (*b*) Mechanism of transmission.
      (*c*) Results.

   (2) Dual Epoch.
      (*a*) Transmitter.
      (*b*) Mechanism of transmission.
      (*c*) Results of transmission.

A reference to the scheme of antenatal life on p. 8 will serve to explain these sub-divisions, and more especially those of the germinal period.

1. Transmission in the Fœtal Period.

(*a*) In the fœtal period, which may be regarded as extending (roughly) from the end of the sixth week to the full term, there are only two possible *transmitters* of the syphilitic poison. One of these "possibles" is at once evident—the mother. If we accept for syphilis the same possibilities as for smallpox, typhoid, malaria, measles, and the like, then it must be regarded as certain that the virus of the disease will in some cases at any rate pass from the maternal to the fœtal organism. The mother who is syphilitic transmits syphilis to her fœtus. This is sometimes called the maternal variety of syphilitic heredity, but, as I have already stated, I prefer not to use the word "heredity" for any morbid state transmitted after the occurrence of conception (post-conceptionally). With regard to the second possible transmitter there is no such obviousness or certainty; but I think it may be that, so to say, the embryo may transmit the poison of syphilis to the fœtus. The embryo may have been infected by the mother during the embryonic period, or again the embryo may have had an infection handed on to it from the germ (fertilised ovum); and it may as it were pass it on to the fœtus. It may be that there was no time for the poison to take effect in the germinal or embryonic period, or its effects, if there were any, might not be recognised as such; so the first distinct signs appear in the fœtal state. I admit that this idea of transmission is unusual, and that it perhaps implies the acceptance of the theory of latency; but, to my mind, it seems to be necessary

if we are to accept the hypothesis of germ and sperm infection with syphilis.

(*b*) With regard to the *mechanism of transmission* in the fœtal period, it must, if the mother be the transmitter, be looked upon as chiefly transplacental. It is, of course, *possible* that it might be through the liquor amnii or transamniotic, but that method cannot be common, if indeed it occur at all. I do not propose to consider here the various possibilities of transplacental transmission of disease from mother to fœtus; these have been fully dealt with in Chapters XI. and XIII. ("placental factor in fœtal pathology," "fœtal tubercle," etc.), and need not be re-enumerated for fœtal syphilis. Whether or not it is necessary for the placenta to be diseased (*e.g.* hæmorrhagic) in order that the virus may pass, cannot be yet regarded as a settled question. The mechanism of transmission from embryo to fœtus is still more obscure and uncertain. It may be that the undiscovered "microbe" or "fungus" of syphilis lies latent in the embryonic tissues, and is thus carried over into the fœtal period, becoming active in the fœtal organs; but here the maze of hypotheses is so bewildering that we refuse to wander further.

(*c*) As to *results*, it must be accepted in the first place that the fœtus may escape infection and be born free of syphilis. This has been shown to be the case with tubercle, variola, measles, typhoid, and other maladies which are transmissible, and analogy as well as direct clinical evidence lead us to expect it in syphilis also. Again, and this is no doubt what most often happens, the poison of syphilis expends its full virulence upon the placental tissue, sets up morbid changes in it, and so kills the fœtus; abortion or premature labour then follows, the former in the early and the latter in the later months of fœtal existence; or, the fœtus may not die in utero but after expulsion as a result of its prematurity. Again, we may suppose that the syphilitic virus, so to say, forces the placental barriers and attacks the intracorporeal fœtal organs; then there occurs the long series of morbid alterations of bone, skin, liver, spleen, blood, kidneys, thymus, etc., to which reference has been made; and, as a result of this syphilitic infection of the fœtus, it is expelled alive with the signs thereof upon it, or dies in utero and is born in a more or less macerated condition. Again, the fœtus may at the time of birth exhibit not only the ordinary signs of syphilis, but also some of the syphilitic dystrophies or malformations; but probably the dystrophies will be found to be only those of organs which are in an embryonic or formative state in the fœtal period, *e.g.* ears, eyes, genitals, limbs, etc. Once more, the fœtus may be born alive and only show external signs of syphilis some weeks after birth; or, it may never do so, and may even give evidence of immunity against syphilis.

The question of the possible transmission of immunity has caused much discussion. The belief that a mother in the secondary stage of syphilis can confer immunity from that disease upon her unborn infant, is an expansion of the statement made by Profeta (and by Behrend) that a healthy child born of a syphilitic mother can be nourished safely by that mother or by a syphilitic nurse; for "the law of Profeta," as it

is generally called, is now held to be that healthy children born of syphilitic parents are not susceptible of infection. It is extremely doubtful whether in its expanded sense the law of Profeta can be accepted as the statement of even an occasional occurrence. There is a certain individuality of the unborn infant to be taken into account which is independent of all maternal influence, and now and again a case of innate immunity to syphilis may occur. Again, it has been found by G. Ogilvie (*Brit. Journ. Dermat.*, xi. 45, 89, 1899) and others, that of reliable evidence in favour of intrauterine immunisation there is extraordinarily little, so much so that Buret (*Progrès méd.*, 3 s., xi. 377, 1900) declares that Profeta has made a hasty generalisation from a few cases, and that he has been deceived by a mirage ("il a été la dupe d'un mirage"). On the other hand, there is a fair amount of evidence in support of the modified belief that mothers who are syphilitic before conception rarely communicate the disease to their offspring in extrauterine life; but there is some proof that in post-conceptional syphilis (*i.e.* maternal syphilis acquired when the offspring is in the fœtal period of his antenatal life) the child may be contaminated by the mother after his birth. It is only with this last-named possibility that we are here concerned. There are so many possible fallacies (*e.g.* difficulty in ascertaining the facts of the case, unknown modes of action of the tissues of the placenta and fœtal organs on toxins and anti-bodies, influence of treatment, etc.) that it seems impossible to decide for or against the "law of Profeta," save perhaps to the extent that it is at any rate certain that it is not "a law." The fact that the mother is in the tertiary rather than in the secondary stage during her pregnancy does not simplify matters much. Theoretically, it may be reasonably admitted as a possibility, that a pregnant syphilitic woman may occasionally transmit to her fœtus alexins or bodies which enable the fœtal organs (including the placenta) to manufacture alexins which render it immune to syphilis for a short time after birth. The last point is to be emphasised, for Hutchinson (*Twentieth Century Practice*, xviii. 396, 1899) and others freely admit that immunity although possible is only temporary. Analogy with vaccinia and malaria and possibly tubercle in pregnancy supports, although not very strongly, the theory of occasional intrauterine immunisation.

Among the most curious results of transmission must be placed those which occur when twins are found in the uterus. When both twins become syphilitic no need for surprise exists; but when the infants are born showing syphilis in very different degree, or still more, when one twin is born healthy and remains so while the other is manifestly syphilitic, the occurrence seems incongruous and even grotesque. Such observations have been several times recorded, as Alfred Fournier (*L'hérédité syphilitique*, p. 294, 1891) and others have shown. No very satisfactory explanation can be found, indeed Fournier (*op. cit.*, p. 296) says "c'est la une énigme de plus dans un sujet qui en comporte un si grand nombre"; but it may be remarked that if the mother can transmit immunising material to her fœtus, it is possible that one fœtus of twins (the one, for instance, with the stronger heart) may conceivably cause alexins or antitoxins to pass

to the other fœtus. This explanation (or *shadow* of an explanation), however, will scarcely hold in the case where the placentas are separate. If the so-called "law of Profeta" had been found to be a law, we might have expected another "law" that the healthy twin in cases of syphilis would show immunity from the disease after birth! "Une énigme de plus!" It may be noted here that the infection of one of two fœtuses in utero is not a phenomenon observed in syphilis only; it has been recorded in connection with fœtal variola (*vide* p. 190).

(*d*) But no allusion has yet been made to what may be called the "*reverse current*" of infection in fœtal life, to what has been termed "syphilis par conception," "conceptional syphilis," "syphilis by *choc en retour*," or "maternal retro-infection." Whether or not this reverse current of infection from fœtus to mother exists, has been the subject of great controversy, and of the most extraordinary diversity of opinions, and it must also be admitted of a most regrettable amount of theorising from most insufficient data, indeed from no data at all. Some few things seem fairly certain among much that is most uncertain. They are these. There is a physiological reverse current from fœtus to mother whereby effete materials and carbonic acid are carried to the placenta and thence pass through it into the maternal circulation (*vide* p. 163). There would also appear, from experimental evidence, to be a matripetal current carrying such poisons as strychnine, curare, hydrocyanic acid, etc., from the fœtus (*vide* pp. 163, 164). Finally, there is some slight experimental evidence in support of the belief that the toxins of the bacillus pyocyaneus and of diphtheria may likewise reach the maternal circulation. When, however, we leave the fairly firm ground on which these statements rest, we find ourselves in a veritable quagmire of hypotheses, in a shifting sand of theories. This much, I suppose, may be said with some slight degree of confidence. When a mother infects her fœtus transplacentally with syphilis and this sets up syphilitic processes in the fœtal organs and tissues, it is quite possible that toxins formed in the fœtal body may pass through the placenta into the maternal organism; it seems even strongly probable that this occurs. It may also be believed that such toxins thus reaching the mother may have some injurious effect upon her; in fœtal smallpox there is some evidence that the maternal fever is increased when the fœtus is in the suppurative stage. But the supporters of the reverse current go much further than this: they imagine a healthy mother becoming infected through her fœtus, she herself being up till then free from infection. It is supposed that the father was syphilitic at the time of fruitful coitus, and that through his infected sperm the impregnated ovum also was infected, that the infection lay latent in the germ and embryo till the fœtal period, and that then syphilis developed in the fœtus and infection of the mother through the placenta followed by virtue of the reverse current. This theory is necessary in order to offer an explanation of the cases in which a pregnant woman, previously non-syphilitic to all appearance, develops the secondaries (sometimes the tertiaries) of syphilis during her pregnancy,

apparently without any precedent primary sore or chancre. The maternal disease thus acquired manifestly lacks the primary stage, and in its abbreviated form is called "syphilis décapitée," an acephalic syphilis so to say. (Too much need not, however, be made of this headless condition of so-called conceptional syphilis, for the syphilis which develops in the fœtus in utero is also always a *decapitated syphilis*). Manifestly the acceptance of this view entails the belief that the father's syphilis (even in a latent condition) can be passed on through the ovum and embryo and fœtus, and infect the maternal organism in this circuitous manner—circuitous as to route, delayed as to time. This is just the crux of the whole matter; and while there are some who admit this direct paternal infection of the germ with transmission onwards to the fœtus, there are others who stoutly maintain its impossibility. Manifestly, there are only two possible transmitters of syphilis to the fœtus in the fœtal period, the mother and the embryo, and the embryo must have got the infection originally from either the mother or the father. With the question of germinal infection I deal later; but if we postulate germinal paternal contagion, then with regard to the possibility of that contagion being handed down from germ to embryo and from embryo to fœtus, and *then* at last infecting the mother, all that can be safely said is that it is of course possible, but its mechanism is outside ordinary physiological laws of transmission and requires the assumption of the genesis of heredity.

But conceptional syphilis is not the only result that may follow upon the presence in utero of a syphilitic fœtus. It has been noticed that if an apparently healthy mother give birth to an undoubtedly syphilitic infant she may nurse that infant with impunity, in other words, she does not develop a mammary chancre. This has been called Colles' or Baumes' law; and, like many other things in connection with antenatal syphilis, it has been the occasion of no small difference of opinion. Little wonder! The phenomena of the transmission of diseases are difficult indeed and capable of being interpreted in various ways, but when we come to consider the phenomena of the transmission of immunity against diseases, the difficulties are multiplied and the possible divergencies of interpretation are greatly increased. And yet the antenatal pathologist has to struggle with these difficulties. Will the reader bear with the writer in his poor efforts to bring some order out of the "*rudis, indigestaque moles*" of this subject?

Maternal immunity against syphilis may be, to begin with, an idiosyncrasy possessed by her; under these circumstances the presence of a syphilitic fœtus in her uterus will neither give her syphilis nor can it be described as conferring upon her an immunity against syphilis, for that she already has. It is possible that some cases regarded as instances of Colles' law may be explained thus. In the next place, it is possible that the mother may take from her fœtus a latent form of syphilis, or that she may already be suffering from the disease in a latent state; at a later period, namely after lactation is over, she may show tertiary symptoms, or, on the other hand, by that time the latency of the disease may have become a

permanent immunity. (All hypotheses, O friendly reader!) Again, it may be that the mother has acquired immunity from the fœtus, that she has been rendered immune by the toxins or antitoxins or anti-bodies coming to her through the placenta from the fœtus (*vide* E. von Düring, *Monatschr. f. prakt. Dermat.*, xx. 245, 1895). The mechanism of this immunisation I must leave unexplained, for physiology has not worked out the matter yet, but apparently it is necessary to regard it as either transplacental or transamniotic. But yet again, the maternal immunity may be capable of another explanation. It may be, as Boulengier (*Journ. d. mal. cutan. et. syph.*, 2 s., vii. 722, 1895) supposes, that the mother really takes syphilis, but that all the strength of the virus is exerted upon the very active organs of the fœtus (placenta included), which are, as it were, a most favourable culture medium for it; according to this supposition, the *mother* has really given syphilis to the fœtus, it has passed through her without touching her, and there is then no need to suppose that the fœtus obtained either the disease or the power to infect or immunise the mother from the father. It is a little difficult to accept Boulengier's further conclusion, that the fœtus who has got the disease in this sort of unconscious way from the mother can then actively immunise the mother; but, as he himself says, it is "hypothèse pour hypothèse," and who knows!

After all, Colles' law is not absolutely a law! Exceptions to it have been reported (*e.g.* by Drennen, *Journ. of Cutan. and Gen.-Urin. Dis.*, xv. p. 125, 1897; by J. A. Coutts, *Lancet*, i. for 1894, p. 1443; by Neuhaus, *Monatschr. f. prakt. Dermat.*, xxviii. p. 616, 1899; and by several others). We may take Jonathan Hutchinson's conclusions (*Twentieth Century Practice*, xviii. p. 375, 1899) on this matter as being practical and as near to the truth as it is at present possible to get,—namely, that the apparently healthy mother may nurse her syphilitic child, the risk to her is infinitesimal while the gain to the child is incalculable, *but* the risk is not absolutely excluded. Possibly the exceptions to Colles' law may be due to a morbid condition of the placenta; possibly also the occurrence of cases showing Colles' law may be due to a morbid condition of the placenta. The reader may even make his own choice! In all this bewildering subject it will be well to remember that it is always very difficult to get the truth, the whole truth, and nothing but the truth, from syphilitic patients, and that still even on the part of the physician skilled in clinical methods *humanum est errare.*

2. Transmission in the Embryonic Period.

(*a*) In the embryonic period of antenatal life (roughly the first six weeks, more exactly the time between the formation of the first rudiments of the embryo in the embryonic area and the appearance of the transition organism, *vide* p. 7), there can be little doubt that syphilis in the mother produces an effect upon the organism in her uterus. The mother in this period, as in the fœtal, must be the chief *transmitter.* At the same time it is possible that the embryo may be

infected from the germ, and the germ in its turn either from the father or the mother; it is even possible that the syphilitic peccant matter (microbe, "fungus," toxin) may exist in the spermatic fluid alongside of the spermatozoa, and may prove the means of infecting the embryo directly after its germinal life is finished. Of this, however, more anon.

(*b*) As to the *mechanism of transmission*, in this early period very little can be said with even a shadow of confidence. Probably the virus will travel again in the blood stream from mother to decidual membranes, and will sometimes pass their barriers to reach the embryo either by the omphalo-mesenteric veins, the allantoidal (umbilical) vein, or (doubtfully) by the liquor amnii. From the practical point of view of immediate results it will matter little whether it reach the embryonic organism or not, for the decidual membranes are, as regards the continuance of antenatal life, the really vulnerable part. How the syphilitic microbe or toxin is carried over from the germ into the embryo and its membranes, we do not, of course, know; possibly it is latent in the germinal period, possibly it sets up changes in the germinal period which are simply continued in the embryonic.

(*c*) The *results* upon embryonic life no doubt vary. In the first place there may be abortion due to changes in the decidual membranes; this may well be believed to be very common. It may be preceded by embryonic death, but of this little or no evidence is forthcoming. At any rate, the occurrence of abortion is equivalent to embryonic death. In the second place, it is possible that it may be the cause of dwarfing or non-development of the embryo; and, in the third place, from what is known of experimental teratogenesis taken in conjunction with clinical experience, it is very probable that the syphilitic poison coming into contact with the forming organs of the embryo will cause them to form badly and so produce malformations and monstrosities. These matters will be more fitly described in the part of this work which deals with the pathology of the embryo; they are introduced here simply to complete the survey of the possible modes of transmission of syphilis to the fœtus.

3. Transmission in the Germinal Period.

The germinal period, it will be remembered (if the reader does not recollect, let him consult pages 8, 9, and 10), consists of two divisions, a long period prior to impregnation, and a very short but very active period following after impregnation. In the former or ante-conceptional period, there is the dual life of the spermatozoon and the ovum; in the latter or post-conceptional period, there is the unified life of the impregnated ovum. In the former the *locus* of the life is the interior of the sexual gland (ovary or testicle); and in the latter it is the interior of the uterus, and for a short time the interior of the Fallopian tube (that is, if we regard impregnation as occurring prior to the arrival of the ovum in the uterus).

Let us consider the possible *transmitters* of syphilis in this germinal

period of antenatal life; and now, for the first time, we are brought face to face with the large problem of the direct influence of the father in infection. But let us deal first with the mother as transmitter. It is possible that the syphilitic virus in the maternal uterus or Fallopian tube may infect the ovum as it is being transferred from the ovary to the uterine interior; it is possible also that the ovum may be already impregnated before it leaves the ovi-sac. These things are possible, but he would be foolhardy who ventured to state them as facts. Our knowledge of the action of microbes and toxins upon the *human* ovum either before or after impregnation is practically *nil;* we are again, therefore, wandering in a maze of theories. But, and this is the important point, all the observers and writers who have dealt with this matter have not kept in mind that it *is* a maze of hypotheses; some, in fact, have made extraordinarily confident assertions about its most doubtful parts. Many of them seem to forget that no one has ever seen the penetration of the human ovum by a spermatozoon! It has, of course, been shown experimentally that tubercle bacilli may be introduced into the hen's egg, and that the bacilli may apparently remain latent in the embryo chick, setting up tuberculosis only after the chicken has left the egg; but there is a great distance between such an experiment and the assertion that a syphilitic microbe can pass from the mother into an ovum in one of her ovaries and set up syphilis in the fœtus that develops from that ovum. We cannot deny its possibility; we may even, from clinical evidence, be very sure that something producing such a result does occur; but the slenderness of the evidence and the lack of knowledge of the mechanism must never be forgotten.

Similar remarks apply to the theories of the father as transmitter of syphilis, either alone, or more often in conjunction with the mother. The idea which seems to be present in the mind of those who believe in infection of the fœtus *a patre* is that of a spermatozoon carrying a bacillus or a toxin of syphilis with it into the ovum, and at one and the same time impregnating the ovum and inoculating the new organism with syphilis. This hypothesis of bacilliferous spermatozoa and their effects may, of course, turn out to be correct; but it has to be remembered that it is purely hypothetical. What happens when bacilli are brought into contact with spermatic fluid? What follows when a spermatozoon is penetrated by one or more bacilli? Does the sexual cell eat them or do they weaken the sexual cell? Must it not be very unlikely that the bacilliferous spermatozoon shall be also the impregnating spermatozoon? Does—but let us get out of the maze of hypothetical cross-questions again if we can. The evidences of purely paternal infection may be enumerated as follows:—(1) The occurrence of cases of fœtal syphilis in which the father alone was syphilitic (a very rare occurrence, let it be remembered); (2) the frequency of abortions when the father is syphilitic and the mother healthy, the abortions being regarded as evidence of syphilis; (3) the good effects of anti-syphilitic treatment of the father alone in such cases, future pregnancies going on to the full term; and (4) the infection of the mother by her fœtus or conceptional

syphilis, on the supposition that in such instances the germ has been directly infected by the father. As a proof of direct paternal infection of the germ, this last occurrence must be left out of account; but the other three pieces of evidence have a certain value, a value so great as to make many believe in the possibility of direct paternal infection without being able to offer any satisfactory explanation of its mechanism. On the other hand, cases supporting the view are admittedly very rare, and sometimes a syphilitic (even a recently syphilitic) father neither gives his wife syphilis nor procreates a syphilitic fœtus. Further, frequent abortions do not of necessity indicate the existence of syphilis, while the results of treatment are of necessity of the nature of *post hoc ergo propter hoc* evidence. It has been said also that animals cannot be inoculated with diseased spermatic fluid; but, as A. Fournier (*L'hérédité syphilitique*, p. 49, 1801) reminds us, inoculation of the subcutaneous tissue is one thing, and impregnation of an ovum is another and a very different thing.

The reader will, I think, have by this time come to the conclusion at which the writer has arrived, that direct paternal infection of the germ (ovum or ovo-sperm) with syphilis can, in the present state of our knowledge, neither be proved nor disproved—it must be left unsettled, lying, as Fournier says, as "une veritable pomme de discorde jetée dans le camp des observateurs." It may be added that direct paternal infection has been affirmed in fœtal malaria, tubercle, and even in fœtal smallpox (*vide* pp. 203, 216, and 190).

From what has been written regarding the transmitters in the germinal period, it will be gathered that nothing of any importance, nothing at any rate with any certainty, can be affirmed about the *mechanism* of transmission in this epoch. We may imagine the ovum or spermatozoon bathed in syphilis-infected fluid and absorbing or being penetrated by the fluid or its bacilli; *but* it is a vision which may or may not be a foreshowing, but still indubitably a vision.

Then, as to *results*. Again, the antenatal pathologist must plunge neck deep into a morass of hypotheses and conjectures. Theoretically, it is to be expected that the results of syphilitic infection in the germinal period will differ very markedly from those following a later infection. Possibly they may take the form of unrecognised (because so precocious) abortions, and of anomalies in the formation of the decidual and fœtal membranes (hydatid mole); possibly, also, the syphilis may lie latent and only cause morbid changes in embryonic or fœtal life. This matter, however, will be returned to again in the discussion of the pathology of germinal life. In the meanwhile the antenatal pathologist may scramble out of his morass of hypotheses and rejoice to be once more on firm earth; it may turn out to be only a little island he has reached in the midst of his quagmire, and that he will be found floundering again almost immediately; but for the time he has a firm foothold. I have said what had to be said regarding the pathogenesis of fœtal syphilis, and must now look at some of the effects of the disease.

Effects of Fœtal Syphilis.

The effects of syphilis upon antenatal life are so serious as to lead writers to search the vocabularies of their various languages for words strong enough to express the degree of gravity arrived at. Fournier, for instance, writes in the following sentences of these results:—"La syphilis est essentiellement meurtrière pour la jeune âge; elle fait de véritables hécatombes d'enfants: elle les tue avant la naissance, au moment de la naissance, après la naissance, dans les premières semaines on pendant les premières annés (hérédo-syphilis). Mais ce qu'il y a le plus à redouter ce sont l'avortement syphilitique et la polymortalité infantile" (*Belgique Med.*, Ann. vi. p. 711, 1899). It cannot be said that Fournier's language exaggerates the baneful, murderous, and malignant effects of syphilis on antenatal life, and it is easy to agree with him when he says that syphilis, alcoholism, and tubercle "constituent la triade des pestes contemporaines."

At any one of the three periods of antenatal life syphilis may prove murderous; it may kill the germ, it may lead to the casting off of the embryo in a recognised or unrecognised abortion sac; it may kill the fœtus either directly or by leading to its premature expulsion from the uterus; and it may send the infant forth into its extra-uterine environment so weak or so diseased as to entail its early demise. It may also permit an extrauterine life, but one rendered so miserable by deformity and weakness as to be almost less to be desired than early death. These are some of its ordinary and manifest effects, and they do not include the evils that may come upon others, or even the later ill-effects of the dire malady upon the individual himself (syphilis hereditaria tarda). For instance, a healthy mother, who has escaped direct infection from her husband, may, if we accept the possibility of conceptional syphilis, receive the poison from the infant in her womb, becoming infected because she is about to become a mother. Again, there are the late developments of congenital syphilis, including the so-called Hutchinsonian triad of (1) malformed teeth, (2) ocular inflammation, and (3) ear disease, especially otitis media, as well as obscure mental conditions and nervous maladies, and the predisposition to suffer severely from many other diseases.

And yet the list of possible evil effects is not finished! There is some reason to suspect that syphilis may pass on (without any fresh infection) to the next generation. Concerning "syphilis of the third generation," as it is called, there is, of course, no lack of difference of opinion. If it be true that the virus can thus pass from the child of a syphilitic parent to the grandchild, then it would seem to imply that at birth the ova in the ovaries of a syphilitic infant are already infected. Cases in which transmission to the third generation was alleged have been recorded by a considerable number of observers, and thirty-eight of these cases have been collected by F. de Armenteros (*Thèse*, Paris, 1900); and the consideration of the clinical evidence therein contained would lead us to the conclusion that the manifestations of this retransmitted syphilis are of the

nature of abortions, dystrophies, malformations, monstrosities, and even of the more ordinary syphilitic, visceral, and cutaneous lesions. But there is always one weak link in the chain of evidence brought forward to prove these cases; the putative parent may not have been the real parent.

Surely Fournier has not used too strong language in describing the results of antenatal syphilis! But even the effects that have been enumerated do not end the tale of disaster, for national life and prosperity also suffer from this antenatal malady, and a fall in the birth-rate accompanied by an increase in infantile mortality cannot be lightly regarded by social economists. Again and again we read of cases in which syphilis has so affected the results of marriages as to give from *fifty to a hundred per cent.* of dead-born or quickly perishing infants. The record (sad record indeed!) for the present seems to be nineteen dead infants as the result of nineteen pregnancies. (D'Aulnay, *Arch. de tocol. et de gynéc.*, xxi. p. 910, 1894). Well may Fournier exclaim, "Quelles statistiques! Quelles horribles tables mortuaires!" If we take even the average results (private and hospital practice), we find them to be 46 per cent. of the pregnancies ending disastrously, with an infantile mortality of 42 per cent. Of course these results are influenced to a large extent by circumstances. Let us then try to ascertain what the modifying circumstances are.

Among the circumstances which modify the effects of syphilis upon antenatal life we may place, *first*, the age of the pregnancy when the infection takes place. If we divide the evil effects into deaths, and deaths plus syphilitic manifestations, we find, according to Fournier's tables, that when infection has occurred before conception the mortality is 65 per cent. and the morbidity 70 per cent.; when conception and infection have occurred simultaneously (a hypothesis), the mortality is 75 per cent. and the morbidity 91 per cent.; while, when the infection has taken place after conception, the mortality is 39 per cent. and the morbidity 72 per cent. We may draw the conclusion, therefore, that so far as antenatal life and health are concerned the most disastrous results are due to infection in the germinal period, and the least disastrous to post-conceptional infection. It has been maintained by some that maternal syphilis acquired in the last three or last two months of pregnancy spares the unborn infant, but unfortunately there is evidence to show that even then "la syphilis est meurtrière pour la jeune âge." It may be said, however, that syphilis acquired post-conceptionally is more dangerous for subsequent offspring than for the fœtus then in utero.

In the *second* place, the results are modified by the transmitter. To quote from Fournier's tables again, when the transmitter is the father alone, the mortality is 28 per cent. and the morbidity ("nocivité") 37 per cent.; where the transmitter is the mother alone, the figures are 60 per cent. and 80 per cent.; and where both parents may be supposed to transmit, the mortality reaches the high figure of 68·5 per cent. and the morbidity the appalling height of 92 per cent. There is then an ascending scale of disaster in which both the mortality

and the index of harmfulness reach a maximum when both parents are transmitters, while the minimum is found when the father alone transmits. Of course, we must not forget that some writers do not admit paternal infection; but the statistics given are compiled from cases in which the father was *apparently* the sole transmitter.

In the *third* place, the age of the syphilis in the transmitter would appear to have a modifying effect upon the results to the fœtus. It would seem that the three years following infection are much more fatal to pregnancies and their results than any later three years. More than this, the first year is by far the worst of the three. It is during this period that the disease is in the stage of the secondaries. The first year after infection Fournier terms "l'année terrible," and with good reason! Of ninety women infected by their husbands and who became pregnant during the year following their infection, fifty aborted or had dead-born infants, thirty-eight gave birth to children who soon died, and only two gave birth to infants who survived. As the syphilis becomes older the danger to the product of conception becomes less, and the question at once arises whether there is any age beyond which lies complete safety to the fœtus. There seems to be no doubt that transmission may occur even when syphilis is in the stage of the tertiaries; but in the case of the father two years would appear to be a working limit, so to say, to the power of transmitting, while in that of the mother it may be extended to seven or eight years. Of course, exceptional instances have been recorded of transmission by either parent after much longer periods (*e.g.* ten to fourteen, even sixteen to twenty years); but these are quite unusual and are probably instances in which no ameliorating effects (*e.g.* from treatment) came into action. Hutchinson (*Arch. Surg.*, xi. 78, 1900) thinks the prolonged ability of the mother to transmit to her offspring may be due to a storing up of the syphilitic virus in the ovaries and infection of future fœtuses by a sort of telegony. "Ova are remarkably retentive of impressions, and are perhaps good storage places for morbid poisons." Perhaps they are.

In the *fourth* place, the character (as regards gravity) of the disease in the transmitter may be supposed to have some influence upon the certainty of transmission to the unborn infant. This is, however, in all probability a pure assumption. It has been shown that a very grave type of syphilis in the transmitter may entail no very disastrous effects upon the offspring. Unfortunately, alas! this is only one side of the picture, for it has also been shown that the existence of mild syphilis in the transmitter does not assume mildness in the consequences which may follow for the fœtus in utero. There is, however, some evidence to support the belief that the state of activity or quiescence of the syphilitic manifestations at the time of impregnation usually has a modifying effect upon the results to the unborn infant.

In the *fifth* place, treatment very clearly and very actively influences the results of syphilis as regards antenatal and immediately postnatal life. In the cases in which the transmission has been by both parents, anti-syphilitic treatment, if persevered in, causes a con-

siderable fall in infantile mortality, and in the cases in which paternal transmission alone is supposed to be in action the fall is even more marked (namely, from an infantile mortality of 59 per cent. to one of 3 per cent., *Fournier*). The question whether the treatment is general (through the maternal system) or local (vaginal applications to the cervix) may be found to have a marked influence upon the degree of good effected so far as the intrauterine contents are interested (G. Riehl, *Wien. klin. Wchnschr.*, xiv. 627, 1901).

Finally, in the *sixth* place, there can be no reasonable doubt that these various modifying factors (age of pregnancy, age of disease, adoption of treatment, etc.) may act in some cases in combination, and produce, on that account, greater or less effects. It is possible, also, that the good effect of one factor may simply neutralise the evil effect of another. Time and treatment, as a rule, lead to attenuation of the transmission-results.

Treatment.

It will be more convenient to take up the treatment of antenatal syphilis in the chapter devoted to Antenatal Therapeutics in general. In fact, the treatment of antenatal syphilis is the key to all antenatal treatment; it is, further, almost the only instance of antenatal treatment which can be said to have shown distinct successes. The reader, therefore, is asked to peruse at this point the chapter on Antenatal Therapeutics with which this volume closes.

I have now endeavoured, as best I have been able, to arrange in order what is known regarding the transmitted diseases of the fœtus. In the immediately succeeding chapters I shall have to consider the transmitted toxicological and toxinic states, and the diseases which we are compelled to call "idiopathic." But, both about the subjects which have been discussed and about those which remain to be discussed, let me say one thing—

> "Little we know.
> Much is to be known.
> Hardly is it to be learned."

CHAPTER XV

Types of transmitted Toxicological Conditions: Sources of Information; Problems; Lead Poisoning; Mercurial Poisoning; Phosphorus Poisoning; Arsenical Poisoning; Poisoning with Copper and Sulphuric Acid; Carbonic Oxide and Coal Gas Poisoning; Effects of Chloroform and Ether; Morphine Poisoning; Tobacco Poisoning; Alcoholism.

In the preceding chapter I have endeavoured, not, I am afraid, with great clearness, but with good intention enough, to give an account of the diseases which may be transmitted from (or through) the mother to her unborn infant. Many of these diseases are known to be due to microbes; all of them are suspected to have such origin; and their transmission must therefore be regarded as essentially a transplacental passage of germs or of their toxins from the maternal to the fœtal organism. Further, it has been shown that there is some measure of proof forthcoming of a reverse current of microbes and toxins from fœtus to mother, with results for the linked organisms which are not yet very clearly ascertainable, but which are doubtless of very considerable importance. A sphere here exists for research of an interesting kind, pregnant with possibilities both pathological and therapeutic. I have been led also to touch upon the great question of the transmission of immunity from the one linked organism to the other, a problem of enormous magnitude and vast importance for the single organism, how much more for the intertwined fœto-maternal economy! Into this problem the antenatal pathologist is not yet able to enter fully, and can at the most speculate somewhat vaguely about possible anti-bodies, antitoxins, and alexins which may be produced in the mother or in the placenta (?), and be passed through the placental barriers to neutralise the lyssins and to destroy the bacteria in the fœtus. The speculation may embrace also a reverse current of antilyssins and microbicidal principles from the fœtus and the fœtal part of the placenta to the mother. With regard at any rate to fœtal typhoid, it has been shown that the clumping principle, the hypothetical agglutinin or paralysin, passes from mother to fœtus; and, as touching syphilis, there is some reason to believe in the action of antitoxins and alexins manufactured in the mother or fœtus, and producing immunity in the fœtus or mother. Into this maze of pathogenic possibilities and protective mechanisms, I have not, I trust, led the reader too far; I have tried rather to suggest, than actually to put into words, many of the problems which exist and which will doubtless in the future come to light. It will be noticed, however, that the discussion has to some degree passed from microbes and bacteria to toxins and antitoxins; and this is a

circumstance of very considerable importance, for it means that we are approaching the purely chemical side of the causation of disease and health, and of disease-manifestations and health-phenomena. It need hardly be said that we are not in a position to translate into chemical symbols the composition of lyssins and alexins and such vitally important compounds; but the tendency of investigation is in that direction. It is therefore suitable, eminently desirable indeed, that I gather together in this chapter what is known of the transmission from mother to fœtus of the substances whose chemical composition is well known and comparatively simple. No doubt, between the phenomena of the transplacental passage of the toxins of disease and those of the transmission of the metallic salts and vegetable poisons, there is, so to say, a wide and unbridged river; but there is some hope of a bridge being ultimately built, of at least some pontoon arrangement being thrown across, and it will be well to anticipate this by constructing the indispensable piers. Let us then, in this chapter, prepare the pier on the chemical side of the dividing river. Let us, in other words, consider the transmitted toxicological states of the fœtus.

Of many poisons, mineral and vegetable, which might be introduced into the maternal organism and pass over to the fœtus, we have absolutely no information, either of a clinical kind from observations on the human subject, or of an experimental nature from animals. With regard to a few poisons we have scanty details, both clinical and experimental; and concerning two or three toxicological substances we have enough knowledge to warrant us in making some statements. On the whole, however, there is great ignorance on a very important matter. I may, for the sake of clearness, arrange this scanty information according to its sources into four parts. These are—(1) The clinical and post-mortem evidence available when a pregnant woman takes, or is given, accidentally or with criminal intent, one or other of the active poisons, mineral or vegetable; (2) the information which can be obtained from the chronic poisoning of pregnant women engaged in dangerous trades or in an unhygienic environment; (3) the facts ascertainable when medicines are administered to the mother during or just before her confinement; and (4) the results of experiments upon animals, when, for instance, a poison is injected or otherwise introduced into the maternal or fœtal organism, and its effects upon the fœtus or mother noted.

With such sources of information at command, I shall endeavour to answer the following questions regarding certain poisons and their effect upon the unborn infant; and I shall condense as far as possible, for, after all, the facts are often so scanty as scarcely to justify generalisations. The questions are—(1) Does the poison pass the placental barriers and reach the fœtus? (2) When it passes, is it to be found in all parts of the fœtus and annexa, or only in special organs? (3) What changes does it produce in the fœtal tissues? and (4) Does it cause fœtal death, and if so, by what mechanism is this brought about? Questions, these are, which the reader will soon find to be more easily propounded than answered!

It will be convenient to consider first the cases of poisoning with lead, mercury, phosphorus, arsenic, and copper; thereafter, those due to carbonic oxide, chloroform, and ether, and to opium, tobacco, and alcohol, will be dealt with.

Lead Poisoning.

It has been shown by Porak (*Arch. de méd. expér. et d'anat. path.*, vi. 192, 1894), by means of experiments upon pregnant guinea-pigs, that lead passes from the maternal into the fœtal body; it does not seem to accumulate in the placenta, but passes at once through it to the fœtus; having reached the unborn infant, it tends to be more widely diffused than in the adult, and has been observed in the skin, liver, nervous centres, and elsewhere. Porak did not find that it caused abortion. J. Balland (*Gaz. hebd. de méd.*, Paris, xliii. 1141, 1896), however, by poisoning guinea-pigs with neutral acetate of lead, produced five abortions out of ten cases; he did not search for lead in the fœtal tissues. With regard to the human subject, direct evidence of the passage of lead from mother to fœtus is wanting; but Hermann Legrand and L. Winter (*Compt. rend. Soc. de biol.*, Par., 9 s., i. 46, 1889) found lead in the liver of an infant, who only survived birth fifteen days; in this case both parents were the subjects of lead poisoning. The conclusion that in the human subject the existence of saturnism in the parents produces evil effects upon the fœtus in utero is, however, founded not upon experiments upon animals, but upon clinical observations. In order to establish firmly this conclusion, observers in the future would do well to submit to chemical analysis the abortion-sacs and dead-born fœtuses and infants of parents known to be suffering from plumbism.

With regard to the *nature of the effects* produced upon antenatal life, much more is known. It was in 1860 that Constantin Paul (*Arch. gén. de méd.*, i. 513, 1860) made a discovery which marked a new era in our knowledge of the relations existing between lead poisoning and pregnancy. He proceeded from the known fact that syphilis in the parents may either kill the fœtus or produce syphilis in it; and, from certain observations to be referred to immediately, he came to the conclusion that, in cases of lead poisoning in the parents, the offspring might be expected either to perish in utero, or to suffer after birth from diseases the result of the parental saturnism. "On comprend que c'est là un sujet de recherches excessivement vaste, et qui exigerait, pour être complet, un grand nombre d'années d'un travail assidu." (True, Monsieur Paul!) His observations were made upon workers in type-foundries, and his attention was drawn to the subject by the following case which he studied in the Necker Hospital. It was that of a woman who had worked for eight years in a type-foundry, and who was suffering from metrorrhagia. Her history was that she had had three healthy infants as the result of three normal pregnancies before she became a worker in lead; thereafter, she had suffered several times from lead colic, and out of ten pregnancies there had been eight abortions, one

dead-born infant, and one child at the full term, who died at the age of five months. This too striking fact ("ce fait trop frappant") led Paul to make further inquiries regarding other workers, women and men, in the same trade; and, in all, he collected eighty-one observations. These he arranged in six series, about which I will (with the reader's kind indulgence) say a few words.

In the first group he placed women who had had more or less serious signs of plumbism. There were four women in this series who had had fifteen pregnancies, of which ten had ended in abortions, two in premature labour, one in a dead-born infant, one in an infant that died in twenty-four hours, and one in an infant that survived birth. In a second group were placed five women (including the original case referred to above), who had had normal pregnancies prior to their working in lead, but who afterwards out of thirty-six new pregnancies had had twenty-six abortions, one premature labour, two dead-births, five infants of whom four died in the first year, and two infants who survived. In the third series is a single case, that of a woman who had ceased to work in the type-foundry; as a worker she was five times pregnant, and had five abortions; after ceasing to work she had one pregnancy, the result of which was a living and healthy infant. In the fourth series were two cases—(1) That of a woman who had ceased to work in the foundry, gave birth to a living infant four years later, and had then returned to work, and had since had one abortion and probably three others; (2) that of a woman who had on two occasions ceased to work, and in each interval had had a living (and surviving) infant, and who had thereafter worked continuously and had two abortions. The fifth series was very interesting; it contained seven cases, in which either the husband alone was exposed to lead poisoning, or in which, although both parents were exposed, the husband alone suffered from signs of saturnism. Out of thirty-two pregnancies, there were eleven abortions and one dead-birth, while of the twenty infants born alive eight died in the first year, four in the second, five in the third, and three survived. The conclusion drawn is that the father as well as the mother may transmit the evil effects of lead poisoning, although in a less grave degree, to the offspring; but to do so he must be suffering from the lead ("en puissance de plomb") at the time of fecundation. In the sixth and final series were the cases where the blue line on the gums was the only sign of plumbism: there were six women in this series, who had twenty-nine pregnancies, among which there were eight abortions, one premature labour, twelve dead infants, and eight living infants; so that, when the effects of the lead on the parent were less marked, the results to the offspring were also less severe. Paul draws the evident conclusion that, while lead poisoning does not prevent fecundation, it very gravely interferes with antenatal life; for, out of a total of one hundred and twenty-three pregnancies, in seventy-three the product was dead before expulsion from the uterus, and thirty-five infants born alive died in the first three years of life. Manifestly it is a grave matter for the fœtus when one or both its parents are "en puissance de plomb." In

a later article (*Compt. rend. Soc. de biol.*, 3 s., iii. 4, 1862), Paul added two other cases to the list, giving a total of one hundred and forty-one pregnancies, ninety-one abortions, dead births, and premature labours, and thirty-five infants who died in the first three years of life. Fournier's exclamation regarding syphilis is surely not inapplicable here also: "Quelles statistiques! Quelles horribles tables mortuaires!"

Paul's observations were so evidently important that they at once called forth a leading article in the *Gazette des hôpitaux* (xxxiii. 225, 1860), and stimulated observers in other countries to make further investigations. Benson Baker (*Trans. Obst. Soc. Lond.*, viii. 41, 1866), for instance, recorded three cases in which lead poisoning in both parents was apparently the cause of one or more abortions; but in one instance there was syphilis also. Baker was of opinion that the lead killed the fœtus in utero, and that thereafter and on that account abortion took place; but he admitted that the expulsion of the uterine contents might be due to the action of the metal on the uterine muscle. Lincoln (*Boston Med. and Surg. Journ.*, lxxxvii. 306, 1872) had an article on "the influence of the exhalations from fresh paint upon the fœtus in utero." J. T. Arlidge also, in a pamphlet on *The Diseases prevalent among Potters* (London, 1872), referred to the great infantile mortality in the offspring of such workers in lead; and F. Roque (*Compt. rend. Soc. de biol.*, 5 s., iv. 243, 1874) ascribed to the working in lead not only the high infant death-rate, but also the frequent occurrence of idiocy, imbecility, and epilepsy; in most of Roque's sixteen families the father alone suffered from plumbism. Sireday (*Journ. de méd. et chir. prat.*, xlvii. 63, 1876) and Ganiayre (*Thèse*, Paris, 1900) also considered the relation of abortion and lead poisoning; and Lefour (*Bull. Soc. d'anat. et physiol. de Bordeaux*, viii. 84, 1887) dealt specially with the father's influence.

An observation, resembling in some of its details that made by Roque, was published by O. Rennert (*Arch. f. Gynaek.*, xviii. 109, 1881). He found that of the children of eleven men who were workers in pottery-glazing, many had certain cranial anomalies. All the eleven men suffered from plumbism; in two instances the wives were also markedly affected, and in some other cases they showed slight signs of poisoning, but some of them were quite free. Either at birth, or soon thereafter, the heads of the infants were in many instances noted to be square-shaped, with very evident tubera frontalia et parietalia; they increased rapidly in size, but the fontanelles were not larger than usual, the sutures did not gape, and the orbits and position of the eyeballs were normal (no hydrocephalus, therefore). There were no signs of rickets in the bones of the chest, limbs, and jaws; and the other organs were healthy. These infants grew fairly normally, neither their intelligence nor their general strength and nourishment being affected; but they had a very special tendency to convulsions (tonic and clonic contractions of the back and limbs), and a great number of them died (twenty-eight out of fifty-six who were affected, or 50 per cent.). Most of the macrocephalic children suffered from convulsions, but even the non-macrocephalic were sometimes affected in this

way; and out of the total number of seventy-nine infants, fifty-six, or 71 per cent., were affected either with macrocephaly or convulsions or both, but it is to be noted that six dead-born fœtuses are included amongst the non-affected. Rennert divides the cases into three groups: —In the first, both parents were affected, and the proportion of macrocephalics was 95 per cent. (eighteen out of nineteen cases, the remaining infant being dead-born); in the second group the mothers were only slightly affected, and eighteen out of twenty-seven cases (67 per cent.) were affected; and in the third group the mothers were healthy, and twenty out of thirty-three cases (61 per cent.) were affected. In Rennert's cases the influence of syphilis and alcohol was apparently excluded. The localisation of the effects of the lead upon the brain and cranium is interesting when taken in conjunction with Porak's experimental results, in which the metal was found specially in the nervous centres. From Legrand and Winter's case (*loc. cit.*), the conclusion, however, may be drawn that lead tends to localise in the liver and spleen; it was calculated that in the liver, which weighed 45 grammes, there were from 7 to 8 milligrammes of the metal; but unfortunately neither the nervous centres nor the placenta were available for analysis. The visceral changes present were of the nature of irritative lesions of the liver and kidneys; and in the latter there was also a developmental arrest in the absence of the zone of glomeruli in process of formation. It is difficult to regard M. Anker's case (*Berl. klin. Wchnschr.*, xxxi. 577, 1894) as a genuine instance of antenatal transmission, for the child was eight years old, and may have received the poison in other ways.

From these scattered references to lead poisoning it is clearly unsafe to draw many conclusions; but it may be tentatively suggested that there is a certain resemblance between the resulting phenomena and those found in syphilis. There is the marked tendency to abortions and dead-births and to infantile multi-mortality; there are indications of dystrophic changes, perhaps located specially in the brain; and there is some evidence of peculiar visceral lesions due to the irritative effects of the metal on the tissues. Apparently, also, there is paternal as well as maternal transmission.

Mercurial Poisoning.

When a pregnant woman is the subject of acute mercurial poison, abortion has been known to follow; but Wynter Blyth (*Poisons*, p. 643, 1895) referred to the case of a girl who swallowed 4½ oz. by weight of the liquid metal in order to procure abortion, but without any such effect, although she suffered later from tremor and paralysis. It is, however, with the effects of chronic mercurial poisoning upon pregnancy and the fœtus that we are more directly concerned. As with workers in lead, so with pregnant women employed in trades in which mercury is employed, there is evidence that the absorption of the metal leads not infrequently to abortion, and that even when the infant is born alive it may show signs of poisoning, *e.g.* mercurial tremors. A. Lizé (*Union méd.*, 2 s., xiii. 106, 1862) has found that,

among women exposed to the fumes of nitrate of mercury, pregnancy was undoubtedly interfered with. Of twelve pregnancies of women (not themselves workers) who were married to workers in mercury, there were two premature labours, two dead-born infants, three children who died during the first four years of life, and five children who survived; of the five surviving children, however, one only was strong, and it is noteworthy that, at the time of his conception, his father was not a worker. In two cases both father and mother were exposed to the poison, and of fourteen pregnancies which followed, five ended in the birth of dead-born fœtuses, and of the progeny of the other nine, only three infants survived their fifth year. In three cases the mother alone was exposed; there were seven pregnancies, three of which ended in abortions, one in a dead-birth, and of the living infants one was tubercular. A curious observation is referred to by Wynter Blyth (*op. cit.*, p. 644, 1895); it was that of a woman, twenty years of age, employed in making barometers, and who suffered from tremor and salivation; during a three months' pregnancy the tremor ceased, but again appeared after she had aborted; she again became pregnant, and the tremor ceased until after her confinement.

With regard to the passage of mercury through the placenta to the fœtus, Porak (*loc. cit.*) found from experiments upon pregnant guinea-pigs that the metal showed a marked tendency to be stored up in the placenta, and that it was not to be discovered in the other fœtal organs; it caused abortion in two cases out of six. A. Plottier (*Thèse*, Genève, 1897) found no mercury in the placenta, liquor amnii, and fœtus of a guinea-pig that had received peptonate of mercury in the form of subcutaneous injections; but in the case of a pregnant rabbit, that received the mercury in the same form and manner, the metal was found both in the placentas and the fœtuses, but not in the liquor amnii. In the case of the human subject, the most important evidence available is got from the cases of syphilis in pregnancy in which mercury has been administered. The results of the examination of the fœtus for mercury in such cases are contradictory, but H. Cathelineau and H. Stef (*Ann. de dermat. et de syph.*, i. 972, 1890; *Bull. Soc. franç. de dermat.*, i. 167, 1890) found the metal in the placenta, liquor amnii, and fœtus in five pregnancies in the human subject, and one in the rabbit. The mercury was detected in the liver, spleen, heart, kidneys, meconium, lungs, and brain; the amount in the liver was 0·00121 gramme in 10 grammes of the organ, or 0·0182 gramme in the whole viscus; the other organs named contained less. Strassmann (*Arch. f. Physiol.*, Suppl. Band, s. 95, 1899) and D. Mirto (*Gior. di med. leg.*, Lancisiano, vi. 1, 1899) have also made observations on the transplacental passage of mercury.

The following conclusions seem fairly warrantable. Mercury given to the pregnant woman in the treatment of syphilis passes to the fœtus, liquor amnii, and placenta; in these circumstances it seems not to cause but to prevent abortion. In non-syphilitic women, however, who have received mercury into the system in connection with their work, and who are suffering from mercurial poisoning, the results would appear to be abortions, dead-births, and congenital

debility; but mercury does not seem to be so fatal in these respects as lead. In one instance at least the signs of maternal poisoning largely disappeared during pregnancy (concentration of toxic action upon the fœtus or accumulation of the metal in the placenta?). Mercury apparently passes to the fœtus in the rabbit also, but not in the guinea-pig; in the latter case it is stored up in the placenta, and, therefore, in one sense reaches the fœtus, the placenta being looked upon as one of its organs. It is not known what changes the mercury produces in the placenta and fœtal organs when it reaches them.

Phosphorus Poisoning.

That phosphorus passes in some form from mother to fœtus is proven by the presence of phosphates in the latter; but in what form the metal passes is not known (*vide* p. 149). Nevertheless, several experiments have been carried out to settle this point. As far back as 1857, L. Restelli (*Gior. d. r. Accad. med.-chir. di Torino*, 2 s., xxix. 257, 321, 1857) made analyses in the case of puppies; and much more recently, L. Borri (*Settimana med. d. Sperimentale*, l. 267, 1896), using much more exact methods, detected phosphorus in the fœtuses and placenta of poisoned rabbits. Both observers obtained positive results, but left the question of the form in which the metal passed uncertain. Porak (*loc. cit.*) got negative results in the case of guinea-pigs.

There is sufficient evidence, both from the lower animals and the human subject, that in maternal phosphorus poisoning, lesions exist in the fœtus similar to those found in the mother. I. M. Miura (*Arch. f. path. Anat.*, 9 F., vi. 54, 1884) found fatty degeneration of several of the fœtal organs along with subserous ecchymoses in two rabbits and two guinea-pigs that had been poisoned with phosphorated oil administered by the mouth. Pulewka (*Diss.*, Königsb. i. Pr., 1885) and S. Friedländer (*Diss.*, Königsb. i. Pr., 1892) reported cases of phosphorus poisoning in pregnancy, and the latter noted changes in the fœtal organs (fatty degeneration). In 1893, also, C. Seydel (*Vrtljschr. f. gericht. Med.*, 3 F., vi. 280, 1893) recorded a case of phosphorus poisoning in which the victim gave birth to twins, dead-born; with the exception of sanguinolent effusion into the serous cavities, the fœtuses showed no naked-eye changes, but, on microscopic examination, extensive fatty degeneration of the liver cells was discovered; the kidneys and heart exhibited no microscopical alterations. G. Corin and G. Ansiaux (*Vrtljschr. f. gericht. Med.*, 3 F., vii. 84, 1894) carried out experiments upon dogs; one of these was pregnant with eight puppies. The membranes were separated from the uterine walls by blood effusion in which small oil globules were suspended; the placental villi were much degenerated, and showed fatty streaks; the liquor amnii had a reddish colour; the fœtal heart contained partly coagulated blood; there was yellow fluid in the pleural and peritoneal cavities, and there were ecchymoses on the pleural and peritoneal membranes; and although the analysis of the fœtal organs did not indicate the presence of phosphorus, the authors

concluded from the other signs that the poison had passed to the fœtuses.

The preceding statements refer to acute phosphorus poisoning; but the question arises whether in the chronic poisoning associated with certain trades any effects upon pregnancy and the fœtus have been noticed. According to Palazzi (*Ann. di ostet. e ginec.*, xxiii. 350, 1901), a case is on record in which for eight days a pregnant woman took small doses of phosphorus causing subacute poisoning; nevertheless she ultimately recovered, and was delivered two months later of a living and well-formed infant. With regard to the women workers in match factories, the facts elicited by Borri were contradictory, in some factories abortions being common, and in others not above the average. Possibly the risks of serious results are nowadays much lessened through improved hygiene.

Arsenical Poisoning.

There are few observations regarding the effect of either acute or chronic arsenical poisoning on antenatal life. Keber (*Vrtljschr. f. gericht. u. öff. Med.* xxiii. 300, 1863) records the case of a woman, pregnant at the fourth month, who poisoned herself with arsenic in the hope of producing abortion. After an illness of two days she died, and apparently aborted after death, for a fœtus about 5 inches long was found lying at the vulva. On chemical examination no trace of arsenic was discovered in the fœtus. Similarly in G. Filomusi-Guelfi's case (*Gior. internaz. d. sc. med.*, Napoli, n.s., x. 392, 1888) no arsenic was detected in the macerated seven months' fœtus of a woman who had premature labour sixteen days after being poisoned. Keber (*loc. cit.*), however, refers to a case published in 1846 in which traces of arsenic were found in the uterus, placenta, and fœtus, but not in the liquor amnii.

Experimental evidence goes to prove that in the guinea-pig at any rate arsenic passes through the placenta to the fœtus. De Arcangelis is quoted by Palazzi (*Ann. di ostet. e ginec.*, xxiii. 350, 1901) as having demonstrated that the metal is found in the fœtus and in the liquor amnii, but in smaller amount in the latter; the quantity which passed was greater in acute than in chronic poisoning; the passage was quick and occurred at all dates in pregnancy. Porak (*loc. cit.*) also found that arsenic passed (with difficulty) to the fœtus, and that it was there stored up chiefly in the skin; a somewhat remarkable observation, when the therapeutic effects of the drug in skin diseases is borne in mind. Porak also found it to be a powerful abortifacient in the guinea-pig, probably on account of the placental hæmorrhages which resulted. In the case of the rabbit, Plottier (*op. cit.*) also got a positive result as to the passage of arsenic.

Data regarding the effect of arsenic on the fœtal organs are too scanty to warrant the drawing of any conclusions.

As to the influence of *poisoning with copper* upon antenatal life, next to nothing is definitely known. Of experimental evidence there

is likewise little; but Philipeaux (*Compt. rend. Soc. de biol.*, 7 s., i. 227, 1880) found that by mixing basic acetate of copper with the food of a pregnant rabbit, small quantities of it could be detected in the fœtal tissues. Porak (*loc. cit.*) noted that, in the case of guinea-pigs, the copper tended to accumulate in the placenta, liver, central nervous system, and sometimes in the skin; but he did not observe any abortifacient action.

Casper (*Handbook of Forensic Medicine*, New Sydenh. Soc., ii. p. 82, 1862) records two cases of poisoning with *sulphuric acid* in pregnancy; in one of these in which the gestation was at the fourth month, the liquor amnii had a decidedly acid reaction; Casper regrets that in the other this point was not investigated. Palazzi (*loc. cit.*) refers to a case seen by Otto in which the mother was poisoned with sulphuric acid, and the five months' fœtus had a reddish brown skin as hard as parchment, with healthy internal organs; the conclusion is drawn that the acid can only have reached the liquor amnii. This case raises, without in a great degree settling, the question of the cause of fœtal death in such forms of poisoning; probably it is in most instances due to the effects upon the mother, while in a few cases it may be caused by the direct action of the poison on the fœtus. To this matter, however, I shall return under the heading of fœtal asphyxia.

It will now be well to consider certain poisonous gases and their effects upon antenatal life. These are carbonic oxide, chloroform, and ether.

Poisoning with Carbonic Oxide or Coal Gas.

Cases of carbonic oxide and coal gas poisoning may be considered together. Breslau (*Monatschr. f. Geburtsk. u. Frauenkr.*, xiii. 449, 1859) narrates how two pregnant women were poisoned by inhaling coal gas (which contains carbonic oxide); one woman gave birth twenty-four hours later to a recently dead fœtus; the other, who was less affected by the gas, had a living infant some time afterwards. In M. B. Freund's case (*Monatschr. f. Geburtsk. u. Frauenkr.*, xiv. 31, 1859) the poisoning was less marked, merely causing headache, but five weeks later a macerated fœtus was expelled from the uterus. D. T. Nelson (*Chicago Med. Gaz.*, i. 42, 1880) also recorded an instance of "coal gas poisoning of a fœtus at term." F. Falk (*Vrtljschr. f. gerichtl. Med.*, n. F., xl. 279, 1884) gave interesting details of a case of carbonic oxide poisoning in a woman, forty-two years of age, who was in the eighth month of her pregnancy. Her blood had the bright red appearance due to this form of poisoning, but the blood of the female fœtus in utero had the usual dark colour, and Falk concludes that the placenta does not usually permit carbonic oxide gas to pass to the fœtus. At the same time he refers to a case noted by Liman, in which both the maternal blood and that of a six months' fœtus showed the spectroscopic appearances peculiar to carbonic oxide poisoning.

There is also some evidence, derived from experiments, bearing upon the transmission of this gas from mother to fœtus. A. Högyes (*Arch. f. d. ges. Physiol.*, xv. 335, 1877), for instance, poisoned two rabbits with carbonic oxide in from one to one and a half minutes; but the spectroscopic examination of the fœtal blood gave negative results. Fehling (*Arch. f. Gynaek.*, xi. 523, 1877) found, however, that if rabbits be submitted to the effect of coal gas mixed with air for a longer time, the blood of the fœtuses sometimes but not always showed traces of carbonic oxide, but always to a less degree than did the maternal blood. N. Gréhant and Quinquaud (*Compt. rend. Acad. d. sc.*, Paris, xcvii. 330, 1883) exposed pregnant dogs to the fumes for thirty-five minutes, and found the gas in the blood of the fœtuses, but always in small quantity. The conclusion, therefore, seems to be justified that, in experiments upon animals, carbonic oxide does pass in small amount through the placenta, but that in the case of the human subject the fœtal death is due rather to the maternal asphyxia than to the direct action of the poison. But, again, the cases are too few to warrant the safe drawing of conclusions.

Chloroform.

When chloroform was first introduced into obstetrics, fears were widely expressed lest it might injure the infant. How can we "know or ascertain the possible consequences of the use of such an agent on the brain of a child? And how can we calculate what may be the ultimate consequences of its action in reference to the development of the mental faculties?" These questions were asked in April 1848; and in October of the same year Simpson answered them by stating that out of 150 infants born under anæsthesia, all except one (a macerated fœtus) were born alive, and that he was not aware that any of them had since suffered from "cerebral effusions," "convulsions," "hydrocephalus," or any other of the "affections which have been prophesied as certain to befall all such infants" (*Obstetric Works*, ii. 638, 1856). The matter was also discussed in Germany (L. Melischer, *Deutsche Klinik*, iii. 271, 1851). Of recent years the question has been raised anew but in a modified form, for it has been asked whether jaundice in the new-born infant might not be due to the effect of chloroform on the fœtus. H. Fehling (*Arch. f. Gynaek.*, ix. 315, 1876) found no trace of any such influence, an experience shared in to a large extent by P. Zweifel (*Arch. f. Gynaek.*, xii. 252, 1877); but Hofmeyer (*Tagebl. d. versamml. deutsch. Naturf. u. Aerzte*, Eisenach, lv. 295, 1882), in the case of twenty-two infants, the offspring of mothers who had been chloroformed in labour, found all of them more or less icteric and showing albumin and tube casts in the urine. In Hofmeyer's cases, however, the labours were long and the amount of chloroform inhaled considerable (30 to 100 grammes); manifestly other influences were at work besides the chloroform. F. Ahlfeld (*Lehrb. d. Geburtsh.*, 201, 1894) is inclined to think that the prolonged use of chloroform in labour may asphyxiate the fœtus, and bases his belief on ten cases of Cæsarean section, in eight of

which meconium was found in the liquor amnii. Ordinary everyday experience, however, shows that chloroform given in labour has little or no injurious effect upon the fœtus.

With regard to the experimental proof of the passage of chloroform from the maternal to the fœtal blood, there is as yet no absolute certainty. P. Zweifel (*Berl. klin. Wchnschr.*, xi. 245, 1874) found that the urine of infants born to chloroformed mothers had a reducing effect upon Fehling's alkaline copper solution. In a later research, Zweifel (*Arch. f. Gynaek.*, xii. 238, 1877) tested the placental blood more accurately, and in six out of seven cases noted quite distinctly the smell of phenyl-carbylamine (isonitrile), a peculiar and penetrating odour. Fehling also got positive results with the carbylamine test (*Arch. f. Gynaek.*, xi. 554, 1877). There is, therefore, strong evidence in favour of the belief that chloroform gas passes into the fœtal blood; and, it may be added, that there is no strong evidence that when there it produces any serious effects.

Ether.

Gloomy forebodings about the effects of ether upon the fœtus in utero were freely entertained, just as we have seen they were regarding chloroform. One writer in 1848 (G. T. Gream, *Pamphlet*, 1848) expresses his fears as follows: "It is admitted by all that the pulsations of the fœtal heart are greatly increased during inhalation —indeed, to such an extent has this been noticed, that in some instances the pulsations could not be counted, so much were they accelerated. Are not effusions to be feared from this? Are not convulsions after birth likely to ensue? And may not that occur which would make the most heartless mother shudder at the bare possibility of herself, by want of courage, being instrumental in producing? May not *idiocy* supervene? Of this we have as yet no experience, nor shall we have, perhaps, for years; but when one such case occurs, will there be found any one who will afterwards be persuaded to submit herself to etherisation during pregnancy?" Fortunately we are often more frightened than hurt, and suffer often more in apprehension than in reality—*Plura sunt quæ nos terrent, quam quæ premunt; et sæpius opinione quam re laboramus!*

As with chloroform so with ether, its transplacental passage to the fœtus has not been absolutely proven, although it is extremely probable. To recapitulate, there is no reason to doubt the passage of either chloroform or ether to the fœtus, neither is there any reason to apprehend toxic effects unless the maternal anæsthesia be very deep and long continued.

I now pass to the consideration of the action of opium, tobacco, and alcohol upon the unborn infant.

Poisoning with Opium.

The subject of the possible poisoning of the fœtus with opium is chiefly remarkable for the lengthy debate, occupying three meetings,

to which it gave rise at the New York Obstetrical Society in 1877. At these meetings, or as a direct result of them, a considerable amount of clinical evidence, of a curiously contradictory sort, was gathered together, mainly in reference to the effect which morphine, administered to the mother during pregnancy or at labour, had upon the unborn infant. The discussion arose out of a case of eclampsia in the mother treated by hypodermic injection of morphine, with asphyxia and subsequent convulsions in the child, the account of which was communicated by J. B. Mattison at the January meeting of 1877 (*Amer. Journ. Obst.*, x. 299, 1877). In all, one and one-third grains of morphine were administered; the infant was asphyxiated at birth, was resuscitated with difficulty, and thereafter passed through nine convulsive seizures; both mother and child recovered. On the motion of Paul F. Mundé, the subject was made the special topic for discussion at the next meeting (February 1877), and Mundé himself opened that discussion, which was entitled "The Influence on the Fœtus of Medicines, particularly Narcotics, administered to the mother during pregnancy and labour." He recorded a case (*Amer. Journ. Obst.*, x. 300, 1877) in which a woman had been taking from twelve to sixteen grains of morphine daily during the whole course of her pregnancy; fœtal movements were normal, and the infant was born alive and apparently quite healthy. Mundé suggested that there may have been gradual habituation of the fœtus to the morphine. It may be noted here that Ernest Kormann (*Deutsche med. Wchnschr.*, iii. 356, 1877) reported a very similar case, in which a truly "morphiophagous woman, who took from two to four times daily a quarter of a hypodermic syringe-ful of morphine—"Dies wurde die ganze Schwangerschaft hindurch fortgesetzt, und trotzdem erfolgte keine der prophezeiheten Störungen"—and the fœtal movements were in no way abnormal, and the infant was born alive and healthy. Kormann concluded that very little or no morphine reached the fœtus through the placenta.

To return to the discussion in the New York Obstetrical Society, Fordyce Barker gave his clinical experience on the matter, and concluded that there was no evidence which could be accepted by science, that narcotic drugs, administered to the mother, ever produced their specific effects on the fœtus in utero. W. M. Chamberlain expressed similar views, founded upon the fact that he had reported a case in which a woman took during pregnancy, labour, and lactation, twenty grains of morphine every day, and the child showed no ill effects. Peaslee continued the discussion, expressing very strong opinions on the innocuousness to the fœtus of opium given to the mother; he asked sarcastically, "Does any physician know of a narcotic which, given to the mother, will even put a fœtus asleep o' nights, in cases where the mother is kept awake and in distress by too forcible and continuous fœtal movements?" W. R. Gillette, however, gave quite a different aspect to the discussion: he brought forward the details of six cases, in all of which morphine was administered to the degree of producing its physiological phenomena, and in all of these instances the infant was born in a more or less

asphyxiated condition and with contracted pupils. All the infants save one recovered, and in the one that died intense cerebral congestion was found. The morphine was given in labour instead of the usual anæsthetics (chloroform or ether). The recovery from the asphyxia was quite unlike that in ordinary cases of apnœa neonatorum. In two other cases, Gillette gave atropine hypodermically to the mother in the second stage of labour; in one of these the infant's pupils were markedly dilated. Skene believed, with Gillette, that morphine, given to the mother, would produce its specific effects on the fœtus. Thomas added notes of two cases in which the fœtal heart-beats seem to have been slowed by morphine.

The discussion closed, as so many such discussions do, with the expression of a very decided difference of opinion among the medical men taking part in it; but to the reader at a distance the impressions given are that Gillette and those who agreed with him had at least some *facts* on their side; and that morphine, given to the mother to the extent of producing specific effects upon her, produced them also upon her fœtus in utero. It is true that soon afterwards W. T. Lusk (*Amer. Journ. Obst.*, x. 413, 1877) gave details of eleven cases in which Gillette's experiment was repeated; only twice did the infants show asphyxia. To this Gillette replied (*Amer. Journ. Obst.*, x. 612, 1877) with a second series of fifteen cases, in which he obtained results almost identical with those previously got by himself; and he attributed Lusk's failure to obtain a similar effect to the fact that he (Lusk) "did not push the drug to a sufficient extent to produce even its safe phenomena." E. L. Partidge's observations (*Amer. Journ. Obst.*, x. 558, 1877) went to support Lusk, while J. J. Lamadrid's case (*ibid.*, 466, 1877) added a little strength to Gillette's opinion. Thus the great battle ended with a splutter of fire on both sides and a few stray shots in the gathering darkness.

Elsewhere than in New York the effect of morphine on the fœtus gave rise to discussion. Fehling (*Arch. f. Gynaek.*, ix. 315, 1876) thought that cases which he had seen proved that the asphyxia neonatorum (with cerebral congestion) which sometimes followed might be ascribed to the morphine. Ahlfeld (*Lehrbuch*, p. 202, 1894) also met with a case which he regarded as one of congenital opium poisoning. Both he and Fehling regarded the negative results of others (*e.g.*, F. Benicke, *Centrlbl. f. Gynäk.*, iii. 179, 1879) as due to habituation of the fœtus to the effects of morphine. P. Kubassoff (*Dissert.*, St. Petersb., 1879) also found that opium produced distinct effects upon the fœtus.

The actual presence of morphine in the infant at birth was shown by Bureau in 1895 (*Journ. de. méd. de Par.*, 2 s., vii. 597, 1895); the mother took one gramme of morphine daily, the infant was born with a club-foot, and morphine was found in the blood of the vessels of the cord and placenta. A. Plottier (*Thèse*, Genève, 1897), in the case of the rabbit, discovered morphine in the fœtuses and placentas, but got doubtful results for the liquor amnii; E. Marquis (cited by Plottier) obtained similar results with fœtal kittens.

A curious piece of evidence which goes to support the view that morphine produces an effect upon the fœtus in utero, is supplied by Féré (*Sensation et Mouvement*, p. 96, 1900). He narrates the case of a pregnant woman with the morphine habit, who, when she attempted to abstain from the drug, was so tormented by excessive fœtal movements that she had to return to the opium, whereupon the fœtal spasms ceased. He had observed the same phenomenon in connection with bromide of potassium.

The general conclusion may therefore be drawn, that morphine given to the mother affects the unborn child, but that while the *habit* persisted in during pregnancy seems to produce no *bad* effects on the fœtus, the taking of large doses at the time of labour predisposes to asphyxia neonatorum. There is no ground for supposing that it leads to abortion; obviously such a result is not to be expected. There is, however, room for much more investigation here; and these views may require to be modified. Alas!

Tobacco Poisoning.

The main question which has arisen regarding the effect of tobacco poisoning upon antenatal life is whether pregnant women working in tobacco factories are more liable to abort than other women. There is again a sharp difference of opinion: for while Decaisne (*Rev. d' hyg.*, i. 914, 1879) and those who took part in the discussion following the reading of his paper (*ibid.*, ii. 35, 216, 1880) were quite convinced that abortion was very frequent in women workers in tobacco in France, and while T. Kostial (*Wchnbl. d. k. k. Gesellsch. d. Aerzte in Wien.*, viii. 313, 1868) bore the same testimony with regard to Austria, Ygonin (*Lyon Méd.*, xxxv. 397, 1880) and Piasecki (*Rev. d'hyg.*, iii. 910, 1881) formed an opinion diametrically opposed. The views of Piasecki and Ygonin have been supported recently by G. Étienne (*Ann. d' hyg.*, 3 s., xxxvii. 526, 1897) with regard at least to the women workers in the factories at Nancy. In de Pradel's case (*Bull. et mem. Soc. de méd. prat. de Paris*, p. 592, 1888) it cannot be proved that the death of the fœtus was due to the influence of the tobacco.

While there is much doubt, therefore, regarding the evil effect of nicotism in cutting short antenatal life, there seems to be no shadow of doubt that there is a very large infantile mortality in postnatal life among the offspring of women workers in tobacco. Possibly this may be due in part to the influence of the milk, but it is more probable that it is on account of congenital debility. Of course it is difficult to exclude the other possible causes of abortion, premature labour, and infantile mortality (*e.g.* syphilis).

Alcoholism.

Round the question of the effect of maternal (and paternal) alcoholism upon the unborn infant there has raged a fierce battle, a battle the issue of which is still in doubt. The arguments which

have been advanced on both sides have not always appealed solely to the medical and scientific aspects of this question, and doubtless preconceived notions have been allowed free play; but there have gradually emerged certain fairly well established facts, and these I may now consider under the headings of experimental and clinical.

With regard, in the first place, to experimental evidence, it has to be recorded that until recent years no absolute proof was forthcoming that alcohol passes from the mother to the fœtus. It is true that Plottier (*Thèse*, Genève, p. 26, 1897) found alcohol in the liquor amnii, fœtuses, and placenta of a rabbit into whose stomach he had introduced 15 grammes of alcohol (with 25 grammes of water); but Palazzi (*Ann. di ostet. e ginec.*, xxiii. 357, 1901) got negative results in the case of a pregnant rabbit, into whose subcutaneous tissue injections of 20 c.c. of ethylic alcohol had been made. M. Nicloux, however, may be said to have settled the question of the passage of alcohol from mother to fœtus, both for animals and the human subject, by a carefully regulated series of experiments, the results of which were published in 1900 (*L'Obstétrique*, v. 97, 1900). By means of a somewhat complicated but reliable apparatus, he was able to ascertain with exactness the amount of alcohol in the blood and tissues, and thus to introduce a new element of certainty into his experiments. In the case of six pregnant guinea-pigs he introduced from ½ to 5 c.c. (per kgr. of body-weight) of absolute alcohol into the stomach by an œsophageal tube; one hour later he killed the animal and extracted the fœtuses from the uterus, and tested both the maternal and the fœtal blood and tissues for alcohol. He found that alcohol passed in very considerable quantity, and that the amount in the fœtal blood was relatively almost if not quite as much as in the maternal; even when the amount given to the mother was very small, it could be detected in the fœtus. Nicloux extended his experiments to the human subject; he gave to the woman in labour about 60 c.c. of rum (containing 45 per cent. of absolute alcohol) mixed with milk; this was administered about one hour before the infant was born; and in all the cases (six in number) alcohol could be easily detected in fœtal blood from the umbilical cord and placenta. There was no evidence of the presence of aldehyde or acetic acid, but only of alcohol. It may, I think, be taken as proven that alcohol passes, as alcohol, from the maternal to the fœtal circulation.

I have now to consider the experimental evidence regarding the effects produced by alcohol on the fœtus. To quote from Nicloux: "La réalité du passage de l'alcool de la mère au fœtus démontre la possibilité de l'intoxication du fœtus; quelle ne doit pas être alors la toxicité de l'alcool pour un organisme et surtout pour un système nerveux en voie de formation?" Now, although it is *a priori* possible, and indeed probable, that ill effects follow the presence of alcohol in the fœtal tissues, and more especially in the central nervous system, yet we must not accept probabilities as if they were proven facts. What then are the facts? M. Carrara (*Riv. di med.*

leg., Milan, ii. 177, 1898–99) examined the nerve centres of the fœtuses in two pregnant guinea-pigs that had been treated with alcohol; he noted the extraordinary freshness of all the tissues (preserving power of the alcohol ?), and observed that, in the large cells of the anterior horns of grey matter in the spinal cord, the chromophilic zones were indistinct, but the nucleus was well marked. Evidently these observations were not such as to justify the drawing of conclusions therefrom, so Palazzi (*Ann. di ostet. e ginec.*, xxiii. 357, 1901) instituted experiments upon fifteen rabbits treated in such a way as to imitate chronic alcoholism (they were injected hypodermically, twice daily, with from 5 to 20 c.c. of alcohol); seven of these animals, although mixing freely with the males, remained sterile; five became pregnant and give birth to living and well-formed fœtuses; of the twenty-four fœtuses, only one showed any microscopic anomalies; while neither the liver nor the kidneys had, so far as Palazzi had been able to examine them, exhibited any microscopical alterations. On the other hand, the experiments made by Féré (*Bull. et mém. Soc. méd. d. hôp. de Paris*, 3 s., xi. 136, 1894, etc.), in which various kinds of alcohol and aldehyde were injected into the hen's egg in incubation, yielded many positive results in the form of non-developments, malformations, and monstrosities. It may be added that Mairet and Combemale (*Compt. rend. Acad. d. sc.*, cvi. 667, 1888) noted that an alcoholised bitch gave birth to deformed puppies. To these teratological results of the action of alcohol, attention will be paid elsewhere when I come to deal with the pathology of the embryo. In the meantime, it may be stated here that experiments with alcohol upon the fœtuses of rabbits and guinea-pigs have given negative results in so far as structural lesions are concerned.

Let us turn now, in the second place, to the clinical evidence upon these matters. There is, to begin with, a very considerable volume of opinion, with some statistics to strengthen it, that parental inebriety leads to sterility, to abortion, to premature labour, and to dead-births. J. Matthews Duncan (*Trans. Edinb. Obst. Soc.*, xiii. 113, 1888) gave a useful summary of the older evidence on this matter, adding some confirmatory facts from his own experience. Many others have written on the same subject and expressed similar views; but the contribution which W. C. Sullivan (*Journ. Ment. Sc.*, xlv. 489, 1899) made in 1899 stood out from most of the others by reason of its exactness and avoidance of fallacies. He specially investigated the reproductive history of chronic drunkards (women) in the Liverpool prison, and he avoided, as far as possible, the cases which were complicated by other degenerative factors. He found that of 120 female inebriates were born 600 children, of whom 335 (55·8 per cent.) died under two years or were dead-born, while the remaining 265 (44·2 per cent.) lived over two years. In the case of sober mothers related to the women above mentioned, the rate of dead-birth and early infantile deaths was only 23·9 per cent. Further, there was found to be a progressive death-rate in the alcoholic family, the number of dead-births and deaths under two years increasing as time

went on. This fact is brought out by one of Sullivan's tables, which I reproduce here :—

	Cases.	Dead and Dead-born, per cent.	Dead-born, per cent.
First-born	80	33·7	6·2
Second-born	80	50·0	11·2
Third-born	80	52·6	7·6
Fourth and fifth-born	111	65·7	10·8
Sixth to tenth-born	93	72·0	17·2

"These figures," says Sullivan, "illustrate very clearly the progressively augmenting character of the influence of the mother's alcoholism; it is specially noteworthy that the rate of still-births shows almost as marked a tendency to regular increase as does the death-rate among children born alive." Further, there was a sensibly higher death-rate among the infants of the mothers whose inebriety was developed at an early period; thus, of 31 women who began to drink at least two years before their first pregnancy, 118 children were born, of whom 74 died in infancy or were dead-born (62·7 per cent.). Sober *paternity* seemed to have little influence, was indeed "almost negligible"; neither did an inebriate ancestry appear to produce any great effect. In seven of Sullivan's cases in which there was conception in a state of drunkenness, in six the children died in convulsions during the first months of life, and in the seventh case the child was still-born. Amidst all this statistical gloom there was but one little bright light, one "scintilla," so to say, or spark of hope,—the fact that residence in prison, with of course a stopping of all alcohol, often enabled an inebriate mother to give birth to a living and surviving infant. For the female habitual drunkard it is apparently the best thing to be committed for a term of imprisonment early in her pregnancy; the prison baby may be the best! A sad fact, but a fact pregnant with hope!

It is unnecessary to dilate upon this aspect of the clinical effects of maternal alcoholism; but I may here refer to the results of acute poisoning with alcohol, a somewhat uncommon accident in pregnancy. Drappier (*Arch. de gynéc. et de tocol.*, xxiii. 476, 1896) has recorded the case of a lady, pregnant for the sixth time, who drank a litre of brandy; she exhibited all the signs of acute poisoning, and died two days later; but before death occurred she was delivered of two dead fœtuses of an intrauterine age of six months. Drappier ascribed the premature delivery to an excessive amount of carbonic acid in the uterine vessels and to death of the fœtuses. How far dead-births and abortions are due to the direct effect of alcohol, and how far to placental disease set up by it, is a question not at present to be answered. Facts are much wanted.

Another question concerned with the effects of alcohol upon antenatal life remains to be considered, namely, the dystrophic or teratological results. With regard, for instance, to epilepsy developing after birth, there is a great deal of evidence that parental alcoholism is an undoubted and powerful etiological factor. Féré (*Famille névropathique*, p. 55, 1898), F. Combemale (*La descendance des alcoholiques*, Montpellier, 1888), L. Leter (*Thèse*, Paris, 1892), Lancereaux (*Leçons de clinique médicale*, p. 59, 1892), and many others have written on this subject; and Bourneville (*Progrès méd.*, 3 s., xiii. 262, 1901) has recently given some startling statistics. Of 2554 children (2072 boys and 482 girls) who were admitted to the Bicêtre and Fondation Vallée between the years 1879 and 1900, all of them suffering from idiocy, epilepsy, imbecility, or hysteria, 1053 were the offspring of drunken parents (933 had drunken fathers, 80 had drunken mothers, and 40 had both parents drunken). About 450 of these children no information could be gathered; while 1051 had sober parents. Certainly 235 were conceived during the drunkenness of the father. The fact which emerged from these statistics, therefore, was that 41·1 per cent. of these idiot and epileptic children had drunken parents. Féré says it is difficult to decide how far we are to blame the alcohol for these results; for they may be due to the primary neuropathic state which led the parents to become drunkards; but when we are dealing with a vicious circle of causes and effects, it is always difficult to allocate the blame correctly. Sullivan (*loc. cit.*) found that out of the 219 children of alcoholic mothers who lived beyond infancy, 9 or 4·1 per cent. became epileptic, an extremely high proportion as compared with authoritative estimates of the frequency of epilepsy in the general mass of the population (1 to 6 per 1000). Other writers found that from 12 to 15 per cent. of the surviving offspring of alcoholics became epileptic.

Besides the predisposition to become epileptic or imbecile, the children of drunken parents are, it is stated, often malformed. E. Fournier (*Stigmates dystrophiques de l'hérédo-syphilis*, p. 318, 1898) has shown that, as with syphilis, so with alcoholism, the progeny is apt to exhibit structural anomalies, such as infantilism, multiple malformations (*e.g.* ectrodactyly, defect of occipital bone, etc.), hydrocephaly, cranial asymmetry, porencephaly, and microcephaly. This statement is simply the modern expression of a belief as old as the times of Hippocrates; and the deformed Vulcan was regarded as the result of Jupiter's drunkenness. In several of the cases of fœtal pathology which I have examined during the past twelve years, alcoholism in the parents (one or both) has been met with, *e.g.*, in a case of vesical exstrophy, in one of congenital heart disease, etc.; but it is, of course, always very difficult to exclude all other causes of malformation, and to be sure that alcohol alone is the etiological factor. If we follow the same principles of fœtal pathology which have been laid down already, we must regard such dystrophies as due to the action of the poison upon the organism in the embryonic stage of intrauterine life, or upon some part of it which still shows embryonic characters while in the fœtal or postnatal period of existence.

Into the question of the hereditary transmission of a craving for alcohol I do not propose here to enter, for that falls to be considered under the pathology of the germ; but it may be said in passing that the children of a drunkard are not necessarily drunkards, although it is probable that they will show weakness in many directions, and one of these directions *may be* a proneness to alcoholic excess.

The action of quinine, salicylate of soda, cocaine, etc., upon the fœtus will be taken up more appropriately when antenatal treatment is considered.

It will be remembered that at the beginning of this chapter it was pointed out that our knowledge of the transmitted toxicological states of the fœtus was most imperfect and even chaotic, an opinion in which the reader, I cannot doubt, now shares. It is therefore most unsafe to attempt to form any general conclusions regarding the effects of poisons on the unborn infant. All that may with any assurance be said is, that there is experimental proof that some poisons reach the fœtus, and that sometimes these poisons produce structural alterations in the fœtus and placenta; and that clinical evidence to a certain extent justifies us in asserting that a similar transmission and similar effects may be met with in the human subject. Here is but a small scientific "scintilla" in a truly Egyptian darkness.

CHAPTER XVI

Ill-defined Morbid States of the Fœtus: in Maternal Eclampsia; Cancer; Diabetes; Leukæmia; Heart-Disease, etc.; Conclusions.

THIS chapter is devoted to the consideration of certain ill-defined morbid states of the fœtus in utero, which may possibly be due to toxinic or toxic principles passing from the maternal circulation into the fœtal. I have considered and reconsidered the advisability of writing about these obscure morbid entities (it is not even certain that they are entities); but I have come to the conclusion to do so for several reasons, and for two in particular. In the first place, I believe that pathological states of the mother, such as eclampsia, jaundice, cancer, diabetes, and the like, do, in some instances, produce morbid changes in the fœtus, and that these changes are not necessarily of the same nature as those occurring in the mother; the fœtal states are due to the maternal maladies, but they are not identical or even similar in their manifestations. In the second place, I believe that these states are of importance because they bridge over the gulf between the transmitted diseases of the fœtus (*e.g.*, variola, syphilis, etc.) and the so-called idiopathic maladies; in the former, it is quite evident that the mother transmits her own malady as such to her unborn infant, while in the latter there is as yet no evidence that the fœtal disease is due to a maternal morbid state. Midway between these two classes of diseases lie the ill-defined pathological conditions of the fœtus to which I have referred, and which fall to be considered in this chapter. Whether it is as yet profitable (in view of the scanty knowledge we possess) to consider them at all is of course a matter of opinion; but, "deliberando sæpe perit occasio," and, after all, it is but a question of a few pages, which the reader may pass over if he so please. At the end of the chapter an attempt will be made to give some cohesion to the various statements which have been considered.

Fœtus in Maternal Eclampsia.

It has been constantly observed that in cases of maternal albuminuria and eclampsia the chances of the fœtus being born alive and surviving birth are very few. When we attempt to go beyond this single observation we plunge at once into a veritable jungle of theories, hypotheses, isolated statements, coincidences, and physiological and pathological assumptions, among which one may long wander looking for the light. It is not possible, with our present knowledge, to find a pathway right through this jungle, at best we can only hope here and

there to find traces of a more or less beaten track ending blindly. Let us try to follow up for a little way one or two of these "blind alleys."

We may commence with the assumption that eclampsia is due to retention of urea in the blood of the pregnant woman; then, in the experimental scientific mind, the suggestion at once arises that, by injecting urea into a pregnant animal, the observer may be able to produce in the fœtus the same morbid changes as are met with in the human fœtus in eclampsia gravidarum. Accordingly, A. Charpentier and L. Butte (*Nouv. arch. d'obst. et de gynéc.*, ii. 397, 1887) made an injection of urea into the jugular vein of a pregnant rabbit; they found urea in excess in the tissues of the fœtuses, and the fœtuses died before the mother; they concluded that the fœtal death was due to rapid accumulation of urea in the unborn infant. But evidence in support of the view that the maternal eclampsia is due to an excess of urea in the blood is unfortunately not forthcoming; in fact, there is evidence of the opposite kind, for the blood of women in eclampsia has been found sometimes to show no excess of urea and their urine to show no diminution (or only a very slight fall) in that constituent. The physiological basis of the experimental work is therefore insecure. It is not a road likely to lead us out of our theory-jungle; it is a *cul-de-sac.*

In another direction it may be possible to make some progress. Let us examine the morbid anatomy of the fœtuses of eclamptic and albuminuric patients. The findings are various. Sometimes the fœtus dies in utero and is born macerated, and then the specimen is next to worthless for pathological purposes, for the post-mortem changes mask those due to the toxins (if such indeed exist). Sometimes the fœtus is born dead, but under circumstances which justify us in stating that it was the obstetric interference undertaken on behalf of the mother that killed the infant. Again, the infant may be born prematurely and succumb from congenital debility or want of the mother's milk; then there will be the histological peculiarities of prematurity existing side by side perhaps with those due to the maternal disease. Again, the fœtus may be born recently dead and in a contracted state: this may mean that the infant has suffered like his mother from eclampsia; it may also mean nothing more than rigor mortis. Yet again, the infant may be born alive, may show albumin in the urine, and may later develop convulsions, and then die; but albuminuria of the new-born is not uncommon quite apart from the history of maternal eclampsia, and convulsions in an infant are not, of course, always of renal origin. It is even thought that the infants of albuminuric mothers may live, exhibiting no other peculiarity than a tendency to develop nephritis when attacked by scarlet fever, etc. (Fieux, *Journ. de méd.*, July 25, 1899). But, it may well be asked, what facts are there regarding the morbid anatomy of the fœtus of an eclamptic mother? It may be answered that such fœtuses are generally under weight, even if born at the full term. This fact I have noted myself, more particularly in a case which I saw in consultation with Dr. Robert Stewart in December 1891. In that case, also, there was some atrophy of the liver, some congestion of the

kidneys, and a considerable meningeal hæmorrhage over the left side of the cerebrum. It cannot be said, however, that the internal changes met with in these fœtuses of eclamptic or albuminuric mothers are by any means constant, far less pathognomonic. Several observers have worked in this field of morbid anatomy, and their labours have been summarised by E. Alfieri (*Ann. di ostet. e ginec.*, xxii. 1077, 1900); some found hæmorrhages in the kidneys, in the convoluted or collecting tubules, or in Henle's loops; others found hæmorrhagic foci in both the liver and kidneys; others described degenerative changes in the renal epithelium and exudations into the glomeruli; others met with blood effusions into the cranial cavity and the spinal canal; and yet others detected changes in the liver, such as extra- and intra-lobular dilatation of vessels, atrophic and rarely fatty degeneration of the hepatic cells, hyaline thrombi in the blood vessels, etc. Manifestly many of these alterations were to be regarded as the results of traumatism in labour, some of them were possibly normal, and all of them were irregular in their occurrence. Alfieri (*loc. cit.*) himself made a painstaking investigation of the subject, and examined carefully twenty-two fœtuses, five of which came from eclamptic mothers, ten of which were cases of asphyxia neonatorum due to various causes, and the remainder were the offspring of mothers with albuminuria, typhoid fever, etc. In the fœtuses born of eclamptic mothers he found, with a certain degree of frequency, particular alterations in those organs which are usually affected in the mothers, namely, liver, kidneys, and supra-renal capsules. These alterations, however, were not constant, nor exclusive; neither were they characteristic of eclampsia. Further, although it was possible that they contributed to determine the death of the fœtus, it was more probable that they were simply the expression of a particularly toxic state, and that, in certain instances, other circumstances (*e.g.* broncho-pneumonia, cerebral hæmorrhage, etc.) might be superadded to cause the fatal issue. Similar changes were found in the fœtuses of albuminuric women who did not develop eclampsia; and, finally, the fœtuses from cases of eclampsia may show no abnormal alterations. Obviously, in the present state of our knowledge, the morbid anatomy of these infants leads us to no useful conclusion; here is, then, another "blind alley."

Again, there has of late been advanced a somewhat novel theory of the origin of eclampsia, to wit, the *fœtal* theory. According to this view, it is not the maternal liver or the maternal kidneys that are to be blamed for the supervention of the convulsions of pregnancy, but the fœtal organism or its annexa. It is thought that by the reverse current, to which allusion has already been made, toxins and toxinic products find their way from the fœtus to the mother, and produce in her such a toxic condition that eclampsia supervenes. The theory, as thus stated, will hardly commend itself; but it is quite possible that if the mother's liver and kidneys be inadequate, the arrival from the fœtus of an extra quantity of toxinic products may turn the scale already inclining towards the dreaded eclampsia. But it may quite well be argued that the maternal hepatic and renal inadequacy have led to the state of fœtal toxæmia, which in its turn

reacts upon the health of the mother. Here, then, is a vicious circle of cumulative cause and effect. No "blind alley" in our jungle of theories is this, but a wandering in a circle with obfuscating effects. For, when we come to examine the "fœtal" theory of origin of eclampsia more closely, it is found to rest upon a clinical observation, namely, the disappearance of the maternal albuminuria after the intra-uterine death of the fœtus; but it is now known that fœtal death is by no means constantly followed by disappearance of the albumin in the urine. In fact, R. Jardine (*Internat. Clinics*, 11 s., ii. p. 27, 1901) records two cases in which the fœtus was not only dead but macerated, and yet the urine contained albumin, becoming, in one instance, nearly solid on boiling.

Again, there is the state of the placenta in albuminuria and eclampsia to be considered. What effect may alterations in it produce upon the fœtus? It is well known that placental hæmorrhages are common in cases of albuminuria, and they are met with in eclampsia, but apparently only in the cases which have been preceded by albuminuria. May not the hæmorrhage allow toxinic products to pass more freely from mother to fœtus or from fœtus to mother, causing fœtal death and maternal eclampsia? It is quite possible. But if the hæmorrhages be slight and their occurrence infrequent, a fibroid condition of the placenta may be produced, which will prevent the free passage of materials from mother to fœtus, and *vice versâ*; under such circumstances the fœtus will be unable to obtain oxygen or to get rid of effete products, and so will pass into a state of intrauterine asphyxia or of intrauterine uræmia. Doubtless there is a certain degree of truth in this view; the placental factor in these ill-defined morbid states, just as in syphilis, variola, typhoid fever, and the like, plays an important part. In this direction progress will no doubt ultimately be made; in the meantime this path also ends blindly!

Another line of investigation has recently suggested itself: since the effete products going from fœtus to mother and *vice versâ* must pass through the placenta, that structure ought itself to produce serious toxic effects. In order to test this conclusion, Palazzi (*Ann. di ostet. e ginec.*, xxiii. 237, 1901) carried out experiments on the toxicity of the placenta. He made a sterilised infusion of the placentas of five healthy women, and injected this into the circulation of a rabbit. One rabbit died of asphyxia, but two other rabbits showed no changes. Further, the one that died had a very large dose (2·70 c.c.). The placenta, therefore, is not toxic in the ordinary sense of the word.

The attempt has been made to connect maternal albuminuria and eclampsia with inadequacy of the maternal thyroid gland. M. Lange (*Ztschr. f. Geburtsh. u. Gynäk.*, xl. 34, 1899) pointed out that when the normal pregnancy-hypertrophy of the thyroid was absent, albuminuria was very commonly present. Theoretically, it may be supposed that the function of the thyroid, and possibly of the parathyroids also, is to regulate body-metabolism and to keep within bounds the quantity of toxins circulating in the blood. In pregnancy it is evident there will be a special need for such a regulating influence;

hence the hypertrophy. Failing the hypertrophy, toxins will accumulate and will throw a heavy strain upon the kidneys; if these organs chance to be inadequate, eclampsia may follow. Oliphant Nicholson (*Scott. Med. and Surg. Journ.*, viii. 503, 1901) has elaborated this view, and has recommended and tested thyroid feeding as the line of treatment in such cases. The matter is still *sub judice*. It has been suggested that when the maternal thyroid fails the fœtal thyroid may take on a greater activity. Be this as it may, there can be no doubt that it will be wise in future *post-mortems* to examine very carefully the state of both the maternal and fœtal thyroid.

Fœtus in Maternal Cancer.

When a woman far advanced in cancer becomes pregnant, what, it may be asked, is likely to be the state of her unborn infant? In a case reported by Levaditi and Paris (*Journ. de physiol. et de path. gén.*, i. 490, 1899), the mother was in a state of marked cancerous cachexia when her child was born; it died in six weeks, and during its short life it had a subnormal temperature and evident wasting; and at death the viscera showed a general streptococcic infection with a predominance of the hepatic lesions. The authors believed that on account of the mother's illness the child was born with its tissues predisposed to afford a suitable nidus for the microbes which are always present on the skin and mucous membranes, but which are not always so virulent in their action. In S. Macvie's case (*Trans. Edinb. Obst. Soc.*, xxiv. 130, 1899), also, the infant died at six weeks, possibly from the same cause; but in this instance there was prematurity of birth to be taken into account. L. X. Bourgeois (*De l'influence des maladies de la femme pendant la grossesse sur la constitution et la santé de l'enfant*, p. 394, Paris, 1861) collected details of eleven pregnant women suffering from cancer: four gave birth prematurely to dead-born infants; one was confined at term of an infant that died on account of the necessary obstetrical interference; the remaining six were delivered of weakly infants, three of which succumbed to marasmus, one died of convulsions, and two survived, one of whom showed signs of struma. Statistics in greater amount are sadly needed, bearing upon this important matter; in the meantime, it may be pointed out that both the maternal cachexia and anæmia may have an injurious effect upon the fœtus in utero. What form the maleficent influence will take we are not at present able to say. It must not be forgotten that the cancerous mother may have children who become cancerous when they become adults; whether, however, this tendency towards malignancy is due to the passage of toxins from the mother to the fœtus in the fœtal and embryonic epochs, or to inherent peculiarities in the ovum in the germinal period of antenatal life, must be left unanswered, but the latter hypothesis is more in favour at the present time. There is an antenatal aspect of the cancer problem just as there is of the consumption question,—an aspect, however, not at all clear nor likely to be clear for some time to come; at present the microbic or parasitic theory has

the wind in its sails, while the theory of the predisposed soil is fallen upon light and variable airs, if it be not altogether becalmed.

Fœtus in Maternal Diabetes.

I have already referred (p. 223) to the supposition that diabetes mellitus might be transmitted as such from mother to fœtus; of this there is no sufficient proof, although the recently reported observation of Chambrelent is strongly suggestive (*L'Obstétrique*, vi. 276, 1901). It was the case of a 4-parous woman whose three first pregnancies had ended in abortions; just before the commencement of her fourth pregnancy it was discovered that she was suffering from diabetes mellitus. During the first three months of gestation the sugar diminished in amount, but thereafter it increased, attaining to 34 grammes per litre. Under antipyrin it fell to 16 grammes per litre at the time of the confinement. The infant weighed 3600 grammes, and had to be resuscitated; its urine on the eighteenth day of life contained over 2 grammes of sugar per litre, but on the twenty-fifth day there was no trace of it.

Apart from the transmission of diabetes, *per se*, to the fœtus, there is sufficient evidence to show that this disease in the mother has disastrous consequences for the unborn infant. In 1882, Matthews Duncan (*Trans. Obst. Soc. Lond.*, xxiv. 256, 1883) gathered together the histories of twenty-two pregnancies in fifteen women suffering from diabetes, including personal observations (three in number) and cases by W. L. Reid, Newman (2), John Williams (2), Lecorché, A. Husband, Bennewitz, Winckel, Davidson, Frerichs, and Seegen. There were four maternal deaths. In seven out of the nineteen pregnancies the child died in antenatal life after having reached a viable age, and in two more it succumbed within a few hours of birth. Hydramnios was frequent, and in Husband's and probably in Reid's case there was sugar in the liquor amnii. Some of the dead infants evidently showed other than mere macerative changes; for instance, the child, a female, in Bennewitz's case weighed twelve pounds, and in one of Duncan's cases the infant was "enormous." In seven pregnancies in women with diabetes, reported by Lecorché (*Ann. de gynéc.*, xxiv. 257, 1885), all save one went to the full term; of the infants, one died in two days, a second succumbed to hydrocephaly at the twenty-first month, a third also had hydrocephaly along with a double congenital hydrocele, and two others were very delicate. From a larger number of observations, Ch. Vinay (*Traité des maladies de la grossesse*, p. 796, Paris, 1894) found that pregnancy was interrupted in from 36 to 37 per cent., while the infants died in 48 per cent. of the cases. The interruption of pregnancy is probably to be accounted for by morbid changes in the uterine mucous membrane (Vinay). An interesting case was reported by Charrin and Delamare (*Progrès méd.*, p. 21, ii. for 1901), in which a woman suffering from diabetes was attacked with eclampsia during labour; the liver of the fœtus exhibited changes similar to those seen in eclampsia, while the blood was like that of diabetic patients (red blood corpuscles were

stainable by magenta red, etc.); the authors explained these fœtal changes on the supposition that the special morbid agencies of both diabetes and eclampsia had forced the placental barriers and attacked the tissues of the unborn infant.

Fœtus in Maternal Leukæmia.

One of the most interesting of the pathological inter-relationships between mother and fœtus is that met with in maternal leukæmia or leucocythemia. Apparently the leukæmic state of the mother has little or no effect upon the blood of the fœtus. At the same time it must be borne in mind that very few cases are on record in which a woman suffering from leucocythemia has become pregnant—six well described cases in all, according to Vinay (*op. cit.*, p. 801). One of the most interesting observations was that made by James C. Cameron (*Internat. Journ. Med. Sc.*, n. s., xcv. 28, 1888). The patient had a splenic tumour during her sixth pregnancy, but it was while she was carrying her seventh child that she became seriously ill. At the seventh month of this pregnancy her red blood corpuscles only amounted to 1,070,000 per c.mm., and there was one white for every ten red; she suffered greatly from dyspnœa and attacks of epistaxis. Premature labour occurred, not a drop of blood was lost, but there was the usual amount of liquor amnii. She recovered. The infant, a female, weighed 4½ lbs., and measured 18½ inches in length; it was apparently strong, and throve nicely for the first day; but on the second day the mother put it clandestinely to her breast; it sickened at once, developed a purpuric rash, and died on the fourth day. Two hours after birth the maternal and infantile bloods were as follows: maternal blood 990,000 red corpuscles to the c.mm., fœtal blood 5,210,000; maternal blood 1 white corpuscle to 4 red, fœtal blood 1 white to 175 red. The placenta was carefully examined: there was something special in its appearance; the blood in the sinuses seemed thin, pale, and watery, that in the placental vessels was of a dark rich colour, only slightly clotted. In the umbilical vein there were 4,610,000 red corpuscles per c.mm., and 1 white to 173 red; in the umbilical artery there were 5,400,000 red corpuscles per c.mm., and 1 white to 270 red; but in the placental sinuses there were only 950,000 red corpuscles per c.mm., and 1 white to 3½ red (*circa*). In the fœtal blood nucleated red cells were present, but not in abnormal numbers. The autopsy of the infant revealed nothing of note: the thymus and thyroid were normal, the spleen was not enlarged, and the bone marrow was red and abundant everywhere. An interesting point in the history of this remarkable case is that several of the earlier children of this woman seem to have been leukæmic, and her mother, grandmother, and brother seem to have been affected with the same disease. Obviously, however, the fœtus of the seventh pregnancy was not leukæmic.

In Sänger's case (*Arch. f. Gynaek.*, xxxiii. 171, 1888) also, the infant, a female, was born alive; it showed no enlargement of the spleen or liver; the blood from the umbilical cord had normal

characters; and six months later the child was thriving well and showing no indications of leukæmia. R. Paterson (*Edinb. Med. Journ.*, xv. 1073, 1869–70), in three cases of leukæmia in pregnancy seen by him, remarked upon the healthy state of the infants at birth. Sometimes, however, the pregnancy is interrupted (G. E. Herman, *Brit. Med. Journ.*, ii. for 1901, p. 1085), and then the infant may succumb. Further, there is some evidence that a toxic product may occasionally pass to the fœtus and cause its death (E. Kirstein, *Dissertation*, Königsberg, 1893). So far, then, as our present knowledge carries us, the leukæmic mother does not give birth to a leukæmic infant. This is a fact of some importance, for fœtal leukæmia exists as a morbid entity, and instances of it have been reported by Klebs (*Prag. med. Wchnschr.*, iii. 489, 509, 1878), Sänger (*Centrlbl. f. Gynäk.*, v. 371, 511, 1881; *Arch. f. Gynaek.*, xxxiii. 198, 1888), Siefart (*Monatschr. f. Geburtsh. u. Gynaek.*, viii. 215, 1898), and L. Pollmann (*München. med. Wchnschr.*, xlv. 44, 1898); but in none of these was the mother leukæmic (in Sänger's and Siefart's cases she had nephritis, in Pollmann's she may have suffered from an infectious process in pregnancy, and in Klebs' she seems to have been quite healthy). It has been rather hurriedly concluded that proof is thus afforded that leucocytes cannot pass the placental barriers; but, as we have seen (p. 142), there is evidence that the contrary is sometimes the case. It may at any rate be reasonably believed that morbid conditions of the maternal blood are not immediately reflected in the state of the fœtal; and observations on anæmic pregnant women (p. 139) support this conclusion, for in them the blood of the unborn infant, although exhibiting some slight poverty in red cells, is by no means anæmic.

Fœtus in Maternal Heart Disease.

Heart disease in the mother is not infrequently productive of premature labour and abortion; sometimes also there is hydramnios, more especially in the cases which are complicated by albuminuria. According to Durozier's statistics (*Arch. de tocol.*, ii. 577, 1875), the pregnancies of forty-one women suffering from heart disease ended in twenty-one miscarriages and dead-births, in five premature labours at six months, and in thirty-seven living infants who died before the age of four years; but these figures no doubt give too gloomy an impression of the effects of these maternal maladies. Vinay (*op. cit.*) met with thirty-two infants, the progeny of women with heart disease, and they were nearly all born alive at the full term. The presence or absence of cardiac compensation must, of course, markedly influence the results. Martel (*Thèse*, Paris, 1896) has endeavoured to discover the condition present in the delicate infants of women suffering from heart disease, tubercle, pneumonia, etc., and has come to the conclusion that their slow increase in weight and frequent untimely death are due to disturbed cellular interchanges represented by an excessive excretion of urea (azoturia); their cells do not fix and retain the substances necessary for their

vegetative life. Such an infant "est un filtre qui laisse passer en grande partie les matières assimilables." The defects in assimilation in their turn are possibly due to toxins which pass from the mother to the fœtus, traversing the placenta. Thus is produced one of those ill-defined morbid states of the fœtus with which this chapter deals.

If it were profitable, some space might be given to the consideration of the state of the fœtus and new-born infant in cases of maternal gout, osteomalacia, gôitre, jaundice, myxœdema, and the like; but it is not profitable, for the facts are far too scanty. At the same time, there is no reason to doubt that progress will yet be made in the investigation of these matters, and that results of value in estimating the influence of maternal upon fœtal conditions will ere long be forthcoming. It would, for instance, be of great interest if we could obtain reliable observations upon the maternal and fœtal blood in one of the rare cases in which a hæmophilic mother gives birth to a hæmophilic infant. Elsewhere (126A), I refer at length to a hæmophilic woman who gave birth to two hæmophilic male children; in her third pregnancy she was put under medicinal treatment, and gave birth to another male infant, and in it there were no signs of hæmophilia. It is difficult to know what to say about such cases, for they are usually quoted as instances of truly hereditary diseases (*i.e.* as morbid states transmitted from parents to children prior to conception); but it is just possible that the maternal influence may be exerted upon the fœtus during the whole period of its antenatal life, and that the so-called hereditary diseases may be in part the result of toxinic activity going on during the fœtal epoch. This matter, however, will again fall to be discussed (*vide* Pathology of the Germ).

Conclusions.

Can we draw any conclusions regarding these ill-defined morbid states of the fœtus which are associated with maternal diseases? Any conclusions at any rate worth drawing? It is doubtful; but the following cogitations may at least be recorded:—

In the first place, it is quite evident that the mother may be seriously ill with diabetes, cancer, leukæmia, heart disease, and even eclampsia, and yet the fœtus be born alive and apparently well. In such instances the infant may even survive birth and show no weakness and no anomaly of assimilation. At first sight, these facts are startling, in view of what has been written about the passages of microbes and toxins from mother to fœtus; but a little reflection will serve to dispel some of the surprise. With even the most easily transmitted malady (*e.g.* smallpox), cases are on record in which apparently no transmission took place; and no great stretch of imagination is required to admit that the same (or a similar) mechanism which prevents the passage of the definite disease (*e.g.* smallpox) may prevent also the passage of the products which set up the ill-defined morbid state. Probably it is an easier matter to save the unborn infant from one form of maternal morbid influence

than from another; but that is a matter of degree which does not affect the validity of the main proposition.

In the second place, it is exceptional to find the maternal morbid state (*e.g.* gout, cancer, eclampsia) reproduced as such in the fœtus. But, again, this ought to excite no great surprise, for the conditions of fœtal life are not such as to predispose to morbid changes, which occur by choice in adult and even in senile tissues; even the new-born infant and young child does not take cancer and gout and eclampsia in the same way as its parents. Some ill-defined morbid state is just the result which ought to be looked for in the fœtus; it may be a disease, or a malformation, or an anomaly of physiological reaction, or a predisposition to develop a disease differing from or resembling that existing in the parent. In a fatal case of eclampsia which was under my care in the Edinburgh Maternity Hospital in April 1901, the mother perished two hours after delivery, having had complete suppression of urine for several hours; the fœtus, which died in birth, had a urinary bladder reaching as high as the umbilicus, distended with limpid urine. This is but one of many illustrations which might be given of the dissimilarity of maternal and fœtal morbid states. *The dissimilarity, however, does not disprove a connection.*

In the third place, the commonest result in the fœtus of these various maternal maladies probably is fœtal death. The fatal issue may be due to the premature termination of the pregnancy, or it may occur quite independently from pathological alterations in the fœtus, or more commonly in the placenta. In the latter case, the unborn infant is the subject of an auto-intoxication, due to the accumulation in its tissues of carbonic acid, and possibly of other effete materials (*vide* Fœtal Death). If the cases of fœtal death be excluded from consideration, the majority of the remainder will probably consist of the infants born weakly, who lose weight, or at least do not gain any for two or three weeks, and then die either "de rien" or of some intercurrent disease which, under other circumstances, would probably be recovered from.

In the fourth place, it would seem that in these ill-defined morbid states are antenatal conditions which it may yet be found possible to prevent, or to some extent ameliorate, by appropriate antenatal treatment. It is not always possible to save these infants after birth, but might not medicinal treatment of the mother, prior to birth, enable the placenta always to do what it apparently sometimes spontaneously does, namely, prevent the transmission of toxins or toxinic products to the fœtus?

CHAPTER XVII

Idiopathic Diseases of the Fœtus—Types: General Fœtal Dropsy—Definition, Clinical History, Symptomatology, Morbid Anatomy, Etiology, Pathogenesis, Diagnosis, Treatment; General Cystic Elephantiasis of the Fœtus—Definition, Clinical History, Morbid Anatomy, Pathogenesis; Congenital Elephantiasis—Definition, Clinical History, Symptomatology, Physical Signs, Pathogenesis, Treatment; Congenital Myxœdema; Atrophic States of the Subcutaneous Tissue.

THE so-called idiopathic diseases of the fœtus constitute a large, but, as I believe, a diminishing group of antenatal maladies. As more accurate knowledge is acquired regarding these morbid states, there can be no doubt that one and another of them will find their way into the groups of the transmitted diseases, toxicological conditions, and ill-defined toxinic states with which the last five chapters have dealt. Further, there arise serious difficulties of definition and classification in connection with this matter, for it is almost impossible to draw a hard and fast line between transmitted and idiopathic fœtal states. For instance, we have seen how a fœtus may be born with smallpox upon it, although the mother was free from that fever during her pregnancy. In which group are we to place this case, among the transmitted or the idiopathic? The mother, we must suppose, transmitted something to the fœtus; on the other hand, the fœtal tissues alone reacted in the characteristic manner. Again, there is a large mass of evidence to show that syphilis, and possibly other morbid conditions, may arise in the fœtus through paternal influence or through maternal influence prior to conception. Are these to be regarded as transmitted? They are commonly called hereditary. Are we then to have a third group to contain the hereditary disease as distinct from the transmitted and the idiopathic? Is any such separation possible? I do not think it is; and I have elsewhere (*Trans. Med.-Chir. Soc. Edinb.*, n. s., xix. 114, 1900) given reasons in support of this contention. But it is unnecessary now to enter into this question; I admit that many of the idiopathic fœtal diseases may yet be found to be transmitted either in the post- or ante-conceptional period, and it is now my duty to describe some types of what are still provisionally regarded as idiopathic maladies of the unborn. I shall select types in the order in which they are placed on page 175.

General Dropsy of the Fœtus.

General dropsy of the fœtus was the disease which in 1887 first attracted my attention to the study of antenatal pathology; and since

that year I have had the extraordinary opportunity of examining eleven specimens of the malady, and have published the results of the examination of several of them (33, 49, 51, 61, 64, 148, and 161). In my work, *The Diseases of the Fœtus*, I have devoted eighty pages (vol. i. pp. 102–182) to the discussion of general dropsy of the fœtus. The result of all these opportunities and of all this writing is, that I now feel far less certain about the pathogenesis of the disease than I did shortly after I had examined my first specimen! Of this, however, I have become increasingly persuaded: general dropsy of the fœtus is not a pathological entity, but a group of structural alterations due to several different causes, and really representing several diseases in the ordinary sense of the word.

This being so, it is difficult to frame a satisfactory *definition* of general fœtal dropsy; but provisionally it may be described as a morbid condition of the fœtus, characterised by general anasarca, by the presence of fluid effusions in the peritoneal, pleural, and pericardial sacs, and usually by œdema of the placenta, and it results in the death of the fœtus or infant before, during, or very soon after birth. It is the "hydropisie généralisée du fœtus" of the French, and the "Haut-und allgemeine Wassersucht" of the German writers, and a common international name for it might be found in "hydrops universalis fœtus." The recorded cases date back to the seventeenth century; but it is comparatively rare, for I have only been able to gather together from literature some seventy cases between the years 1614 and 1898.[1] It is common, and indeed almost constant, to find a state of general œdema of the grossly malformed twin fœtus (acardiac, acephalic, and acormic), but that is not included among the cases of general fœtal dropsy properly so called.

The *clinical history* of cases of this fœtal malady offered several points of interest. The mother was nearly always well advanced in her child-bearing life, and in only seven out of sixty-five cases was her age less than thirty; in only one instance was she primiparous, in all the others she was a multipara, and had generally had a large number of pregnancies. For instance, in one of the cases reported by me (49) the mother was thirty-seven years of age, and her ninth, tenth, and twelfth gestations ended in the birth of dropsical fœtuses. This character of family prevalence or the repetition of identical morbid states in successive infants of the same parents has been noted in several of the clinical histories (cp. Nachtigäller, *Dissert.*, Berlin, 1896). The maternal health seems to have been often bad; but it was generally of an ill-defined character ("delicate," "weakly"), and in only two or three instances was any special disease, such as syphilis, recognised. The previous obstetric history was often bad also; for instance, in Protheroe Smith's case (*Trans. Obst. Soc. Lond.*, xvii. 303, 1876) the first child was a healthy male, then came two miscarriages at the third month, then a healthy full-time female, then an abortion at the sixth week, a full-time female that was jaundiced and died in three days, then a still-born female at the twenty-sixth

[1] The bibliographical list will be found in the *Diseases of the Fœtus*, vol. i. pp. 160–164; and vol. ii. p. 235.

week, then a still-born male also at the twenty-sixth week, and finally the dropsical fœtus at six and a half months. The previous pregnancies generally differed very considerably in their characters, but agreed in being morbid in one way or another (premature delivery, abortion, dead-birth, congenital debility of infant, hydrocephalus, jaundice of the new-born, etc.). Sometimes, but rarely, the paternal medical history was referred to; in Seulen's case (*Neue Ztschrft. f. Geburtsk.*, ii. 17, 1835) the father suffered from jaundice and dropsy; in Fuhr's (*Dissert.*, Giessen, 1891) he was an alcoholic; and in one of my cases (49) he was markedly anæmic. The history of paternal syphilis is remarkable by its absence.

The *symptomatology* of the pregnancy which ended in the birth of a dropsical infant was frequently noteworthy. Very often it terminated prematurely (fourth month to near the full term). The mother's health was seldom quite good, and usually she suffered from one ailment or another. Maternal dropsy, limited or widespread, was a comparatively common complication. The unusually great degree of abdominal distension, a condition due in part to the large size of the fœtus and placenta and in part to the frequently occurring hydramnios, was also often noted; and in some cases there was albuminuria, and in others anæmia. Hepatic derangements, bronchitis, malaria, alcoholism, and heart disease were met with, but in isolated instances as a rule; and in the great majority of cases maternal syphilis was pointedly excluded. With regard to fœtal symptomatology, the only recorded fact was the occasional statement that the fœtal movements were feeble.

The birth of a dropsical infant was, if near the full term, a tedious and often an instrumental matter. Abnormal presentations were unusually common. The delay in labour was sometimes overcome by the natural efforts and sometimes by manual or instrumental traction; but in certain instances the procedures which were finally adopted before birth (in fragments) was effected, reached the utmost limits of embryulcia, evisceration, disruption, and dilaceration. In some cases the medical attendant seems to have lost all nerve, as first one limb and then another, and then a fragment of the trunk or the head, was dragged to light from the maternal passages. When, however, the fœtal abdomen, being within reach, was tapped, it was seldom found necessary to resort to such embryoclastic procedures. The third stage of labour was often rendered somewhat difficult on account of the large size and dropsical state of the placenta, and by reason of uterine inertia due to delay in the earlier stages. The puerperia, it is noteworthy, were generally quite normal; in fact, the rapid disappearance of many of the maternal symptoms, immediately after the emptying of the uterus, suggested the conclusion that the fœtal condition was often the cause rather than the result of the mother's ill-health.

The postnatal clinical history of the dropsical infant was chiefly remarkable for its abbreviation. Often the fœtus escaped antenatal only to meet intranatal death, and if, by any chance, he came into the world alive, it was seldom that the lungs could act properly, on account of the fluid accumulations in the thorax and abdomen. In

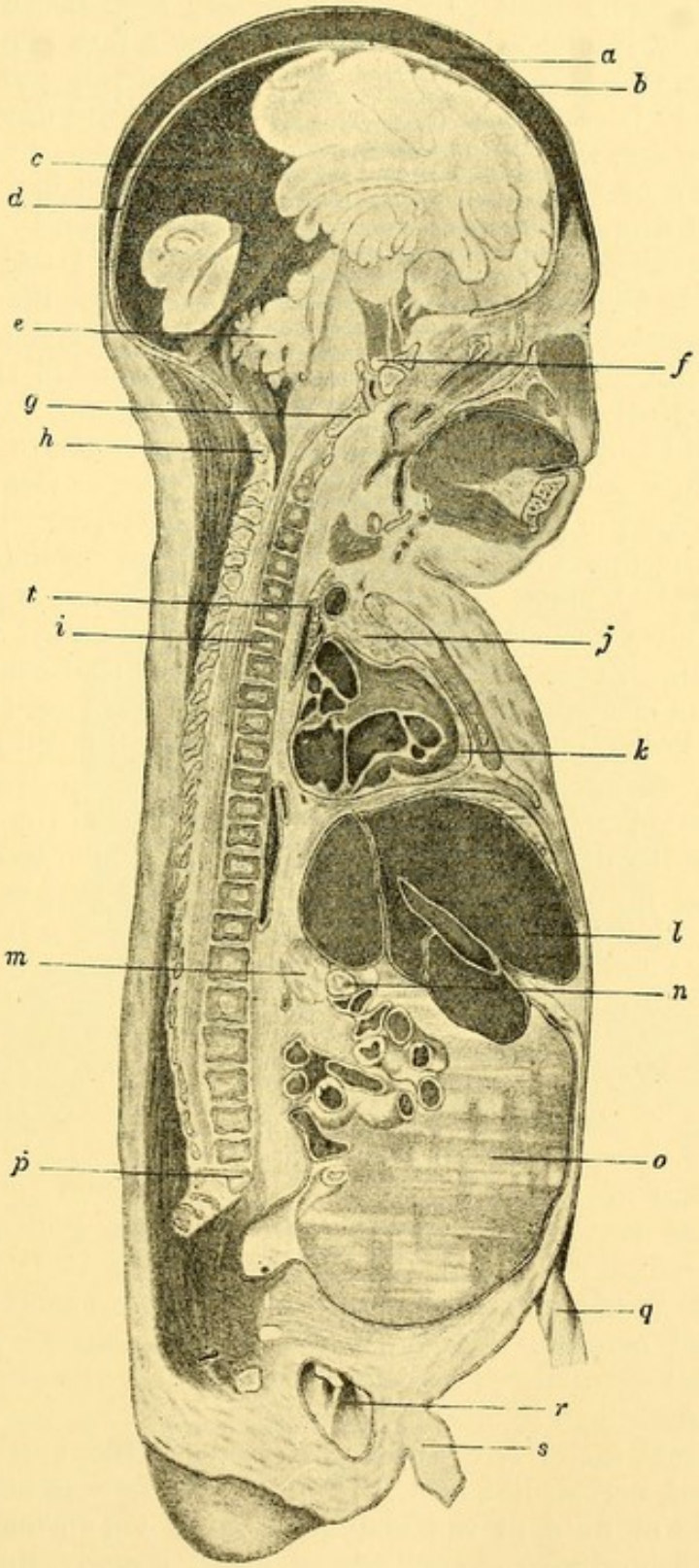


FIG. 30.

Vertical Mesial Section of Fœtus with General Dropsy, left face shown. (½ natural size.)

a, Anterior fontanelle; *b*, Œdematous scalp tissue; *c*, Hæmorrhage in falx cerebri; *d*, Posterior fontanelle; *e*, Cerebellum; *f*, Pituitary body; *g*, Basi-occiput; *h*, Posterior arch of atlas; *i*, First dorsal vertebra; *j*, Thymus gland; *k*, Fluid in pericardium; *l*, Liver; *m*, Pancreas; *n*, Pylorus; *o*, Fluid in peritoneum; *p*, First sacral vertebra; *q*, Umbilical cord; *r*, Tunica vaginalis testis; *s*, Penis; *t*, Trachea.

one case (Seeger, *Miscell. Acad. nat. curios.*, Dec. i., Ann. i., p. 132, 1670), however, life lasted a few days, and for a few hours in a few other instances; but generally the potential mortality of this intra-uterine malady became real at birth. *Stat sua cuique dies!* "Water-babies" these are, with a brief tenure of life!

The study of the *morbid anatomy* of the recorded instances of general fœtal dropsy reveals some alterations common to all the cases and some peculiar to one or two. I believe that I was the first (in 1887) to study the pathology of this fœtal malady by means of frozen sections, a method which materially assisted in clearing up certain doubtful points. The appearances presented by one of the slabs (the left) of a vertical mesial section are shown in Fig. 30.

The weight and measurements of the fœtus were not often recorded; but, when they were noted, they were always larger than they ought to have been for the period of antenatal life arrived at. The abdomen especially was apt to have a greatly increased circumference. A general dropsical state of the subcutaneous tissue was the most evident and most constant macroscopic condition, and it was noted in all the recorded cases. It was sometimes stated that certain parts of the body were specially dropsical, *e.g.* the scalp, the face, the abdomen, the limbs; but sometimes there was an equally diffused œdema. Usually the effusion was serous in type, but sometimes it resembled partly congealed gelatin, a condition possibly due to the undeveloped or mucoid state of the subcutaneous tissue when attacked by the œdema. The fluid oozed freely from superficial cuts or tears in the integument, and I have several times noted that if a fœtus showing this disease were left overnight on a plate, its bulk was greatly reduced in the morning. Virchow (*Arch. f. path. Anat.*, xxii. 426, 1861) found albumin, but no sugar, in this fluid in one case. The subcutaneous œdema may sometimes be so great as to cause great deformity, as a glance at Fig. 31 (which represents the head of a dropsical fœtus examined by me in May 1893 (61), which had occurred in the practice of Dr. F. W. Mann of Ashton-under-Lyne) will immediately and convincingly prove. The skin has a dusky red, livid, coppery, or sometimes a pink colour. There is great friability of the tissues, particularly of the subcutaneous but also sometimes of the muscular and osseous. It is to this character that we must ascribe the piecemeal extraction of the fœtus which has occasionally been so graphically described by obstetricians.

In the great majority of the reported cases the presence of fluid in the pleural, pericardial, and peritoneal cavities was noted (Fig. 30). The presence of fluid in the abdomen was a very constant feature; and the effusion was described as clear, straw-yellow, brownish yellow, olive-green, clear green, citron, or brownish in colour, and transparent in character. Sometimes flakes of lymph were found floating in it; sometimes it was albuminous; and in one of my cases there was some bile pigment and a very small proportion of proteids. Hydrothorax and hydropericardium were also very common; and in a few instances hydrocele and hydrocephalus existed. The appearances presented by the viscera were far from uniform, and indeed

varied within wide limits; but the most frequently recorded character was a general bloodlessness (*e.g.*, of the liver, brain, heart, and thymus). Further, in a few cases, disease or malformation of the heart was noted; in Virchow's case (*loc. cit.*) there was transposition of the great vessels, defect in the interventricular septum, and signs of fœtal endocarditis; in Lawson Tait's (*Trans. Obst. Soc. Lond.*, xvii. 307, 1876) there was a closed state of the foramen ovale with wide patency of the ductus arteriosus; and in R. Pott's (*Jahrb. f. Kinderhlk.*, xiii. 11, 1879) there was persistence and stenosis of the truncus arteriosus communis. A diaphragmatic hernia, leading, it was supposed, to compression of the inferior vena cava, was noted by

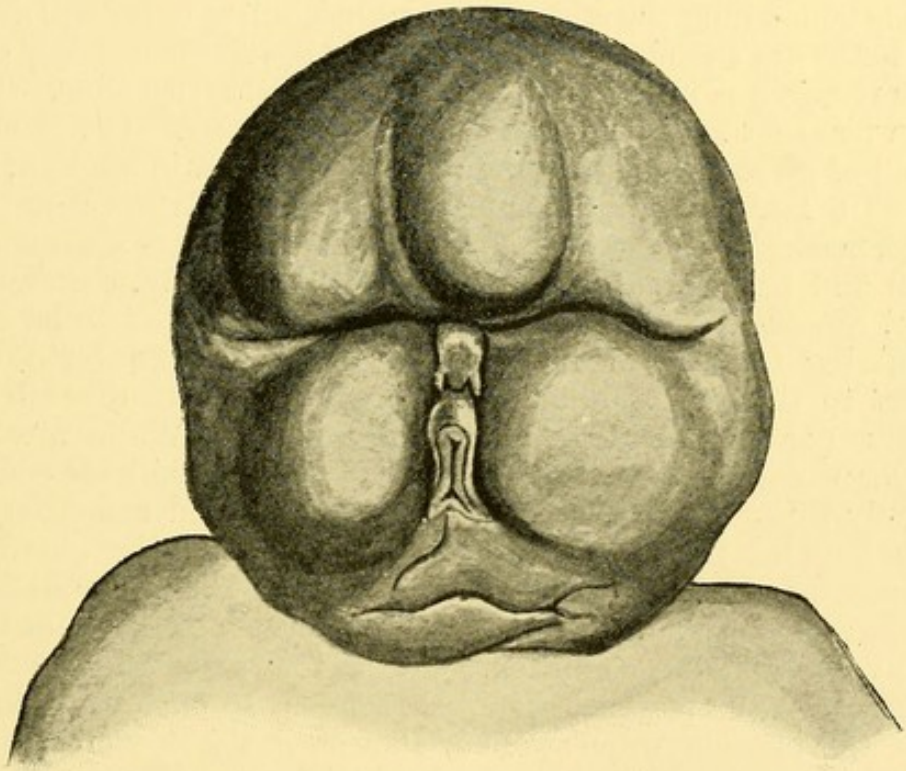


FIG. 31.—General Dropsy of the Fœtus.

C. Behm (*Ztschr. f. Geburtsh. u. Gynäk.*, ix. 197, 1883). Signs of peritonitis were found in six cases (out of sixty-five); it was therefore relatively uncommon, for the presence of fluid in the peritoneal cavity could not of itself be taken to imply inflammation. The liver had no constant appearances ("large," "small," "anæmic," "congested," "soft and friable," "firm and cirrhotic"); and the spleen varied in much the same way. In some cases the kidneys appeared normal to the naked eye, in others they were finely granular, in others they were the seat of cystic degeneration, and in others they were small, soft, and pale; but in most of the records no description at all is given of them. The intestines were generally small, contracted, and with a short mesentery. There was a uterus septus with vagina duplex in one of E. Hönck's dropsical fœtuses (*Dissert.*, Kiel, 1887); and in a few cases it was noted that the bones were friable.

In very few instances was there any record of the microscopic

appearances of the tissues. In one case, that reported by E. Schütz (*Prag. med. Wchnschr.*, iii. 449, 1878), there existed the histological changes in the vessels and organs which are usually regarded as characteristic of fœtal syphilis; and the mother also showed signs of syphilis. In a few cases a leukæmic or leukæmoid condition was discovered, and in my own cases (49) there was some indication of this. There was an excess of white corpuscles in the blood and in all the organs, but especially in the kidneys there were numerous accumulations of leucocytes. Sänger (*Arch. f. Gynaek.*, xxxiii. 198, 1888) considered that the instance of fœtal dropsy seen by him was really of the nature of congenital splenic or splenomyelogenous leukæmia. It is doubtful whether the few details available concerning the microscopical appearances in general anasarca of the fœtus are sufficient to warrant any conclusions being drawn; further research is imperatively demanded in this direction.

The placenta had somewhat constant characters. It was of large size, and of great weight (3 lbs. in one case, 3½ lbs. in another, and as much as 6 lbs. in a third); and it was nearly always soft in consistence, markedly œdematous, and easily torn. It was also commonly anæmic and pale, almost fleecy white in colour. W. Jakesch (*Centralbl. f. Gynäk.*, ii. 619, 1878), with what he admitted to be a somewhat daring freedom of imagination, compared the birth of the placenta to the slow rolling forth of wool from an overfilled torn woolsack ("dem langsamen Hervorwälzen von Wolle aus einem überfüllten angerissenen Wollsacke"). The umbilical cord was commonly thick and œdematous, often friable, and sometimes irregularly inserted into the placenta. In one case, the chorion and amnion were thickened; but it was seldom that any allusion to their characters was made. Hydramnios was a common but not a constant concomitant condition. In a few cases the microscopic appearances of the placenta were mentioned. In one of my cases the villi of the chorion were swollen, showed a slight increase in the amount of stroma, and had some degree of œdema in their epithelial covering. In Siefart's case (*Monatschr. f. Geburtsh. u. Gynaek.*, viii. 215, 1898) the villi were very large, the intervillous spaces were small and contained little blood, the stroma of the villi was œdematous, and the walls of the capillaries were thickened.

With general fœtal dropsy, as with all the so-called idiopathic fœtal diseases, the *pathogenesis* is very obscure, and even the *etiology* is imperfectly known. Doubtless, if the obscurity were less marked, the disease would be found to have passed out of the group of the idiopathic diseases into that of the transmitted morbid states. At the same time, it must be borne in mind that investigators have sometimes made these questions more difficult than need be. For instance, it has seldom fallen to the lot of one observer to examine more than one or two cases of the disease, and it has followed, naturally enough, that he has considered these cases as typical ones. Now, if a physician's knowledge of dropsy in the adult were limited to two or three cases, it is not likely that it would be at all sufficient. Further, there is no reason to expect that all cases of fœtal dropsy shall be due to one

and the same cause or shall present identical characters; in the adult, dropsy is a sign of various affections residing in various organs; the same state of things may hold regarding fœtal dropsy. Unfortunately these almost self-evident facts have not always been kept in mind.

According to some writers, the cause of fœtal dropsy is to be sought for in purely maternal states. Maternal alcoholism, maternal hydræmia, and maternal nephritis have all been adduced as possible factors. H. Strauch (*Dissert.*, Berlin, 1880) strongly advocated the theory of maternal nephritis: the mother had a contracted kidney, producing increased arterial tension and venous stasis; there was, therefore, increased pressure in the maternal portion of the placenta and an exudation of serum into the intervillous spaces, an occurrence further predisposed to by the hydræmic state of the maternal blood; the placenta being the place of least resistance, œdema occurred there even if not in the other maternal organs; and the blood coming from the fœtus in the umbilical arteries met with resistance in the placenta, which caused increased venous pressure and œdema in the fœtus. A purely paternal cause has been referred to tentatively by some writers, and it is a suggestive fact that the first four cases of the disease which I met with were the offspring of a woman and her sister-in-law, and both the woman and her brother showed the same gravely anæmic state.

According to other writers, the cause of fœtal dropsy resides in the fœtus itself, and the disease is truly idiopathic. Thus Lawson Tait (*loc. cit.*) thought that he had found the *fons et origo morbi* in premature closure of the foramen ovale; the closure was not complete, a crescentic valvular opening $\frac{1}{12}$-inch in size forming the communication between the two auricles. W. Osler (*Keating's Cyclop. Dis. Children*, ii. 752, 1889) found a very similar cardiac anomaly, but he could not recognise a very clear connection between the state of the heart and the fœtal disease. Other writers looked to the cystic state of the kidneys as the cause, obviously a very inadequate theory. G. Raineri (*Gaz. med. di Torino*, xliii. 21, 1892) considered that the œdema of the fœtus and placenta might be ascribed to the hindrance of the hepatic circulation and the obstruction of the renal secretion, due to the infiltration of these organs with leucocytes, for he regarded the state of the liver as similar to the interstitial hepatitis of the syphilitic fœtus. Abnormal states of the fœtal blood have been regarded by some as the causes of the dropsy, and perhaps the most popular of recent theories has been that of a "leukæmoid if not perfectly leukæmic" condition.

Finally, many writers, recognising the inadequateness of either the maternal or the fœtal causes, have sought for coexisting causal conditions in both mother and fœtus. Virchow (*loc. cit.*), for instance, found the immediate causes of the dropsy in narrowing of the pulmonary ostium of the heart, accompanied by cirrhosis of the liver and incipient granular degeneration of the kidneys. The state of the heart he ascribed to fœtal endocarditis, and this in its turn he sought to trace to syphilis or rheumatism in the mother, but could get no information

on the point. The thromboses in the maternal placental sinuses he regarded as a third series of disturbances, which by hindering the circulation in the fœtus tended still further to promote the general dropsy. Sänger (*loc. cit.*) regarded maternal nephritis as the primary cause; this set up leukæmia in the fœtus, not in a mechanical way, but because the hydræmic state of the mother's blood interfered with the normal formation of the fœtal. The leukæmia thus produced was the immediate cause of the dropsy, for the conversion of leucocytes into erythrocytes being interfered with, the former accumulated in the fœtal blood, escaped through the thin vessel walls, and formed lymphoid infarcts in the skin and glandular and other organs, and serum, escaping along with the leucocytes, caused œdema of these structures. Sänger considered that a similar transudation of serum took place in the fœtal part of the placenta, and that fluid passed from the vessels of the villi into the stroma. Fuhr (*op. cit.*), also, looked for a complex causation. He summarised the pathogenetic stages thus:—(1) Chronic maternal endometritis, intensified by nephritis; (2) hyperplasia of the chorionic villi due to decidual increase following upon the endometritis; (3) excessive absorption of fluid blood into the fœtal circulation (partly from maternal hydræmia), over-filling of the circulation in the fœtus, with resulting obstruction and œdema; (4) hydramnios, due to increased secretion from the fœtal kidneys, an increase, not, however, sufficient to overcome the obstruction; and (5) œdema of the placenta due to secondary obstruction in that organ.

It is of course quite clear from all that has been stated, that the pathogenesis of fœtal dropsy is obscure; it is probable also that its obscurity has been increased by neglect of a proper comprehension of the peculiarities of fœtal physiology. It would seem that it must, in the first place, be admitted that its causes are not always the same; as in postnatal so in antenatal life dropsy is a sign of various morbid states. Provisionally it may be supposed that general œdema of the fœtus may arise in the later months of fœtal life from maternal causes; possibly, conditions which increase the blood pressure in the placenta, by causing structural changes in its maternal and (secondarily) in its fœtal parts, may thus lead to backward pressure and transudation of serum in the fœtal body. Again, it may be supposed that in the early fœtal or late embryonic period structural anomalies may arise in the fœtus (heart, kidneys, liver, blood) which will directly produce the dropsy as it is produced in the adult, although with slight differences and exaggerations on account of the peculiarities of the intrauterine environment. These fœtal conditions, it may yet be found possible to trace back again to morbid maternal states; and it may even be that maternal or paternal conditions existing in the sexual cells before impregnation may be potent to direct the life of the impregnated ovum into abnormal manifestations. Let us here leave this subject; it is clear that it is obscure; this alone is clear.

It can scarcely be hoped that much success will attend attempts at antenatal *diagnosis* in regard to general fœtal dropsy. The presence

of the maternal morbid states (dropsy, albuminuria, heart disease, etc.) which have been regarded as causal may arouse suspicion, and the history of the earlier occurrence of a dropsical fœtus in the same family may greatly strengthen the suspicion; the diagnosis of hydramnios will also aid. As a rule, however, the fœtal disease will only be detected during the progress of labour, and the sooner it is then detected the better will it be for the patient and her medical attendant.

The antenatal *treatment* will consist in the correction of maternal disorders by means of milk diet, iron, chlorate of potash, strychnine, etc., and will be possible, as a rule, only when the mother has already given birth to a dropsical infant in an earlier pregnancy. The intranatal treatment will take the form of a reduction of the bulk of the fœtus by the aspiration of the peritoneal effusion; extractive interference (forceps, hands) may be needed before the child can be born. After birth the aspiration of the thoracic cavity might be practised in the hope that respiration might be established, and that the dropsical conditions would gradually disappear. I have had under my care a case of very serious neonatal anasarca which ultimately recovered, and I am inclined to hope for a similar happy result in some cases of antenatal œdema. In some instances, at any rate, the examination of the tissues and organs showed no lesions sufficiently grave to exclude all hope of independent postnatal life, if once the pulmonary respiration could be fully established. *Spes incerta*, perhaps; but still a flicker of hope.

Congenital Cystic Elephantiasis.

The curious deforming malady known as congenital cystic elephantiasis is probably nearly related to general fœtal dropsy. It is, however, a disease which affects chiefly the subcutaneous tissue, leading to an increase in its dimensions and the formation in it of cysts of various sizes, with clear serous or curd-like contents. It may implicate the subcutaneous tissue all over the body, but frequently it is very pronounced in a special region, *e.g.* the back of the head and neck. Fluid in the body cavities is sometimes but not always met with, and in this character the disease differs from general fœtal dropsy. Cystic elephantiasis is doubtless related also to the local conditions known as cystic hygroma of the neck, fibroma molluscum, and some forms of congenital sacral tumour.

There are not many cases on record in which the morbid condition of the subcutaneous tissue was the sole anomaly from which the fœtus suffered; in fact, the disease is very rare alone. There are, however, not a few cases in which it occurred along with grave malformations or in association with other fœtal diseases. Thus, there are instances in which it was met with in the grossly malformed twin of the so-called parasitic type, as in the specimen described by me in 1892 (*Diseases of the Fœtus*, i. p. 184); and F. Caruso (*Arch. di ostet. e ginec.*, vi. 193, 1899) has put on record a case in which it was combined with fœtal "rickets." If, however, we confine our attention to the cases in

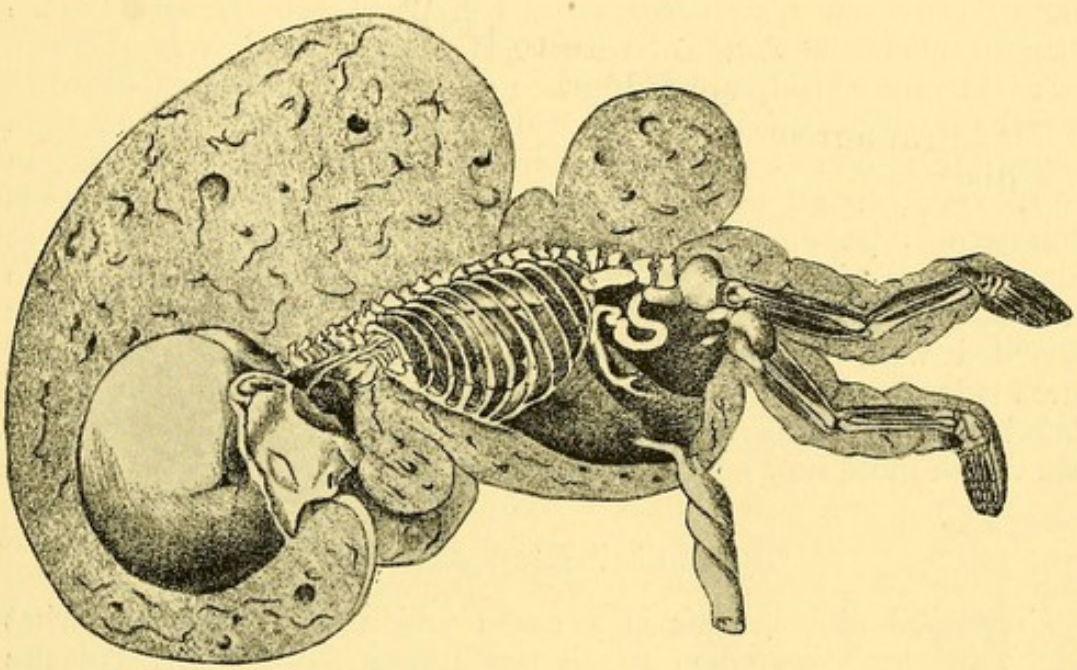
which the condition of the subcutaneous tissue was the chief, if not the only anomaly, we arrive at the following conclusions.

The mother was generally a multipara, and had enjoyed fairly good health till the commencement of the pregnancy which ended in the birth of the fœtus with cystic elephantiasis. That pregnancy nearly always ended prematurely, and was generally associated with hydramnios; and during its course the mother suffered from dropsy, albuminuria, and unusual abdominal distension, with the symptomatic consequences of these alterations. The infant rarely survived birth, a result due in some cases as much to the prematurity as to the morbid changes.

The fœtus was generally larger and heavier than it ought to have been. Its bizarre appearance was due not so much to the general gelatinous anasarca, as to the cystic accumulations in the subcutaneous tissue of special areas. A. Meckel (*Arch. f. Anat. u. Physiol.*, p. 149, 1828) called his specimen a "monströse Larve eines Fötus" (monstrous mask of a fœtus), and used to exhibit it with lions', elephants', and calves' heads as an example of what the older writers named "molæ spuriæ"; he regarded it at first as an acephalus, for it seemed to consist solely of a trunk with limbs bearing a fleshy, spongy mass instead of a head; but when he came to make a section through the mass, he was greatly surprised to find underneath a well-formed fœtal face (*vide* Figs. 32, 33). Meckel said he felt like a child who sees a man, masked like a bear, throw away the mask and reveal his face. H. Steinwirker's specimen (*Dissert.*, Halle, 1872) was somewhat similar in appearance, but was not so grossly malformed; and F. Neelsen (*Berl. klin. Wchnschr.*, xix. 36, 1882) compared his case of cystic elephantiasis to the plum mannikins of the Christmas markets in Germany.

The *dissectional appearances* varied considerably. In C. Everke's specimen (*Dissert.*, Marburg, 1883), for instance, there was a fibro-myxomatous stratum, 6 mm. in thickness, between the skin and the subjacent muscles, and the large swelling on the back of the neck was found to contain six smooth-walled cysts with yellowish brown semi-fluid contents; there were some anomalies of the abdominal viscera (contracted state of intestines, enlarged spleen, etc.). In A. O. Lindfors' case (*Ztschr. f. Geburtsh. u. Gynäk.*, xviii. 258, 1890) there was an umbilical hernia and an amniotic band attached to the left hand; there was a large occipital tumour consisting of a thin-walled cyst with serous contents; the heart showed a common ventricle and a common auriculo-ventricular opening, and the auricles were very incompletely separated.

Neelsen (*loc. cit.*) gave details regarding the *microscopic appearances* of his specimen. The skin was fairly normal, but the lymphatics of it and of the subcutaneous and intermuscular structures were greatly dilated and tortuous, and here and there formed real cystic spaces; possibly the large cysts marked a further evolution or the same changes. In one or two cases the placenta was œdematous and friable, but details regarding both it and the membranes were seldom forthcoming.



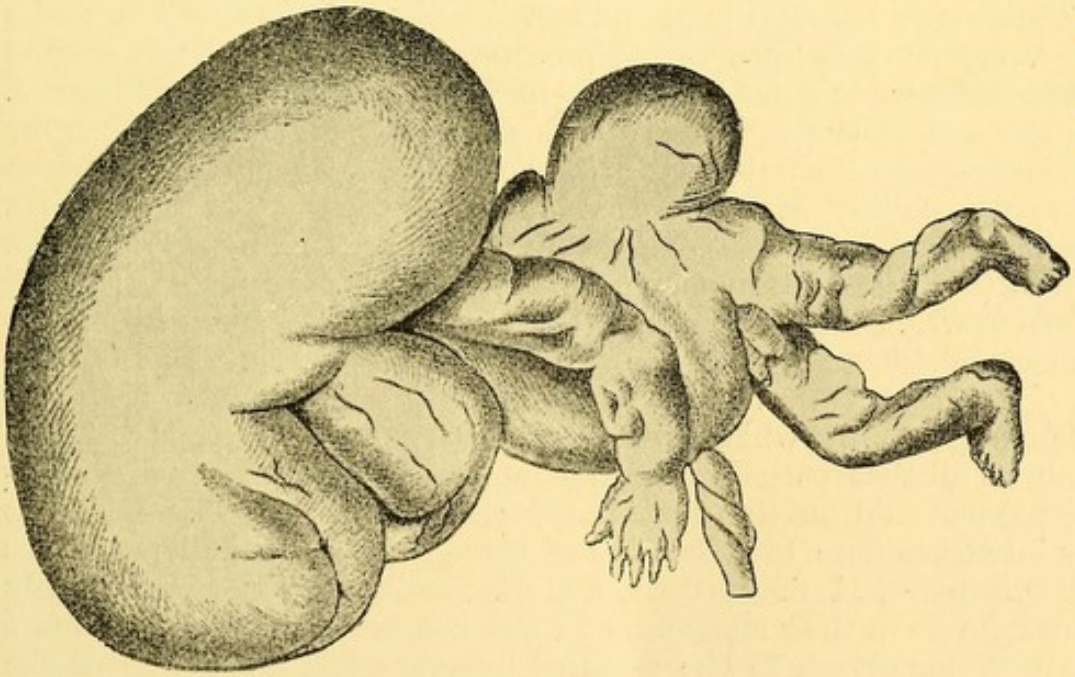


Fig. 32.—Meckel's Case of Cystic Elephantiasis.—Fig. 33.

The etiology was most obscure in all the recorded cases,—and there seemed to be nothing to suggest a maternal cause. The nature of the morbid process was a condition of dilatation, or of dilatation and occlusion of lymphatic spaces and vessels, a lymphangiectasis. Upon this point most of the observers agreed; but whether the distension of the lymphatics or the hyperplastic changes in the subcutaneous tissue were to be regarded as the primary phenomena there was very considerable difference of opinion. In the absence of general agreement upon these questions, it is needless to spend time discussing the correctness of the term "elephantiasis" as applied to the disease. In all probability it is in its first stages œdematous in its nature; but on account of the early period of intrauterine life at which it commences it takes on changes (due to the embryonic state of the tissues) of a quite peculiar kind, changes which are not easily reconciled with the alterations found in later antenatal life. Of course it is not the same disease as elephantiasis Arabum, but it is related to the malady known as congenital elephantiasis, a morbid state which must now engage our attention.

Congenital Elephantiasis.

Congenital elephantiasis is a name which has been somewhat widely and loosely applied to all the hypertrophic or hyperplastic states of the subcutaneous tissue or tissues which may be present at birth. It has, as we have seen, been given to the soft cystic variety of this disease; it is given also to the widely distributed as well as to the strictly localised hard and soft varieties (*elephantiasis congenita dura, mollis*), and by a forced process of extension to such morbid states as multiple cutaneous neuro-fibromata and fibroma molluscum. At one end of the series of pathological changes it passes over by gradations into general fœtal dropsy of the gelatinous type (as seen more particularly in the twin fœtus), and at the other end into a confused and heterogeneous group of neoplasms, including nerve nævus (so called) and congenital unilateral hypertrophy or partial giant-growth. An eminently good and complete account of this difficult chapter in fœtal pathology is given by F. Esmarch and D. Kulenkampff in their monograph, *Die Elephantiastischen Formen* (Hamburg, 1885), which extends to nearly 300 pages, and which contains all that pathologists (and more particularly German pathologists) had said on this matter prior to the year 1885. It is not my intention here to describe the three forms named Elephantiasis telangiectodes, E. fibromatosa, and E. neuromatodes; these closely approximate in their characters to the congenital neoplasms; but I shall confine myself to the cases of hypertrophic thickening of the subcutaneous tissue of one or several limbs or parts of the body which are found at birth, and which are more nearly related to the instances of cystic elephantiasis (already referred to). It is true that in them the vessels and nerves and even the bones and muscles and fibrous tissue in the neighbourhood may be involved in the hyperplastic processes, and thus connecting links with elephantiasis telangiectodes,

neuromatodes, fibromatosa may be formed; but the outstanding character is hyperplasia of the subcutaneous tissue with special involvement of the lymphatics. In this restricted sense let us deal with congenital elephantiasis.

The *clinical history* of cases of congenital elephantiasis is chiefly remarkable for the occasional record of family prevalence and of hereditary transmission. M. Nonne (*Arch. f. path. Anat.*, cxxv. 189, 1891), for instance, met with eight instances of the disease in fourteen individuals in the same family in three generations. There was the man H. H., whose age when examined by Nonne was 34; his father had been healthy, but his mother had suffered from a congenital enlargement of the lower limbs. H. H. was born normal, but almost immediately afterwards it was noticed that his feet and legs were unusually large, and the enlarged extremities grew proportionately with the rest of the body. The hypertrophy was chiefly below the knee, and affected very markedly the dorsum of the foot, and just above the malleoli were two grooves on the right and one on the left leg. The surface of the skin had a normal appearance (elephantiasis glabra), but there were some papillary growths attached to the toes. There was pitting on firm pressure, and the pitting remained long. H. H.'s sister, H. M., age 30 years, had a condition very similar to that described above; but in her case the right leg and foot were normal, the anomaly being restricted to the left side; there was the same swelling especially of the dorsum of the foot, the same grooves, and the same papillary growths attached to the toes. H. M. was married and had had four pregnancies: the first ended in the birth of an infant with enlarged lower limbs, who died in infancy; the second was an acephalic (anencephalic?) full-time infant with similarly affected lower extremities; the third pregnancy resulted in the birth of a female child, still alive (age 6 years), with elephantiasic enlargement of the right leg and foot; and the product of the fourth gestation was a full-time male infant, showing the same abnormality in both lower limbs but in a less degree. As has been already stated, the mother of H. H. and H. M. had also suffered from congenital elephantiasis of the legs, and one of her sisters had the same condition in a more aggravated form. When the family history was traced further back, the inevitable maternal impression appeared, for the grandmother of H. H. and H. M. had been frightened during pregnancy by a woman with dropsical legs. J. H. Jopson's two cases (*Arch. Pediat.*, xv. 173, 1898) were brothers, and their father had suffered like them from congenital enlargement of both lower limbs below the knees; and Milroy (*Proc. Nebraska Med. Soc.*, p. 27, 1892) recorded twenty-two cases of hereditary œdema of the lower limbs in ninety-seven individuals in six generations, and in all but two the œdema was congenital.

There is, as a rule, little information to be obtained regarding the character of the pregnancy which ends in the birth of an infant with elephantiasis; but one of Moncorvo's cases formed an important exception. In 1895, Dr. Moncorvo (Rio de Janeiro) kindly sent me a photograph of a little patient suffering from congenital elephanti-

asis, which is reproduced here (*vide* Fig. 34); and I communicated the details of the case to the Edinburgh Obstetrical Society at its December meeting (*Trans. Edinb. Obst. Soc.*, xxi. 25, 1896). The infant was a male, of mixed race, five months old. The father had suffered from acquired syphilis, and on several occasions had had lymphangitic attacks affecting the limbs, and principally the arms. The mother, a half-breed like her husband, had had seven children, of whom four (the first, second, fourth, and fifth) were already dead. While nursing her second last infant she had been attacked by lymphangitis in the left breast, going on to suppuration.

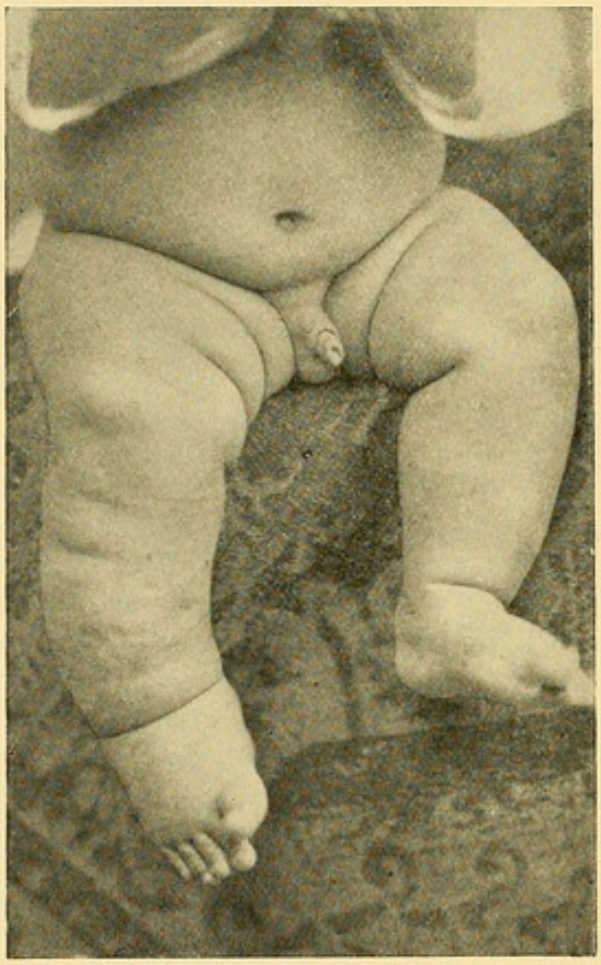


FIG. 34.—Congenital Elephantiasis.

During the last pregnancy she had had several falls, followed by more or less troublesome results. The first, a fall in the street, with bruising of the abdomen, at the fourth month, had been followed for eight days by abdominal pains; two months later, the abdomen was bruised again by a second traumatism; this was succeeded by abdominal pain, a rigor, and rise in temperature; at the seventh month she fell across the tramway rails in the street, again bruising the hypogastrium, which became the seat of a lymphangitic attack, going on to suppuration and fever of a remittent type, and lasting about a week; again, at the eighth month, she received a blow on the abdomen. Labour took place at the full term, and it was at once noticed that although the infant was alive and active, he had an ab-

normally large right lower limb. He showed, also, signs of hereditary syphilis. There was marked hypertrophy of the right lower limb from groin to foot, which was most evident in the foot and lower two-thirds of the leg, and there were deep grooves to be recognised (Fig. 34). The skin was smooth and of normal colour and temperature, but drier than in other regions, and firmly adherent to the subcutaneous tissue. Palpation revealed a feeling of elastic hardness of the tissues, more marked on the dorsum of the foot, less so on the thigh. The circumferential measurements of the right thigh were about 2 cms. greater than those of the left, while those of the leg and foot were from 4 cms. to 6 cms. greater in the right than in the left limb. Sensibility to touch and the reaction to electricity were less marked in the right than in the left leg. The microscopic examination of the mother's blood showed only a slight exaggeration of the number of leucocytes, whilst blood serum taken from the lower third of the right leg of the infant revealed the presence of a certain number of the streptococci of Fehleisen, either single or grouped, as diplococci or in chains. The infant was put on a course of iodide of potassium, and the limb was subjected to elastic compression, with the result that the dimensions of the hypertrophied extremity were considerably reduced. This was the tenth case which Dr. Moncorvo had seen (*Satellite*, vi. 35, 1892; *Ann. de dermat. et syph.*, 3 s., iv. 233, 1893; *ibid.*, v. 186, 1894; *Journ. de clin. et de thérap. inf.*, iii. 663, 1895), and in one or two of them there was a family history of proclivity to lymphangitic attacks. Further, in one of the three new cases which he contributed to my journal (*Teratologia*, ii. 79, 1895) in 1895, there was a doubtful history of abdominal traumatism and lymphangitis in the mother at the eighth month of pregnancy. I have given full details of Moncorvo's cases, for they have an important bearing upon the question of pathogenesis, to which reference will immediately be made.

Some idea of the *symptomatology* and *physical signs* of fœtal elephantiasis will have been gained from what has been recorded above; but certain facts may be added. Although the lower limbs are frequently the seat of the disease, they are not constantly so; for, while they were affected in the cases already mentioned and in those described by Otto Schloss (*Dissert.*, Bonn, 1890), P. Archambault (*Ann. de dermat. et syph.*, 3 s., iv. 448, 1893), Waitz (*Arch. f. klin. Chir.*, xxxix. 229, 1889), and Steinthal (*Med. Cor.-Bl. d. württemb. ärztl. Ver.*, lxvi. 33, 1896), yet in that reported by Osler (*Journ. Anat. and Physiol.*, xiv. 10, 1879) it was the right upper limb, in W. B. Coley's (*New York Med. Journ.*, liii. 706, 1891) it was the face and scalp, in T. Spietschka's (*Arch. f. Dermat. u. Syph.*, xxiii. 745, 1891) it was the whole body except the right upper limb and the genitals, and in M. Mainzer's (*Deutsche med. Wchnschr.*, xxv. 436, 1899) it was the left upper limb and the external genitals as well as the lower extremities. In most of the cases the condition did not interfere with the postnatal life of the child, and in some there was a distinct tendency to diminution in the amount of the subcutaneous hypertrophy. There was some difficulty in progression when the

lower limbs were affected; there was always the deformity; and in a few cases the usefulness of the limbs was seriously interfered with. The skin covering the diseased part was generally normal in appearance, but in a few cases there was an excessive vascular development, and in one of Rose's cases (*Monatsschr. f. Geburtsk.*, xxx. 339, 1867) the enlargement was almost entirely due to fat. Now and again grooves were described on the affected limbs, and in G. Reinbach's case (*Beitr. z. klin. Chir.*, xx. 645, 1898) the grooves seem to have been due to amniotic bands encircling the part. Although in most of the cases the appearances did not closely resemble elephantiasis Arabum as met with in the adult, they did so in a very striking way in the patients seen by Mainzer (*loc. cit.*) and Reinbach (*loc. cit.*). In the former the external genitals were affected: the labia majora, the nymphæ, and the clitoris all showed the elephantiasic thickening, and between the posterior commissure and the anus was a reduplication of loose skin. Both legs and the right foot exhibited the same enlargement, which by the help of the Röntgen rays was seen to have left the bones untouched. The left upper limb was enormously enlarged, and the thickening was especially marked in the forearm and hand. On the toes of the right foot were some grooves suggesting amniotic bands. The skin everywhere retained its normal colour, and there were no traces of angiomata or fibromata; but in the areas of thickening there was some cutaneous dryness and roughness. The child had neither heart disease nor nephritis, and the thyroid felt normal; there was no syphilis.

It is a curious speculation to inquire whether the fabulous people, the Sciapodi, described by Ctesias, had perchance their origin in the birth of an infant with congenital elephantiasis of one foot. They are represented as possessing a single foot which was so large as to be used as a sunshade, and pictures of them are to be found in the older works on Monstrosities.

The *pathogenesis* of congenital elephantiasis has that common character of antenatal morbid states—obscurity. It has been suggested that the hypertrophy may be due to an amniotic band encircling the limb; and in a case of multiple malformations in a fœtus which I examined some years ago, there were indications that this view might occasionally be correct. In J. Schnitzler's case (*Wiener klin. Rundschau*, ix. 165, 1895), also, there was confirmatory evidence. But obviously it cannot account for all the cases. Some have seen in the disease a true elephantiasis Arabum of intrauterine origin; but there is next to no evidence of the transplacental transmission of this disease (*vide* Prince A. Morrow, in *Twentieth Century Practice*, xviii. 424, 1899), and R. Sarra (*Pediatria*, iii. 155, 1895) found no traces of filariæ in a case of fœtal elephantiasis examined by him. Its origin in the passage of streptococci from mother to infant, which was supported by Moncorvo, cannot be accepted as frequently correct, for it is rare to find any history of maternal lymphangitis or erysipelas in pregnancy. A family predisposition to neoplastic changes in the connective tissues, as imagined by Spietschka, cannot be accepted as a satisfactory explanation, for family prevalence and heredity,

although met with, are not at all frequent. It may possibly be due to long-continued irritation of the subcutaneous tissues by some toxin circulating in the blood; but this supposition does not of course satisfy the requirements of an adequate theory of pathogenesis.

It is cheering to be able to chronicle improvement and even recovery under *treatment* with iodide of potassium, electricity, and elastic compression. There is sometimes a natural tendency towards cure, and possibly to this, as much as to the treatment, the improvement may be due. So that, after all, the cheerfulness of the believer in therapeutic successes in antenatal maladies may be premature.

The above maladies (general fœtal dropsy, general cystic elephantiasis, and congenital elephantiasis) I have selected as types of idiopathic diseases affecting chiefly the subcutaneous tissue; but it will be evident to the reader that indications are not wanting of their possible transmitted character. In some instances, at least, there is ground for believing that the maternal (or paternal) health had a determining influence upon the evolution of the fœtal malady. The diseases are retained in the idiopathic group, but there is reason to expect that ere long they will have to be transferred to the transmitted.

There are also certain morbid states of the subcutaneous tissue which have not yet been established as truly present at birth; among these is myxœdema, due to the absence of the thyroid gland. Bourneville (*Progrès méd.*, 3 s., ii. 33, 49, 1895) explains the absence of the symptoms of myxœdema in the early months of life as due to the influence of the mother's milk; after weaning, the defective state of the thyroid makes itself felt, and the pachydermatic cachexia becomes evident. It seems more probable, however, that the thyroid in the fœtus and at birth does not possess the same regulating influence over body metabolism (including of course that of the subcutaneous tissue) as it does later; possibly, therefore, its defective action will not reveal itself by the same alterations in the subcutaneous and other tissues at birth as it does later (*vide* p. 166).

Atrophic as well as hypertrophic states of the subcutaneous tissue have been met with in the fœtus. F. Ahlfeld (*Berl. klin. Wchnschr.*, xxxi. 812, 1894), for instance, has described a fœtus with atrophy of the subcutaneous adipose tissue in a case of defect of the liquor amnii (oligohydramnion); the mother was a deaf-mute, and so perhaps was the father. Possibly the "living skeletons" who are exhibited at shows and fairs and Christmas carnivals are in some cases examples of this congenital atrophic state of the subcutaneous tissues. The so-called "elastic skinned men," also, show a condition which is probably due to congenital defective growth of the subdermal rather than to abnormal elasticity of the dermal tissues.

CHAPTER XVIII

Idiopathic Diseases of the Fœtus (*cont.*): Types of Skin Diseases: Fœtal Ichthyosis (Grave Form)—Definition, Synonyms, Clinical History, Symptomatology, Appearances (Macroscopic and Microscopic); Fœtal Ichthyosis (Mild Form); Tylosis Palmæ et Plantæ; Fœtal Keratolysis; Hypertrichosis congenita—Definition, Synonyms, Recorded Cases, Clinical History, Pathogenesis; Localised Form of Hypertrichosis; Congenital Alopecia—Clinical Characters, Pathogenesis; Antenatal Pemphigus or Epidermolysis bullosa hereditaria; Congenital Absence of Skin; Acanthoma or Amnioma of the Skin.

In this chapter I propose to consider some types of fœtal disease of the skin. Some difficulty has arisen in selecting these types, for there is a large number to choose from, as may be seen by a reference to my scheme of classification of fœtal skin affections (*Diseases of the Fœtus*, ii. p. 227, 1895). Some of the maladies therein enumerated (*e.g.*, those connected with the transmitted morbid states, the fevers, syphilis, purpura) have, it is true, been already considered; but there still remains a large number of others. From these I select fœtal ichthyosis (one of the epidermidoses), tylosis palmæ et plantæ (one of the acanthoses), hypertrichosis and hypotrichosis (two of the trichoses), pemphigus (one of the angiotic acantholyses), and congenital absence of the skin (an atrophic dermatosis). The various forms of nævus I do not specially deal with, as every text-book on Dermatology and Surgery devotes considerable space to them. The same general principles of Antenatal Pathology (*vide* Chapter XI.) must be applied to the study of the skin diseases as have been applied to the other maladies with which the preceding chapters have been occupied. Incidentally it may be remarked that the congenital skin diseases have come prominently before the notice of the public as well as the profession; for the sufferers from them bulk largely in shows at fairs, in "dime museums," and at Christmas carnivals. The curiosity of the public with regard to "alligator boys," "hairy men," "spotted girls," and "freaks" of that kind is great, and while it may be far from commendable, it, at any rate, provides funds for the support of these victims of antenatal pathology.

Fœtal Ichthyosis (Grave Form).

This malady may be provisionally *defined* as a skin disease of the fœtus, developed probably about the fourth month of intrauterine life, characterised by the existence over the whole surface of the body of horny epidermic plates, separated from each other by fissures and

furrows, associated with certain deformities of the mouth, nose, eyes, ears, and extremities, and leading to the death of the infant very soon after birth.

It has gone under various *names*. It was first described about the end of the eighteenth century (Richter, *Dissertatio de Infanticidio*, 1792), and up to the middle of the nineteenth century it was called a congenital hypertrophy of the epidermis or "cutis testacea" (Behrend, *Ikonogr. Darstell. der nicht-syph. Hautkr.*, p. 84, Plate xxix. 1839). A. Keiller (*London and Edin. Month. Journ. Med. Sc.*, iii. 694, 1843) simply described his case as one of "thickening and deep fissures of the skin in an infant at birth"; but J. Y. Simpson, who communicated Keiller's case, entitled his paper "Intrauterine Cutaneous Disease," and went on to say that "it would appear to be much more analogous to ichthyosis than to any other skin disease that can be referred to, and therefore, suggested for it the name of 'Ichthyosis Intrauterina.'" This designation, or its synonym "Ichthyosis congenita," has been widely adopted and is now in general use, although recently there has been a tendency to prefer "Hyperkeratosis" or "Keratoma." The peculiar appearances of the infant affected with this disorder have led to the occasional employment of the singularly descriptive name of "Harlequin Fœtus" (Bland Sutton, *Trans. Med-Chir. Soc. Lond.*, 2 s., li. 291, 1886).

It would seem that the disease is rare, for up to the year 1895 there had only been recorded some forty-two cases; and, taking into account the very striking appearances that the infants present, it is unlikely that many escape recording.

With regard to *clinical history*, it is most noteworthy that the parents of infants suffering from ichthyosis were generally themselves free not only from ichthyosis, but also from all kinds of skin affections. Anton Wassmuth (*Beitr. z. path. Anat. u. allg. Path.*, xxvi. 19, 1899), however, has recorded a case in which the parents were cretins. The obstetric history was in the great majority of instances good. One striking fact, however, must be noted—the occurrence of more than one ichthyotic infant among the offspring of the same parents, or family prevalence. Thus, Okel's two specimens (*Verm. Abhandl. v. einer Gesellsch. pract. Aerzte zu St. Petersb.*, viii. 185, 1854) were borne by the same mother; so were Houel's two cases (*Compt. rend. Soc. de biol.*, iv. 177, 1853), and those of G. A. Haus (*Norsk Mag. f. Laegevidensk.*, lxii. 542, 1901); and the mother in Oestreicher's record (*Arch. f. Dermat. u. Syph.*, xxiii. 837, 1891) had three normal infants by her husband, and after his death three ichthyotic fœtuses in three successive years illegitimately, and presumably by the same man. The condition of the fœtal skin seems occasionally to have retarded the progress of labour; but a premature ending to the pregnancy was common. Obscure abnormal symptoms have been described by the mother during gestation; hydramnios has been met with; and there has been the usual crop of stories of maternal impressions.

The infants were all weakly when born, and died within a few days or hours thereafter; and it is particularly noteworthy that only

in one recorded case (J. F. Jahn, *Dissert.*, Leipzig, 1869) was the subject dead-born, so that it may be concluded that fœtal ichthyosis is not fatal to intrauterine although it is most uniformly so to post-natal existence. This latter result is in large measure brought about by the associated deformities, and especially by the state of the mouth, which practically prevents sucking. The child usually cried loudly and continuously during its short tenure of life; but in some cases the cry was weak and buzzing (G. Vrolik, *Tab. ad illustr. Embryog.*, Pl. xcii., 1849). Respiration was impeded, but urination and defæcation usually took place naturally; in Souty's case (*Bull. de l'Acad. roy. de méd.*, viii. 82, 1842–3), however, no urine was passed. In most instances the infant slept little, and in some cases (Jahn, *op. cit.*) special reference was made to the highly offensive, cadaveric smell which came from the skin.

The *appearances* of the general body surface, with its thick horny yellowish epidermic plates of all sizes and shapes, with intervening cracks or fissures of a red or bluish tint, are very characteristic (Fig. 35). Some of the older authors described the eyeballs as absent and their place taken by two red fleshy masses; but it is now known that these fleshy tumours are really the greatly swollen and congested conjunctival surface of the eyelids everted in ectropion (Fig. 36), for on separating these we can see the normal eyeball.

The whole body presents a particularly hideous and repulsive appearance, and we can scarcely wonder that such epithets as "horrible" and "terrible" have been freely used by writers in describing their specimens. The thickened plates with intervening fissures have been compared to a coat of mail, to the bark of some trees, to the dermal covering of the armadillo, the coat of the tortoise, and (by a stretching of the imagination) to the dress of the harlequin. The epidermic layer is much harder than usual; it is variously described as "leather like," "horny," and "cartilaginous"; it is cold to the touch. The plates differ greatly in size and shape, and the appearance produced by them has been compared by Radcliffe Crocker (*Diseases of the Skin*, 2nd Edit., 343, 1893) to a "loosely-built stone wall," to a stone-dyke as we call it in Scotland. The thickest plates are on the back, chest, and scalp; the thinnest are on the hands and feet and round the anus; their margins are usually bevelled off and their surface is commonly smooth, but sometimes shows small spines. The deepest cracks or fissures are generally found on the scalp in the neighbourhood of the greatly deformed ears; some of them are bridged over by a thin, transparent pellicle, but this is often absent. The hands and feet are greatly thickened and malformed; the digits resemble birds' claws (onychogryphosis), are sometimes united to each other, and are sometimes absent. The dissectional appearances of the internal organs would appear to be unimportant; congestion seems to have been fairly constant, and the cause of death was generally found in a broncho-pneumonia or pulmonary œdema. In 1901, Drs. A. S. Daniel and L. Cordes kindly sent me a photograph of a very typical case reported by them (*Journ. Amer. Med. Assoc.*, xxxv. 1081, 1900). In this case the kidneys showed the lesion of

Fig. 35.—Straube's Case of Fœtal Ichthyosis.

acute exudative nephritis; the child had died suddenly twenty-seven hours after birth.

The *microscopical appearances* of the skin (Figs. 37, 38) have been

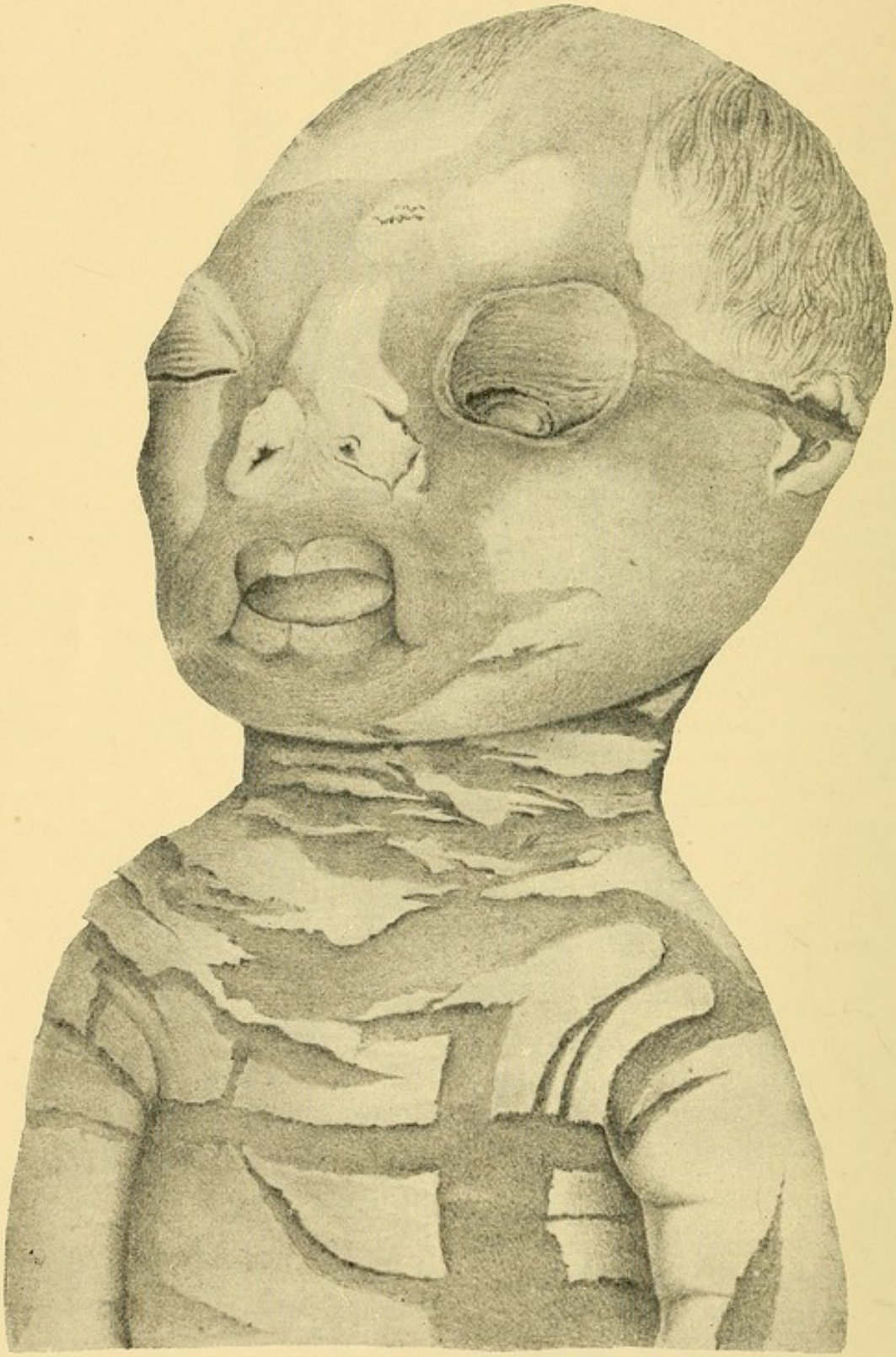


FIG. 36.—Kyber's Case of Fœtal Ichthyosis.

well described by E. Kyber (*Medizin. Jahrb.*, 397, 1880) and T. Carbone (*Arch. per le Sc. med.*, xv. 349, 1891). The most striking feature is the enormous thickening of the epidermic layer,

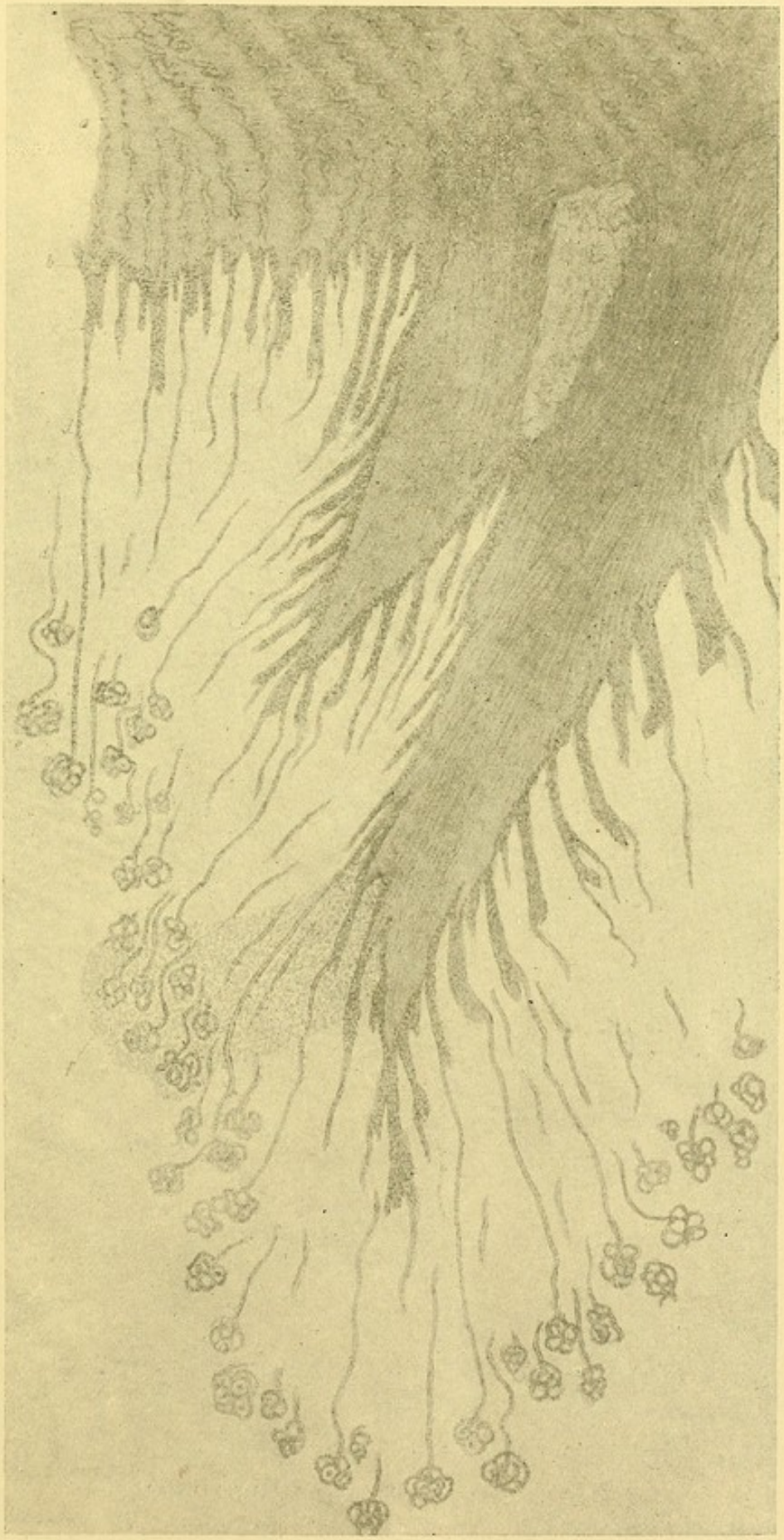


FIG. 37.—Skin of Palm of Hand in Fœtal Ichthyosis (Kyber).

a, Stratum corneum with sweat canals ; *b*, Stratum Malpighii ; *c*, Projection passing down between the papillæ ; *d*, Sweat ducts ; *e*, Sweat glands.

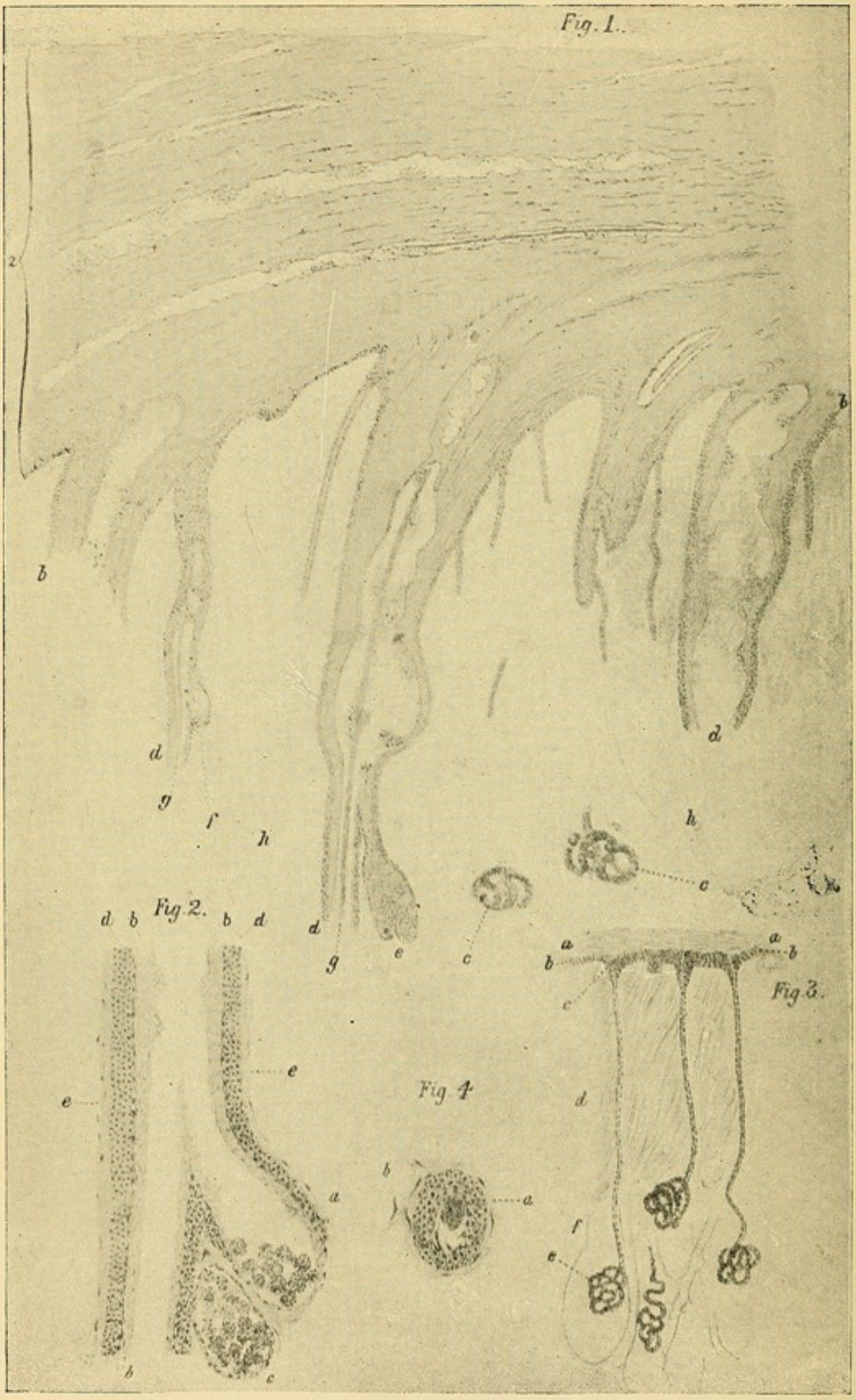


FIG. 38.—Kyber's Specimen of Fœtal Ichthyosis.

Fig. 1.—Vertical Section of the Skin of the Chest in a thickened area. *a*, Stratum corneum, with hair canals containing lanugo hairs; *b*, Stratum Malpighii; *c*, Sweat glands; *d*, Hair sac; *e* and *f*, Sebaceous glands filled with fat cells; *g*, Lanugo hairs; *h*, Corium.

Fig. 2.—Vertical Section of Hair Sac with Sebaceous Gland from Skin of Head (Kyber).

which is almost entirely situated in the stratum corneum, the rete Malpighii, with the exception of the interpapillary prolongations, being even diminished in thickness in some instances. It is usually stated that there is no stratum granulosum of Langerhans, and no layer of flattened cells containing kerato-hyaline; but G. A. Haus (*loc. cit.*) found both. There is a well-marked stratum lucidum, and the passage from it into the horny layer is not sudden and sharp as in normal fœtuses but more gradual. In the normal infant, also, osmic acid stains deeply the deepest and the most superficial layers of the stratum corneum, leaving the intermediate layers unstained; but in fœtal ichthyosis there is no such colour reaction, or only the presence of some fine black lines. This difference has been attributed to impeded sebaceous secretion. It is doubtful whether the cells of the rete Malpighii show signs of great activity or not. The hair follicles are, in many instances, completely plugged by the thickened horny substance, and the external root sheath of the hair is also thickened. The sebaceous glands are atrophied and the hairs themselves are thin. The sudoriparous glands, however, are hypertrophied (Kyber) and their ducts are elongated; but Carbone (*loc. cit.*) did not note this hypertrophy. The cutis vera is fairly normal; certainly the papillæ are longer than usual, but they are also thinner, and probably are not much if at all increased. The amount of adipose tissue is smaller than usual, but the subcutaneous tissue, like the true skin, shows feebly indicated alterations or none at all. In the furrows between the horny plates the histological appearances differ from those above described, chiefly in the absence of any marked thickening of the stratum corneum; and the rete Malpighii may be made up of only two or three rows of flattened cells. In some of the deep cracks the fissure extends directly down to the cutis vera, upon which lie only some pus cells and broken-down epithelial cells. Intermediate types are also met with.

To summarise: the changes in the skin consist in hyperkeratosis, along with the results which this alteration produces upon the hairs and sebaceous and sudoriparous glands. The condition of the rete Malpighii is puzzling; but possibly at one stage or another in the evolution of the disease it may show signs of proliferative activity. If, however, the disease is primarily due to an anomalous growth of the epitrichium of early fœtal life, it may not be necessary to look for changes in the rete Malpighii. The chemical analysis of the epidermic scales, made by B. Livingstone (*Amer. Journ. Obst.*, xv. 988, 1882) showed fat, cholesterine, and possibly hippuric acid; and the burnt residue was made up of salts of lime, magnesia, and iron. Very little information was forthcoming regarding the placenta, membranes, and cord; but the epidermic thickening does not seem to have extended to the sheath of the cord,—a striking fact. There was hydramnios in Jahn's case (*Dissert.*, Leipzig, 1869) and in W. R. Smith's (*Amer. Journ. Obst.*, xiii. 458, 1880),—also striking facts, but standing almost alone. A thorough investigation of the fœtal annexa in these cases is a *desideratum.*

Fig. 3.—Vertical Section of Skin of Palm of Hand in a Normal Infant (Kyber). *a*, Stratum corneum; *b*, Stratum Malpighii; *c*, Interpapillary projections; *d*, Corium; *e*, Sudoriparous glands; *f*, Adipose tissue.

Fig. 4.—Transverse Section of Hair Sac containing Hair from Skin of Head (Kyber).

The *etiology* of fœtal ichthyosis is unknown. The parents were generally quite free from skin disease of all kinds and from syphilis. Sex seems to have no importance. Family prevalence, however, was unusually common when we remember how rare the disease is; and in one case (Carbone's) the parents were nearly related (uncle and niece). The *pathogenesis*, likewise, is most obscure. Whether or not the disease is ichthyosis modified by intrauterine environmental conditions, is after all comparatively unimportant. The real difficulty is to find any explanation for the extraordinary thickness of the stratum corneum of the epidermis. H. C. L. Barkow (*Beitr. z. path. Entwickelungsgeschichte*, iv. 52, Breslau, 1871) thought that the first stage in the production of the disease was pemphigus; after the blebs had formed they burst and the tears remained as the fissures between the epidermic plates; the hypertrophy constituted the second stage. There is little to commend this view, for Barkow's case seems to have been the only one in which there was any sign of pemphigus. A more attractive theory is that which regards the thickened horny layer of the epidermis as the direct derivative of the epitrichium (*q.v.*, page 85). This theory has been commended by Ohmann-Dumesnil (*Teratologia*, ii. 149, 1895), who thinks that through an arrest in the development of the hair and sebaceous glands the epitrichium remains attached to the underlying stratum corneum and stimulates it to excessive growth. I suggest, however, that absence or defective development of the epitrichium, also, may permit a more luxuriant growth of the underlying horny layer. Why in certain cases this anomaly in the formation of the epitrichial layer should exist is, of course, a difficult question. It may be noted that J. M. Winfield (*Journ. Cutan. and Gen.-Urin. Dis.*, xv. 516, 1897) has recorded a case of congenital ichthyosis with absence of the thyroid. If we accept the view that fœtal ichthyosis is due either to persistence or to absence of the epitrichium, we place the condition among the monstrosities rather than the diseases of antenatal life; but this is no great objection to the theory. For it has been pointed out that during the fœtal period some embryogenesis is still going on (*e.g.*, in the skin), and morbid causes acting on these parts still in the embryonic stage would produce teratological results. There is nothing inherently improbable in the view that fœtal ichthyosis is a monstrosity rather than a disease. Truly, the appearances which it presents are monstrous enough!

The *prognosis* in cases of fœtal ichthyosis is of the gravest. Although not fatal to the beginning of postnatal life, it is absolutely so to its continuance, and death has invariably followed at a time varying from a few hours to nine days. The infant is often premature, is sometimes inherently weak, is unable to suck, and the cracks and fissures in the skin soon become "the haunts of pyogenic microbes." He is called the "harlequin fœtus"; but truly his postnatal life is a brief and a sad harlequinade enough!

Fœtal ichthyosis has been noted in the lower animals (*e.g.*, the calf), and F. R. Liebreich (*Dissert.*, Halle, 1853) has found a possible paternal cause in some of these cases.

Fœtal Ichthyosis (Mild Form).

An infant suffering from the mild type of fœtal ichthyosis is born with a continuous layer of a collodion-like substance over the whole body; after birth this substance desquamates in small tissue-paper like flakes. It is sometimes but not often accompanied by an ectropion condition of the mouth, eyes, and anus. This is the "collodion fœtus" then; it is the attenuated form of fœtal ichthyosis (Hallopeau and Watelet, *Ann. de dermat. et syph.*, 3 s., iii. 149, 1892).

In this type, as in the grave form, the parents are generally free from all kinds of skin disease; and, as in the grave form, family prevalence has several times been noticed. Some curious occurrences have been recorded. In a case of H. Auspitz (*Arch. f. Dermat. u. Syph.*, i. 253, 1869), the pregnancy was plural, the twins were of different sexes, the ichthyotic one was a male and the normal one a female. In F. Warner's observation (*Med. Times and Gaz.*, p. 144, i. for 1882), two sisters married their cousins (two brothers), and each woman gave birth to an ichthyotic fœtus. In G. T. Elliot's case (*Journ. Cutan. and Gen.-Urin. Dis.*, ix. 20, 1891), a man, who had been twice married, had by his first wife healthy children, and one with palmar hyperkeratosis; by his second wife he had two ichthyotic infants. Family prevalence was met with by Michelson (*Berl. klin. Wchnschr.*, xxiii. 520, 1886), by A. J. Munnich (*Monatsh. f. prakt Dermat.*, v. 240, 1886), and by others.

In no case was the infant born dead, and in only a few instances did it succumb soon after birth; so the mild form of fœtal ichthyosis cannot be regarded as fatal to either intrauterine or postnatal life, although it is exceedingly difficult to cure completely. In one or two instances there was recovery, in others there was a localised involution of the malady with a tendency to revert; but in most of the cases the lesion either remained *in statu quo* (as adult ichthyosis or xeroderma), or showed an increase in severity with advancing age.

The appearances at or soon after birth are very characteristic. The subject has already been called the "collodion fœtus," for the whole body is covered with a firm, dry, shining, and tense membrane ("fest wie ein Trommel," says Behrend in the *Berl. klin. Wchnschr.*, xxii. 88, 1885); and M. Perez (*Progrès méd.*, vii. 524, 1880) spoke of the infant as covered by a horny cuirass, an "ongle immense." Cracks and fissures traverse this collodion-like covering, but are generally quite superficial. Soon after birth desquamation commences, the epidermis being shed in large yellow squames, or in small fragments like films of white tissue paper. The associated deformities of the mouth, nose, ears, eyes, and limbs are evident, but are never so marked as in the grave form of fœtal ichthyosis.

The microscopic appearances of the skin have been specially studied by J. Caspary (*Vrtljschr. f. Dermat.*, xiii. 3, 1886), and are reproduced in Fig. 40. (Fig. 39, also taken from Caspary, is given for the sake of comparison; it represents the skin of a normal but somewhat atrophic infant.) The skin has only half the normal

thickness, and the subcutaneous adipose tissue is also diminished; but the epidermis is relatively increased, and constitutes fully one

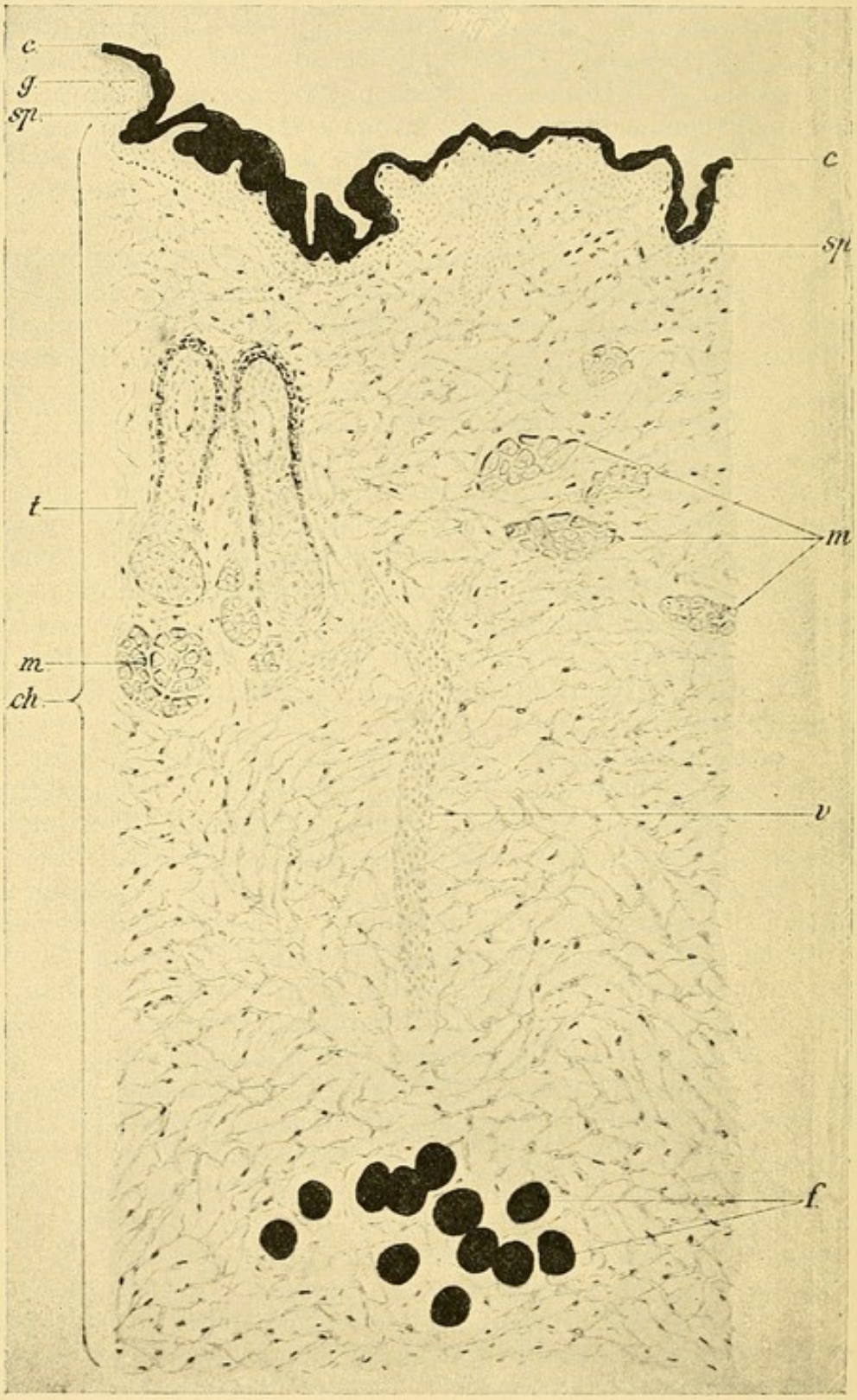


FIG. 39.—Skin of Normal Infant (Caspary).

c, Stratum corneum; *l*, Stratum lucidum; *g*, Stratum granulosum; *sp*, Stratum spinosum; *ch*, chorium; *d*. Sudoriparous glands; *f*, Fat cells; *m*, Transversely cut bundle of non-striped muscular fibres; *t*, Sebaceous glands; *v*, Vein.

quarter of the total skin thickness. There is no superficial fatty layer, and no sebaceous glands are to be seen; and there are only a few hair follicles, but the sudoriparous glands appear to be well formed. All the layers of the epidermis (stratum corneum, stratum lucidum, rete Malpighii, and even the stratum granulosum) are thickened. Caspary's description applies to an infant of eighteen months, but in the absence of observations on the fœtus it must be taken as typical.

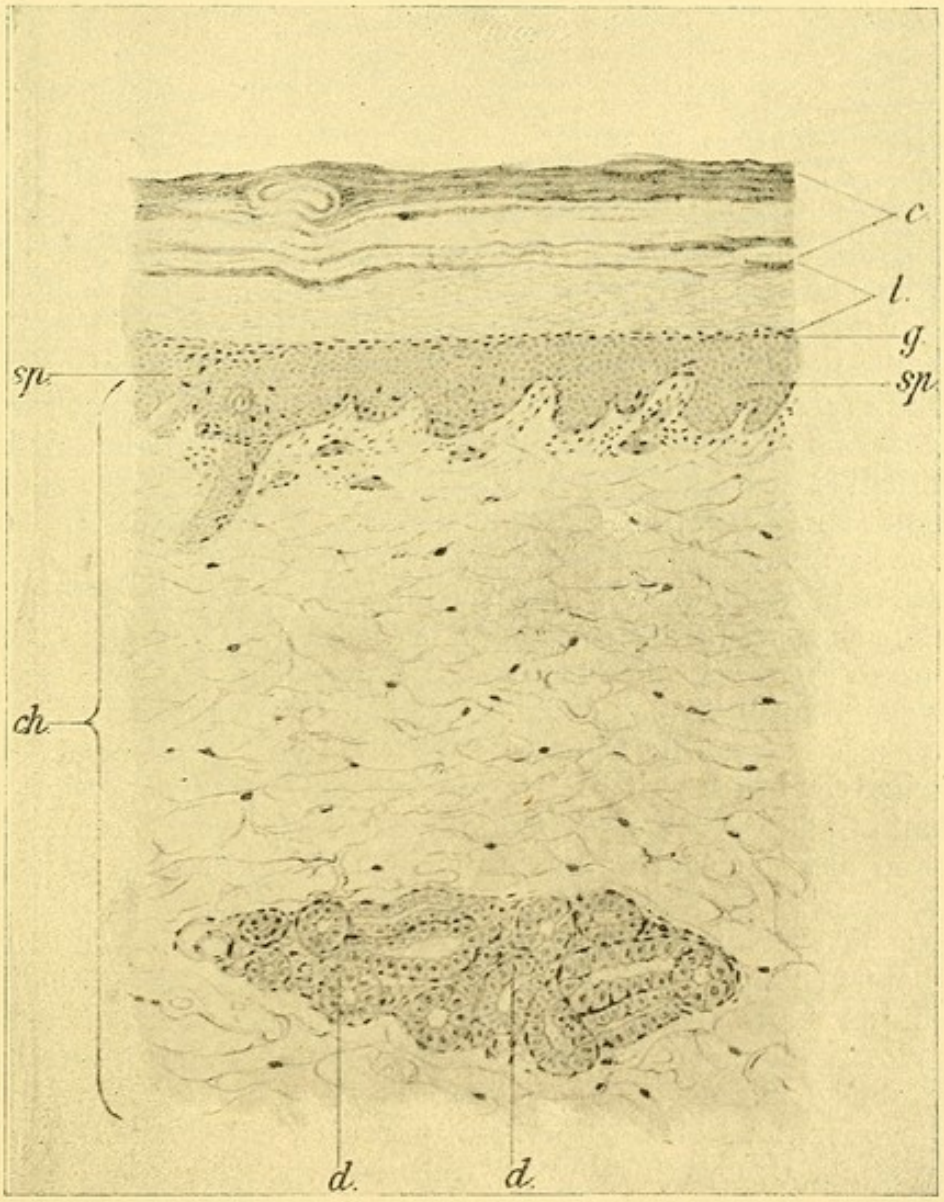


FIG. 40.—Skin of Ichthyotic Infant (Caspary). Letters as in Fig. 39.

The same remarks apply to the etiology and pathogenesis of this, the minor form, as to the grave type of fœtal ichthyosis. Pathologically it is ichthyosis; probably it is due to an anomaly in the development of the epitrichium. It is an interesting fact that a typical case of the disease with very marked deformity may apparently be developed after birth, as Lang's case seems to prove (*Berl. klin. Wchnschr.*, xxii. 819, 1885). It would be of the utmost value if, in the case of ichthyosis developed in childhood, details of the

state of the skin at the time of birth could always or often be obtained. With regard, for instance, to ichthyosis hystrix (the so-called "porcupine disease"), it is usually stated that the disease was not present at birth, and it is therefore not included among the fœtal diseases; but a careful inquiry has in some cases elicited the information that, although the skin was not ichthyotic at birth, neither was it normal. For example, it has sometimes been stated that at birth red spots, or raw-looking areas, or bruises were visible upon the skin; these have a pathological significance, and ought to be inquired into.

Tylosis Palmæ et Plantæ.

Under this name, or under its synonym "keratoma plantare et palmare hereditarium," has been described a congenital disease characterised by a hypertrophy of the horny layer of the epidermis of the palms and soles only, and not of the general surface of the body. The horny plate upon the palms and soles has a thickness varying from one-eighth to one-sixteenth of an inch, and its surface is either smooth or pitted. In the case described by the late Dr. George Elder and myself (87), the palmar plate had a dirty yellow colour, and a hardness and roughness readily noticed on shaking hands with the little patient (a girl, 8 years of age). The thickening was greatest on the hypothenar eminences; but it was present also on the thenar eminences and on the palmar aspect of each finger; indeed, no part of the palm was quite free from it except along the lines of flexure. It did not, however, reach the dorsum anywhere, and it was sharply limited at the line of flexure of the wrist. Peeling in fairly large scales occurred at times, usually every spring and autumn. The soles were similarly affected.

In this case (seen by Elder and myself) there was, as has been so often found by other writers, a distinct history of transmission from ascendants to descendants. The mother had the same disease of the palms and soles, so had an aunt, and so had the great-grandmother and her sister. In this family tree all the affected persons were females; but this is not an invariable occurrence, for in another "hard-handed" family, one member of which I have seen, the disease was found in males and females in almost equal numbers. The latter family was that referred to by Dr. Allan Jamieson at a meeting of the Edinburgh Medico-Chirurgical Society (*Trans. Med.-Chir. Soc. Edinb.*, n. s., xx. 3, 1901). Further, in Thost's case (*Dissert.*, Heidelberg, 1880), in Unna's (*Vrtljrschr. f. Dermat.*, x. 231, 1883), in G. H. Fox's (*Journ. Cutan. and Vener. Dis.*, iii. 145, 1885), in W. Horton Date's (*Brit. Med. Journ.*, p. 718, ii. for 1887), in Hutchinson's (*Arch. Surg.*, i. 158, 1890; ii. 74, 1891), and in Radcliffe Crocker's (*Brit. Journ. Dermat.*, iii. 169, 1891), many members of the family were affected, but sex seemed to have absolutely no determining influence. Family prevalence and transmission from parents (or grand-parents) to children have been more frequently recorded in connection with this malady, perhaps, than with almost any other; this is a striking fact, and must have a meaning. But what?

Tylosis palmæ has rarely if ever been observed at the moment of

birth; but in some instances it was noticed in the first week of life and became very noteworthy when friction began to act on the palms and soles. Probably, if these parts of the body were carefully scrutinised at birth, some slight morbid change would be recognised. The lesion is usually painless; tactile sensibility is blunted, as is sensibility to heat, cold, and pain; there may be either dryness or increased secretion (hyperidrosis).

According to Thost (*op. cit.*), the microscopic appearances are as follows: "The papillæ are increased in length five-fold, although their breadth is somewhat less than normal; the prickle cells are not enlarged or altered, but are greatly increased in number, and the rete Malpighii is on this account much thicker; the stratum granulosum is normal; the horny layer is much thicker, and the cutis vera and vessels are also somewhat enlarged."

In its pathology it is probably more of the nature of a hyperacanthosis than of a hyperkeratosis; but all dermatologists are not agreed upon this point. To solve the difficulty by calling it a nævus is to darken what is already dark, for nævus is not a precise pathological term. Its pathogenesis remains most obscure. It seems to require intermittent pressure after birth to develop it fully, whereas in fœtal ichthyosis the thickening of the epidermis has occurred to its fullest extent antenatally. It is remarkably hereditary, in the usual sense of the word; and it has been suggested that it may be a reversion to the type of our arboreal ancestors. The exact limitation of the lesion is remarkable; and even if the disease be due to some anomaly in the epitrichium, the localisation of the anomaly is still unexplained.

The malady does not endanger life, although it may give trouble to the sensitive mind; and treatment has generally been directed towards diminishing the disagreeable roughness of the palms of the hands. Pumice-stone has generally been used, and some benefit has resulted from painting the affected parts with a solution of salicylic acid in ether.

Fœtal Keratolysis.

In my work, *Diseases of the Fœtus* (vol. ii. 188, 1895), I have described, under the name of *fœtal keratolysis*, a state of abnormal looseness of attachment or of actual desquamation of the epidermis of the living fœtus. Peeling of the cuticle normally occurs after birth, and when it takes place antepartum it is generally regarded as a sign (and a sure sign) of fœtal death and commencing maceration; but there seems to be no doubt that occasionally the living infant comes into the world with desquamation in full progress. I have already (p. 73) referred to the exaggeration of normal neonatal desquamation, which is called keratolysis neonatorum or Ritter's disease, but in that malady there is not always reason to believe that there were any changes occurring antenatally. In the present morbid state desquamation is already in active progress when the infant is born.

Its medico-legal importance is very evident, for, as Blundell

(*Obstetric Medicine*, p. 341, 1840) puts it, "Though the desquamation of the cuticle is a strong *presumptive* argument in affirmation of the death of the fœtus, it certainly is not *demonstrative*, for cases have been related—and among the rest one by Dr. Orme—in which the cuticle has separated in consequence of cutaneous affections, the child being alive notwithstanding."

I place fœtal keratolysis here among the idiopathic maladies, not because I think that it is never the manifestation of a transmitted disease (*e.g.*, measles, scarlet fever, erysipelas, syphilis), but simply to emphasise the fact that sometimes no such pathogenesis is possible. Doubtless, in some instances, it is the evident sign of the antenatal occurrence of syphilis or of one of the desquamative exanthemata; but in others a different explanation has to be sought. Thus, it is sometimes associated with general anasarca: in several of the cases I have examined I have noted this association, and A. Ribemont-Dessaignes (*Ann. de gynéc.*, xxxii. 8, 1889) ascribes it then to rupture of little epidermic vesicles containing opalescent fluid. In other instances it may be the sign of fœtal pemphigus, and in several of G. F. G. Hueter's eighteen cases (*Dissert.*, Marburg, 1858) it may thus have originated; in yet other instances it may simply indicate post-maturity of the fœtus due to a protracted gestation of the mother, as in the observations of A. W. Edis (*Brit. Med. Journ.*, i. for 1875, p. 44), and A. R. Manby (*ibid.*, ii. for 1879, p. 691). Finally, it may be due to some disturbance of the nutrition of the skin of a local kind, *e.g.*, compression of a large blood-vessel (H. T. Hanks, *Amer. Journ. Obst.*, xiii. 595, 1880). In Cordon's observation (*Journ. de méd., chir., et pharm.*, xxv. 556, 1767) there was family prevalence, three infants being born with it to the same mother. C. L. Göckel (*Miscell. curios.*, Dec. ii., Ann. vi., obs. 151, p. 313, 1688), finding that the mother had suffered from malaria in pregnancy, thought the fœtus had been scalded by the hot liquor amnii—"dieses Kind ist gebrühet auf die Welt kommen" he unhesitatingly averred.

In many of the recorded cases the infant died soon after birth, but in most of Hueter's observations it was alive when the mother left the Maternity Hospital. In some instances the desquamation was universal, affecting the whole body (*e.g.*, in Charrier's case, *Gaz. d. hôp.*, lii. 989, 1879); but in most it was more or less localised, and it is noteworthy that the localisation was not always to the parts which had been subjected to pressure in labour. Information regarding the vernix caseosa was not always forthcoming; in some of Hueter's cases it was absent, but in others it was copious. The desquamation itself was sometimes described as furfuraceous, sometimes as in "large flakes"; usually the exposed surface had a pale rose or salmon tint, and not the bright red colour seen in post-mortem maceration. The last-named character is not constantly distinctive, and Schuhl (*Arch. de tocol. et de gynéc.*, xix. 385, 1892) has reported a case in which both varieties of desquamation were present. The postnatal treatment will consist in the protection (by ointments, vaseline, cotton-wool, etc.) of the denuded areas of skin from the effect of cold, from irritation, and from septic infection. In the absence of antenatal diagnosis,

treatment before birth is impossible. The relation between this disease and keratolysis neonatorum, if indeed any relation at all exist, is not well known; much research is needed upon this point, as also in regard to its bearing upon the normal desquamation of the new-born infant.

Hypertrichosis Congenita.

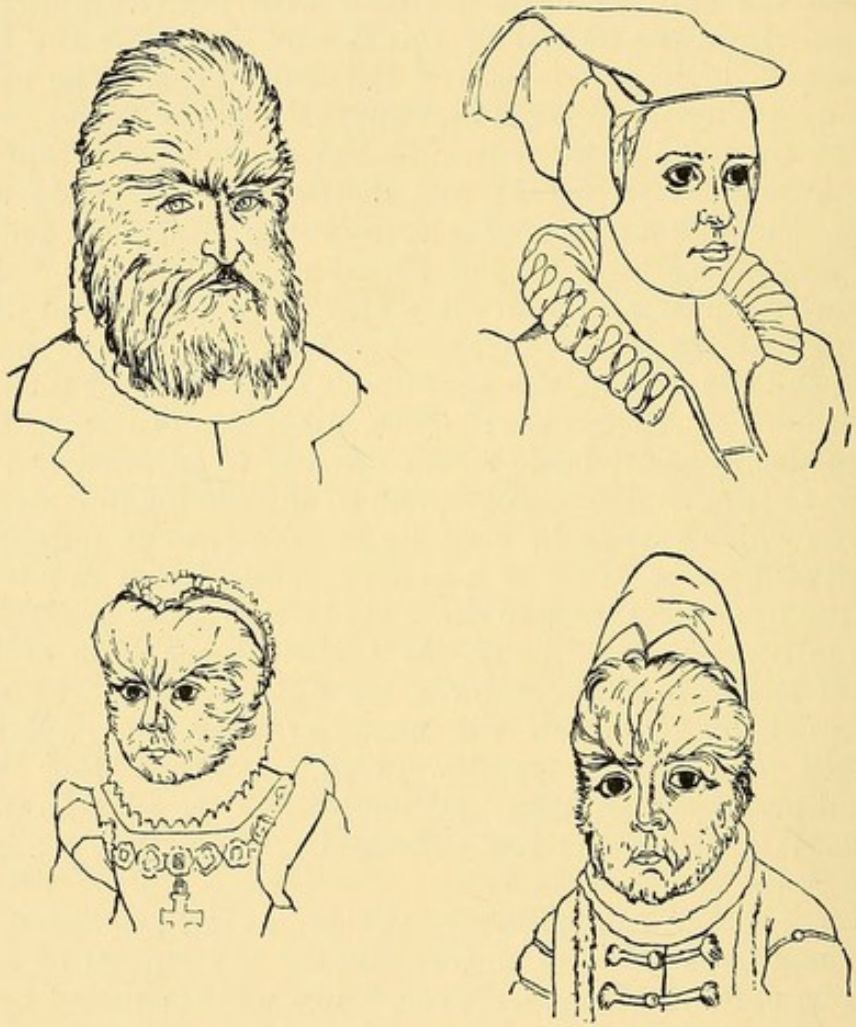
Hypertrichosis or excessive hairiness is a term having a somewhat wide range of application. The old woman who develops scattered hairs upon the chin, and the old man with bushy eyebrows and a copious growth in the nostrils, external ears, and over the body, are both instances of hypertrichosis of the senile type. The adult man whose body, either in a special and unusual locality or over its whole surface, is provided with hair, and the adult woman whose hairy covering resembles in extent and distribution the male type, are examples, the one of heterotopic, and the other of heterogenic hypertrichosis. Further, at the period of puberty the hair which then normally appears in both sexes may be excessive, and the girl at this time may show the arrangement and development of hair which belong to the boy; again, the appearance of the hair at puberty may be precocious in either sex: these, likewise, are hypertrichoses. There are also hypertrichoses which are due to injuries and diseases of nerves, to trophic disturbances, and to chronic inflammatory states. The nævus which carries hair on its surface (nævus pilosus) has by some writers been regarded as a hypertrichosis, but it is advisable to restrict the use of the term to the cases in which the underlying skin is apparently normal. Finally, the infant at the time of birth, or very soon thereafter, may show a general or a localised excessive growth of hair, to which the name of *congenital hypertrichosis* (*universalis, localis*) is correctly given. In the other varieties, congenital predisposition may, and doubtless does play an important part, but it is with the truly congenital form that we are here specially concerned.

If birth occur prematurely, the infant will show a sort of physiological hypertrichosis universalis, for the lanugo of fœtal life will still be present. This, however, is not what is meant by general congenital hypertrichosis, which is rather the persistence till birth at the full time and throughout postnatal life of this same lanugo, more or less altered in its physical characters. It is not yet definitely known in what relation excessive hairiness stands to the fœtal lanugo, and it is therefore not justifiable to define hypertrichosis as a persistence of the lanugo. Accurate reports are much needed of the condition of the hair at and immediately after birth in the subjects of this trichogenetic anomaly; doubtless this lacuna in our knowledge will ere long be filled, and we shall then know with some certainty whether the lanugo itself becomes the hair of the "hairy infant," or whether it falls off and is replaced by an entirely new growth.

Various names have been given to general congenital hypertrichosis, among which are *polytrichia, trichauxis, hirsuties adnata,*

dasytes, pilosism, and *hypertrichiasis.* Individuals affected with the anomaly in its most marked form have been called "hairy men," "homines pilosi," "human monkeys," "missing links," and "Esaus." German equivalents are "Haarmenschen," "Waldmenschen," and "Hundemenschen"; and in French the expressions "les hommes velus," "les hommes des bois," and "les hommes-chiens" are met with.

Cases of general hypertrichosis congenita are rare. The first recorded case seems to have been that of Esau, who "came out red all over like a hairy garment" (*Genesis* xxv. 25), or more literally "all of him as a cloak of hair." The meaning of this hairy birth



Figs. 41–44.

has greatly puzzled the commentators, and Kalisch pointed to it as "a foreboding of the animal violence of Esau's character." In the Middle Ages there was a difference of opinion also as to whether or not Esau's state constituted a monstrosity, and Pohlius, in 1669, wrote a work with the interrogative title, "De Questione an Esau fuerit Monstrum." Among other historical examples was the girl born near Pisa, hairy all over ("totam hirsutam"), whose mother had been gazing at a picture of John the Baptist during her pregnancy (*vide* T. Fienus, *De viribus imaginationis,* p. 224, 1635); and there was the hairy child belonging to the Ursini family, who had bear's claws as well as the hirsute covering. There was the remarkable hairy family ("homines

sylvestres") from the Canary Islands described by U. Aldrovandus (*Monstrorum Historia*, p. 16, 1642); and there was also "Die haarige Familie von Ambras," consisting of a hairy man, his wife normal in the matter of hair, and his hairy son and daughter (Figs. 41–44), described fully by C. T. von Siebold (*Arch. f. Anthrop.*, ix. 253, 1877–8). Another well-known example of hypertrichosis was "Barbara Ursler," who was publicly exhibited in London in 1655, and who is described in Caulfield's *Portraits, Memoirs, and Characters* (vol. ii. p. 168, London, 1794–5), and has been recently considered by Stricker (*Arch. f. path. Anat.*, lxxi. p. 111, 1877). John Crawford, who studied medicine in the University of Edinburgh in the early years of the past century, and who was afterwards envoy to the Court of Ava, brought before the notice of European authors the famous hairy family of Burma (*Journal of Embassy to the Court of Ava*, London, 1834); and many others have since contributed details regarding this family. It consisted of a hairy man married to a normal woman, of his hairy daughter, and of two hairy grandsons the children of the daughter by a normal man; the dentition of these individuals seems to have been defective (*vide* J. J. Weir, *Nature*, xxxiv. 223, 1886). Reference must also be made to the hairy Mexican woman, Julia Pastrana, described by J. Z. Lawrence (*Lancet*, ii. for 1857, p. 48), H. Beigel (*Arch. f. path. Anat.*, xliv. 418, 1868), F. L. Neugebauer (*Kilka slow o mezkiem owlosieniu u Kobiet*, 1897), and by J. Ranke (*Verhandl. d. München. anthrop. Gesellsch.*, 1–4, 1888); she seems to have had hypertrophy of the maxilla (E. Magitot, *Gaz. méd. de Paris*, 4 s., ii. 609, 1873). In Chowne's case (*Lancet*, i. for 1852, pp. 421, 514; ii. for 1852, p. 51) the hairiness was widespread although hardly universal; the patient, a woman, had a hairless brother and one hairy sister (Wilson, *Lectures on Dermatology*, p. 102, 1878). The girl Teresa Gambardella, described by C. Lombroso (*L'uomo bianco e l'uomo di colore*, p. 155, 1871), resembled Chowne's patient to a certain degree. Then there were the famous Russian "hairy men" or the "Kostroma people" described and discussed by many authorities (E. R. Perrin, *Bull. Soc. d'anthrop. de Paris*, 2 s., viii. 741, 1873; C. Royer, *ibid.*, p. 718; C. S. Tomes, *Brit. Med. Journ.*, i. for 1874, p. 413; R. Virchow, *Berl. klin. Wchnschr.*, x. 337, 1873; G. T. Jackson, *Med. Record*, New York, xxvii. 568, 1885; and A. Ecker *Gratulationsschrift*, Braunschweig, 1878); these two men (father and son?) had a very remarkable skye-terrier appearance, they were both nearly edentulous, and their nails were soft and thin (J. Parreidt, *Deutsche Monatsschr. f. Zahnhlk.*, iv. H. 2, 1886). Finally, among the well-known instances of hypertrichosis, there was Krao, "the missing link," who was seven years old when she was exhibited by Farini in London in 1883. When seen by A. H. Keane (*Nature*, xxvii. 245, 1882–3), she was of average intelligence, her face and low forehead were covered down to the bushy eyebrows with deep black, lank, and lustreless hair, Mongoloid in type; her whole body was overgrown with a less dense coating of soft black hair; the skin beneath was dark olive brown; the feet were prehensile, and the hands could be bent back at the wrists; and

there was slight prognathism. She was said to be the child of Siamese parents (*Nature*, xxvii. 579, 1882–3). Fauvelle (*Bull. de la Soc. d'anthrop. de Paris*, 3 s., ix. 439, 1886), writing in 1886, when Krao was about eleven years old, found the second dentition complete, save that the upper canines had not yet been cut.

From the preceding summary of the best known of the recorded cases of congenital hypertrichosis, certain outstanding characters in the *clinical history* and *symptomatology* will have been recognised. Heredity has been very evidently present in several cases, as in the von Ambras Family and the Hairy Family of Burma; family prevalence, also, was noted in several instances. In two cases reported by P. Michelson (*Arch. f. path. Anat.*, c. 66, 1885) these characters were also present: in one, the hairiness affected a man, (Joseph Fieber), a native of Silesia, his eldest daughter, his mother, and two brothers; in the other, the father was the subject of hypertrichosis, and so were two of his sons. In both of Michelson's family histories defective dentition was present, and it was sometimes transmitted along with the hirsuties and sometimes apart from it. The sisters Francina and Fytje P., described by Geyl (*Biol. Centralbl.*, viii. 332, 1888–9), were examples of the minor degree of hypertrichosis universalis. Lina Naumann, the hairy girl, seen by L. Fürst (*Arch. f. path. Anat.*, xcvi. 357, 1884), was, however, an exception to the above rule, for she was apparently the only member of her family affected; but she resembled Krao and Julia Pastrana in the possession of normal teeth set on hypertrophied alveolar margins. Marietta S., also, reported by C. Hennig (*Jahrb. f. Kinderhlk.*, xl. 107, 1895), seems to have been a solitary instance of hypertrichosis; but from the description it would appear to have been a case complicated with nævus pilosus.

Details of the state of the hairy infants at birth are sadly lacking. In Geyl's two patients (*loc. cit.*), marked hair on the scalp and long lanugo on the forehead and cheeks were present at birth, but at the age of two and a half years there was a sudden increase in the hair over the limbs and body. In Fürst's patient (*loc. cit.*) the abnormal hairiness of the body was clearly visible within the first week of life, and bushy eyebrows were noticed at birth. In the "homo hirsutus" described by Krebs (*Hosp.-Tid.*, 2 R., v. 609, 1878) the excessive hairiness did not appear until the third month of life. It was usually found that the face and hands were specially hairy, and this gave a very characteristic animal appearance to many of the individuals; but in Pickells' patient (*Edinb. Med. and Surg. Journ.*, lxxvi. 316, 1851) the face and hands were free, while the rest of the body was hairy. In some, the hair was very coarse, but in others it was soft and silky; usually it followed the lines of direction taken by the lanugo in fœtal life. The hypertrichotic condition apparently did not interfere with postnatal existence in any of the recorded cases, and it was not associated with sterility. There was sometimes a correlative variability seen in the dental development, and reference has been made to the alveolar hypertrophy in Julia Pastrana and others; but sometimes there was apparently compensatory defective

development of the teeth, as in the Russian "hairy men." It may be noted here that congenital alopecia has also been found associated with dental defects (*vide infra*), and Magitot (*loc. cit.*) has referred to it both in hairless men and in the hairless Chinese dogs. The Ainos of Japan are distinguished from Mongolian and Japanese peoples by a sort of racial hypertrichosis; they also show a marked development of the alveolar border of the superior maxilla with consequent prognathism (Ashmead, *Sei-i-kwai Med. Journ.*, xiv. 183, 1895).

The *pathogenesis* of hypertrichosis congenita is closely beset with problems. There seems to be something paradoxical in the idea that this excessive production of hair is an arrested development; but on examination it would appear that the theory of an arrest is better supported by facts than any other. The persistence of the lanugo is undoubtedly of the nature of an arrested development, for normally it is shed before or soon after birth. But is hypertrichosis a persistence of the lanugo? In order to answer this question, it would be necessary to have a knowledge of the state of the hair in "hairy infants" during the first hours of life, and more especially of its microscopical characters; this knowledge is not yet in our possession. We do not know whether in these cases a casting of the hair occurs at birth or not. As has been pointed out by P. G. Unna (*Histopathology of the Skin*, N. Walker's Transl., p. 1151, 1896), if the former be the case, and if the embryonic hair follicles, instead of becoming shorter all over the body at this period of life, retained their double length, then, in spite of the abundance of hair, it is justifiable to speak of hypertrichosis as an arrested development. But if on the trunk and limbs the ordinary casting of the hair had taken place in utero and all the hair follicles had shortened, and if, later, these follicles had (as occurs normally on the scalp) again expanded to the original (double) length, and so given rise to another and a very strong growth of hair, then the condition would be that of a true hypertrichosis, analogous to the hypertrichosis of puberty. Unna is of opinion that both these possibilities may occur, and that while for instance the former view holds with regard to the Russian "hairy men," the latter explains such cases as Krao and Julia Pastrana; he prefers to call the former (the simple persistence of the fœtal hair) "trichostasis" or "hair-stagnation," while the latter is true hypertrichosis. It is easy to exaggerate, as I think Unna does, the difficulty of accepting the theory of an arrest of development; congenital ichthyosis also is characterised by excessive growth (of the stratum corneum), and this is probably due to an anomaly of the epitrichium, likewise an arrest of development. If the theory be correct, then in some instances hypertrichosis is truly a monstrosity rather than a disease, while in others it is more correctly a disease; so that after more than two hundred years we might write again as Pohlius did in 1669, "De questione an Esau fuerit monstrum." In a similar unsettled state we must leave the question of the atavistic nature of congenital hypertrichosis.

No treatment has been proposed or indeed thought of for general hypertrichosis; but, for the localised form, electricity and the Röntgen rays have been employed for cosmetic purposes. The localised form,

it may be remarked, has usually been confounded with hairy nævus (nævus pilosus); but it ought to be distinguished from it, for in true hypertrichosis the underlying skin ought neither to be pigmented nor abnormally vascular. No doubt most of the cases of "bearded infants" and babies born with hairy "tails" have been instances of nævus affecting the face or sacral region, and the so-called "bathing drawers" nævus is a well-known variety of cutaneous pigmentation; but true cases of hypertrichosis localis occur, although rarely. For instance, there was A. H. Dodd's case of lumbar hypertrichosis (*Lancet*, ii. for 1887, p. 1063), and there was also Balmanno Squire's (*Brit. Med. Journ.*, i. for 1893, p. 1265), in which a patch of long hair was present on the side of the neck. L. A. Parry (*Lancet*, i. for 1896, p. 1717) recorded a case of lumbar hairiness affecting two sisters. The so-called "lady with the horse mane" was a case of hypertrichosis localised in the dorsal region; in this case there was a defect in the vertebral column (spina bifida occulta) underlying the hair. This association of lumbar hypertrichosis with spina bifida occulta has been noted by several observers in other cases, *e.g.*, by W. Stricker (*Arch. f. path. Anat.*, lxxiii. 624, 1878), by F. von Recklinghausen (*ibid.*, cv. pp. 243, 373, 1886), by C. Brunner (*ibid.*, cvii. 494, 1887), by G. Joachimsthal (*ibid.*, cxxxi. 488, 1893), and by others. In some of these instances there was a further complication which came on in later life, namely, perforating ulcer of the foot. Some of the cases reported as infants with tails were no doubt instances of lumbar hypertrichosis. Bland Sutton (*Lancet*, ii. for 1887, p. 4) wrote suggestively on this subject, as did also Emil Kruska (*Dissert.*, Jena, 1890).

Congenital Alopecia (Hypotrichosis).

It is well known that early baldness (alopecia prematura) is hereditary in some families; but true congenital alopecia, or the absence of hair at birth, is very rare. When this anomaly is met with, it is usually stated, as in J. B. Luce's case (*Thèse*, Paris, 1879), that the infant is hairless at birth, and remains so for months or even years, but that ultimately a certain degree of hairiness is attained. P. de Molènes (*Ann. de dermat. et syph.*, 3 s., i. 548, 1890) also reported a case in which at birth there were only a few downy hairs on the scalp and a few eyelashes; some years previously the mother had suffered from alopecia, and she had given birth to another child who had developed alopecia of the scalp some time after birth; the present child, a female, had normal nails, and the first dentition progressed in the usual manner; under treatment, hair began to appear at the age of four years. The author regarded the alopecia as a trophoneurosis, and from the standpoint of Antenatal Pathology we may look upon such cases as instances of delayed sprouting of the hair. In another group of cases the congenital alopecia persists throughout life. This was apparently the condition of affairs in M. Schede's two patients, a brother and a sister (*Arch. f. klin. Chir.*, xiv. 158, 1872), whose heads were as smooth as a billiard-ball ("wie eine Billardkugel"); hair

rudiments were found only in the deep layers of the cutis. Possibly this was also the case in the Australian hairless individuals (brother and sister) described by N. Miklucho-Maclay (*Verhandl. d. Berlin. Gesellsch. f. Anthrop.*, p. 143, 1881). In yet another group of cases the alopecia is associated with defective dentition and nail-formation (J. Thurnam, *Med.-Chir. Trans. Lond.*, xxxi. 71, 1848). Several instances of this type are referred to by R. Bonnet (*Uber Hypotrichosis congenita universalis*, Wiesbaden, 1892), who also mentions examples in the lower animals. It would appear to be transmitted by heredity (J. Hutchinson, *Arch. Surg.*, ii. 253, 1891). Perspiration may also be entirely absent.

It is quite evident that congenital alopecia is an arrested development, and its association with defective formation of the nails and teeth emphasises and confirms this conclusion. Evidently the arrest may neither be complete nor permanent, and in this manner are produced the various types which have been described above. Treatment with stimulating applications and perhaps thyroid extract ought, therefore, to be persisted in, for it may be ultimately rewarded by success. Antisyphilitic treatment ought also to be tried, as alopecia may be due to syphilis.

Like hypertrichosis, alopecia is a malformation rather than a disease; and with it as with hypertrichosis the question at once arises if it can at all be regarded as idiopathic, since it seems in some cases to be hereditarily transmitted and to show family prevalence. I do not attempt to justify the inclusion of these two morbid states in the group of the idiopathic diseases of the fœtus; but I repeat that I regard the group as a convenience rather than as an expression of strict classification. Further, there are many cases in which no heredity can be traced.

Antenatal Pemphigus.

In 1891, Bar (*Arch. de tocol.*, xviii. 953, 1891) met with a case of pemphigus in an infant at birth; there were also patches of denuded skin on the scalp, and he suggested that in some instances the hairless areas of alopecia might be looked upon as the final stage in the development of the bullæ of pemphigus. Whether this supposition prove to be right or wrong, there can be no doubt that in certain cases pemphigus affects the fœtus. I have already (p. 74) referred to the occurrence of pemphigus in the new-born infant, in whom it may be due to syphilis or to some septic or infectious condition; but there are also instances in which the child is born with a strongly marked and often a transmitted tendency to form bullæ on the slightest provocation, *e.g.*, a slight blow. In these cases the tendency is doubtless present in antenatal life, although sometimes no bullous formations are noticed till the second week of life. It has been proposed to separate this morbid tendency from ordinary pemphigus neonatorum, to call it "congenital traumatic pemphigus," or to give to it such names as "epidermolysis bullosa," "congenital bullous dermatitis," and "hereditary dermatitis bullosa"; further, attempts

have also been made to separate two sub-varieties, under the designations of "bullous dermatosis" and "epidermolysis bullosa"; but it is generally agreed that in the present state of our knowledge dermatologists are not warranted in making these distinctions. There is in all the cases a constant tendency to form bullæ (containing blood or serum) after the most insignificant traumatism; this tendency is noted at or very soon after birth; the general health is unaffected; sometimes the malady tends to disappear, sometimes it is accompanied by the formation of epidermic cysts; and often there is a distinct history of heredity and family prevalence. The nails are often defective. A considerable number of articles have appeared dealing with this disease, among which I may mention those of Tilbury Fox (*Lancet*, i. for 1879, p. 776), A. Goldscheider (*Monatsh. f. prakt. Dermat.*, i. 163, 1882), A. Valentin (*Berl. klin. Wchnschr.*, xxii. 150, 1885), Max Joseph (*Monatsh. f. prakt. Dermat.*, v. 5, 1886), Carl Blumer (*Dissert.*, Zürich, 1892), H. Hallopeau (*Ann. de dermat. et syph.*, 3 s., vii. 453, 1896), M. V. Augagneur (*ibid.*, viii. 665, 1897), Wallace Beatty (*Brit. Journ. Dermat.*, ix. 301, 1897), T. Colcott Fox (*ibid.*, ix. 341, 1897), and John T. Bowen (*Journ. Cutan. Gen.-Urin. Dis.*, xvi. 253, 1898). Little is known of the pathology of the affection, and much less of its pathogenesis; to describe it as an angiotic acantholysis does not add much to our knowledge of its exact nature. The antenatal factor, however, is an important one, and possibly when the mechanism of neonatal desquamation is better understood, so will also that of hereditary bullous formation. Blumer (*op. cit.*) compared the disease with hæmophilia: both maladies are congenital and inherited, and due to a defective formation of the blood vessels which may be termed "dysplasia vasorum"; in hæmophilia bleeding occurs, in epidermolysis exudation. According to Wallace Beatty (*loc. cit.*), whose paper contains many bibliographical references, the bullæ may form either in the stratum corneum or may involve the rete mucosum also. Drugs or other treatment have hitherto been powerless to influence the progress of the disease, but chloride of calcium might be tried antenatally as well as postnatally.

Congenital Absence of Skin.

In March 1859, W. O. Priestley (*Trans. Obst. Soc. Lond.*, i. 60, 1860) exhibited a drawing taken from the head of a new-born child, which showed a curious "circular wound" of antenatal origin. It was quite circular, was as large as a shilling, and was situated directly over the posterior fontanelle. It seemed as if "a piece of the scalp had been punched out by a circular instrument." The process of repair had begun, the edges of the wound were still sharply defined, and its floor was formed by the pericranium with its supply of delicate capillaries. The cranial bones were entire and of their usual form. The child was well formed, there were no skin eruptions, and a profusion of dark hair covered the head except in the above-mentioned circular patch. There was no history of syphilis, and the

labour (the mother's third) had been comparatively easy. In 1880, Hans von Hebra (*Mitth. a. d. embryol. Inst. d. k. k. Univ. in Wien.*, ii. 85, 1880–83) described a somewhat similar case, in which the cutaneous defect was also on the scalp but was bilateral and had a more elongated and irregular form. These patches, reaching from the outer angle of the eye outwards and upwards, had a reddish-yellow colour and carried no hairs; they were thus easily distinguishable from the surrounding scalp, which was covered with long hairs. The parents were healthy and the labour had been normal. The bones of the head showed no defects, and there were no signs of pemphigus or any other skin disease. The child died when five days old from peritonitis. The microscopical appearances showed a real defect in the development of all the layers of the epidermis and of the associated glands, fat, and hairs; the surrounding normal skin was sharply marked off from the defect. In neither of these cases were details regarding the placenta and membranes given. A third case resembling those already described was put on record in 1894 by V. W. Matthes (*Dissert.*, Marburg).

An earlier observation than any of these, seems, however, to have been that of W. Campbell of Edinburgh (*Edin. Journ. of Med. Sc.*, ii. 82, 1826) who, under the title of "Congenite Ulcer on the Cranium of a Fetus," described a case in which there was an area without skin about the size of a crown-piece situated between the bregma and the posterior fontanelle; bleeding from this denuded area took place, proving fatal, on the eighteenth day of life. Curiously enough, the mother of this child in her next pregnancy gave birth to another infant with a similar spot on the scalp, but in this instance cicatrisation had begun in utero. The labour was easy and natural.

These cutaneous defects, however, are not always localised on the scalp, for Hochstetter (*Charité-Ann.*, Jahrg. xix. 542, 1894) met with the case of a full-time male fœtus with patches on each side of the abdomen, a little above the level of the umbilicus; these were somewhat triangular scars which had been bright red at birth; there was club-foot on the left side; and the placenta and membranes were said to be normal. Other cases were that reported by B. S. Schultze (*Ztschr. f. Geburtsh. u. Gynäk.*, xxxi. 225, 1895), in which there was also paralysis of the right facial nerve and contracture of the right sternomastoid muscle; that seen by Hugo Goldberger (*Centralbl. f. Gynäk.*, xx. 784, 1896), in which the infant was one of twins, the other twin being a fœtus papyraceus; and that recorded by F. Ahlfeld (*Eine neue typische Form durch amniotische Fäden hervorgebrachter Verbildung*, Wien, 1894), who regarded the defect as due to the tearing through of an amniotic adhesion. Ahlfeld referred also to cases by Dohrn (*Ztschr. f. Geburtsh. u. Gynäk.*, xiv. 366, 1888) and R. von Braun (*Centralbl. f. Gynäk.*, xviii. 73, 1894), in the latter of which the cutaneous defect was situated on the knees.

In some instances the skin defect was associated with other malformations, *e.g.* polydactyly, and this fact seemed to Ahlfeld to support his theory of the amniotic origin of these denuded areas. We must imagine the existence of a tubular adhesion between the

amnion and the skin surface; if this is torn across near the skin, the resulting absence of the superficial layers of the integument will be produced. The whole question of amniotic influence will require consideration under the heading of Teratogenesis, but in the meantime it may be noted that the recorded absence of any gross alterations in the placenta and membranes does not exclude the possibility of the existence of amniotic adhesions. At first, the amnion is in contact with the surface of the embryo in its whole extent; normally it separates everywhere from it as the liquor amnii is secreted; but, under some circumstances, this separation does not take place perfectly, and the attached amnion is drawn out into a band, a so-called amniotic adhesion. The tearing across of this "adhesion" would give rise to a raw area if the tear be close to the skin. If, on the other hand, the tearing across be at some distance from the skin, the result may be a small projection which might be called an amniotic appendage or perhaps an amnioma. In a case reported by J. Dalston Jones (*Trans. Med.-Chir. Soc. Lond.*, 2 s., xiv. p. 59, 1849), a cutaneous defect and a nipple-like projection existed side by side. Such an appendage or nipple-like process was, I believe, the congenital growth which I described some years ago as an acanthoma of the hairy scalp (98). With its description I may close this chapter on Fœtal Diseases of the Skin.

Acanthoma or Amnioma of the Skin.

In October 1896, one of my midwifery students at the Western Dispensary, Edinburgh, informed me that he had been much puzzled to make out the fœtal presentation in a case of labour attended by him on the previous day. His first diagnosis of a vertex presentation had been weakened by the detection of a finger-like projection attached to the presenting part. He was not long in doubt, however, for the labour terminated speedily and naturally; it was then seen that the vertex certainly had presented, but that there was also a congenital growth attached thereto, and it was this that had simulated the presence of a finger. It may be said that the infant, a girl, was the ninth child of a healthy mother, aged 34 years. There were eight brothers and sisters, some of whom were rachitic, and all the nine children had been born within twelve years. The present pregnancy had been quite uneventful; even the ubiquitous and popularly omnipotent maternal impression was wanting. The child showed no other malformations, and there was no family history of deformity. The tumour showed some tendency to wither; but in three weeks I excised it, as the mother was most anxious that the deformity resulting from its presence should be removed. One small artery spouted as the base of the growth was being cut through, but two stitches controlled the hæmorrhage, and the wound healed rapidly.

Attached to the right side of the vertex of the child's head, about half an inch from the line of the sagittal suture, and nearly midway between the anterior and posterior fontanelle, was the finger-like growth. It will save many words of description if I simply state that

it very closely resembled the infant's thumb, both in size and shape. Of course, however, it carried no nail. It stood out from the surrounding hairy scalp on account of its being covered by a delicate pink and hairless skin, and a slight constriction about its middle was clearly visible (Fig. 45).

At its base of attachment the surrounding skin was slightly irregular and thickened. It usually lay flat against the head, but it could be placed vertically, and, indeed, was freely movable. It had evidently no connection with the underlying bone or with a suture. No hard rod could be felt in it, and in fact it had almost the consistence of a lipoma, which at first it was thought to be. At the same time I was struck by the resemblance it bore to a preauricular appendage which I met with and removed some time ago. It was therefore with considerable interest that I looked forward to its

FIG. 45.

microscopic investigation. It may be noted that the skin of the scalp was normal, and was well supplied with dark hair.

The growth was embedded in paraffin, and horizontal sections were cut in the usual way. The characteristic appearances are exhibited in Fig. 46. The most striking feature is the marked development of the prickle-cell layer of the epidermis, without the least indication of a coincident increase of the stratum corneum. There is, therefore, hyperacanthosis without hyperkeratosis.

Another interesting character is the presence of sebaceous glands in every stage of development, from the simple slight downgrowth of the epithelium to the fully elaborated gland, and showing all the stages between the undifferentiated cell of the epithelium and the highly specialised cell of the gland. Nevertheless no hairs were to be seen in any of the sections examined. There is no adipose tissue

to be noted, and the corium presents no striking alterations; here and there traces of sudoriparous glands were visible, but no spiral ducts were observed. At certain places, and especially near the terminations of the sebaceous glands, open spaces were noticeable, but I am inclined to regard these as artificially produced during preparation for histological examination. Finally, there was no central rod of cartilage, and the vascularity of the tumour was little marked; there was no pigmentation.

The congenital growth in this case consisted, as has been shown, of skin; but it has to be noted that in certain particulars the skin was in an imperfectly developed state. There were no hairs, although the tumour took its origin from a scalp well supplied with hair; the sweat glands were only represented by traces; the sebaceous glands

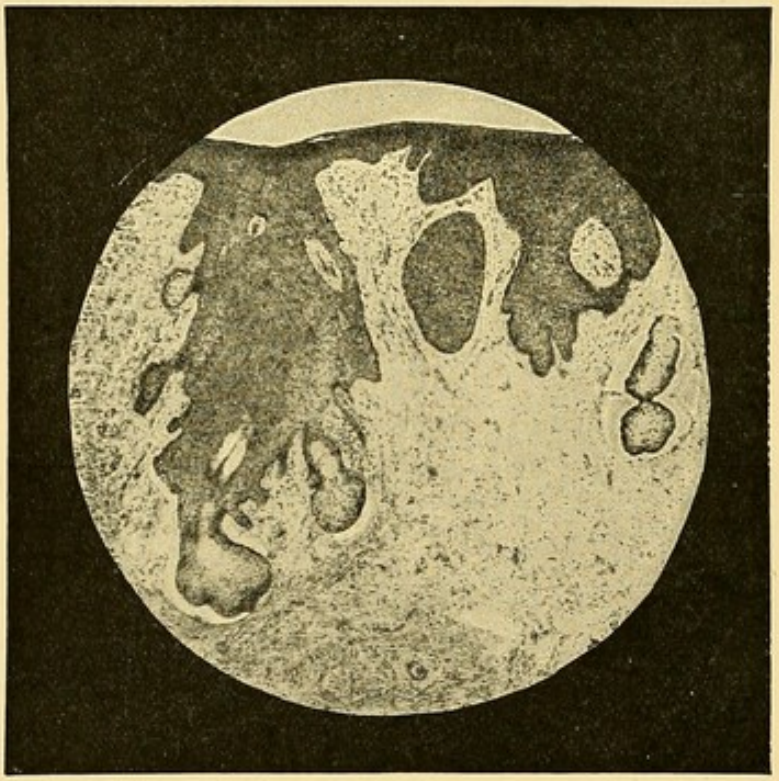


Fig. 46.

were present in every stage from the most rudimentary to the fully formed; and there was a total absence of adipose tissue in the subcutaneous layer. The outstanding feature was the hyperplasia of the prickle-cell layer. The first impression gained from the study of the histology of the growth was that here we had to do with tissues which had fallen behind in the general development of the body. The second notion was that some source of irritation must also have been in action, for, as Dr. Allan Jamieson (who was kind enough to examine the sections with me, and advise me thereupon) pointed out, the appearances, especially in the Malpighian layer, closely resembled those seen in some forms of chronic eczema. These ideas, along with a similarity in the appearance and history of the growth, led me to examine again a preauricular appendage which I removed in 1894 from a boy, 12 years of age. Although smaller in size, it resembled

in appearance, consistence, and clinical history the tumour now under consideration. In its histology it showed a similar imperfectly developed condition of the subcutaneous parts, with, however, a more mature epidermis and epidermic appendages; but then, of course, it must be remembered that it had been attached for twelve years to the patient's face. A plate representing the microscopical appearances of this preauricular growth accompanied the paper in which I recorded its history and inquired into its mode of origin (75).

It seems to me that it is a probable explanation of the origin of both these nipple-like processes, to regard them as due to delayed separation of the amnion from the body surface, resulting in a drawing out of the underlying parts in the form of a small projection. The structure of the projection will depend upon the nature of the underlying parts: if they contain cartilage, so probably will the projection; if they are simply made up of incompletely developed skin, then that will be the chief constituent of the projection.

At the time when I published the above case, I called it interrogatively an acanthoma on account of the hyperplasia of the prickle-cell layer; but that term scarcely conveys to the mind the idea of immaturity in the elements of the skin, which is, I believe, so important a character of the appendage. To call it an amnioma is of course to take for granted its amniotic origin, and it cannot be definitely proved that such is its origin. Nevertheless, I have placed the observation here, at the end of this chapter on the Fœtal Skin Diseases, to suggest to others the need for the investigation of all such appendages and so-called amniotic adhesions.

It will have become evident to the reader, if he has carefully considered the types described in this chapter, that fœtal skin diseases lie on the border line between diseases and malformations. He will be prepared to admit that several of them would be much more correctly named malformations (even "monstrosities") than diseases. From the scientific standpoint also many of them fall into the category of malformations, for they represent delayed or disturbed formation of the skin or of parts of it. This is one of the chief reasons (if it be not the chief) why fœtal skin diseases differ so widely in their characters from postnatal cutaneous affections. That they arise in the fœtal period and yet are malformations is, I need hardly say, due to the fact that till quite the end of the fœtal epoch of antenatal life the skin has not completed its development; it is still in the embryonic or formative stage when most of the other tissues have passed out of that into the stage of growth and active functional life. But this projection of embryonic into fœtal life has been already (*v.* pp. 93, 97, 98) discussed, and need not be further referred to. I may close this chapter with the reflection, which is a most obvious one, that in the future the dermatologist and the obstetrician must work more into each other's hands, if progress is to be made in the study of the pathology and pathogenesis of "congenital skins." Let a fresh advance be made, then, and by the help of such an obstetrico-dermatological alliance let progress be accomplished in this direction. *Renovate animos!*

CHAPTER XIX

Types of Idiopathic Diseases of the Fœtus (*cont.*): Diseases of the Bones: Nomenclature; Classification; Type A, Characters; Type B, Characters; Type C, Characters; Type D, External Appearances, Clinical History, Pathology, Pathogenesis; Type E, Characters; Bibliography.

Diseases of the Fœtal Skeleton.

To describe with any pretence to clearness and exactness the morbid conditions of the fœtal bones, is an impossibility at the present time. The skeleton at birth is still partly in the embryonic or formative stage, and diseases and malformations of its constituent parts are associated together in a manner which proves disconcerting to the pathologist, and altogether fatal to the best hopes of the nosologist. Notwithstanding the accumulation of many observations of congenital bone disease, and notwithstanding their investigation by eminently competent observers, it is still preferable to avoid any classification of them. Possibly it would be well to do here as I have done elsewhere (8), and group them together under the one comprehensive title of "osteogenesis imperfecta"; at the same time it is only fair to indicate some of the types which have been marked off and described by various workers in this most difficult department of antenatal pathology.

Before doing so, however, let me point out that the fœtal bone diseases are grouped with the idiopathic maladies simply for convenience, and not because it is certain that they always arise, as it were, spontaneously in the fœtus. They are not, as has been said already, always *diseases*, they are sometimes malformations in the correct sense of the word; neither are they always *idiopathic*, they are sometimes transmitted in the widest sense of the word. Some proofs of this latter statement may here be furnished. Porak (*De l'achondroplasie*, Clermont, 1890), for instance, records a case of the disease known as achondroplasia, in which both mother and fœtus showed the same anomaly of the skeleton. Further, G. Boeckh (*Arch. f. Gynaek.*, xliii. 363, 1893) gives in detail the family history of an achondroplasic woman, whose sister, niece, father, and great-great-grandfather were all affected with the same condition of dwarfism. It has occasionally been found that other kinds of antenatal bone diseases show this transmission from ascendants to descendants. It would seem, however, to be a rare occurrence. Still more interesting are the results of some experiments by Charrin and Gley (*Compt. rend. Soc. de biol.*, 10 s., ii. 705, 1895; iii. 220, 1031,

1896); these observers succeeded, by inoculation of the parent animals with the toxins of diphtheria, tubercle, and blue pus, in producing some young ones with deformities of the hind limbs resembling the condition known as "fœtal rickets" in the human subject. The animals experimented upon were rabbits, and the males alone were inoculated with the pyocyanic toxin.

Nomenclature.

Many pathologists and not a few obstetricians have written on the subject of fœtal rickets. As a general rule, those who have written with an experience based upon the examination or dissection of one case or specimen have not succeeded in clearing up, to any appreciable extent, the obscurity that surrounds the whole subject; their contributions are often of great value as records of individual cases, generally very fully described, but suggest little that is helpful to an understanding of the large problem of the relation of antenatal bone diseases to each other. Those who, like E. Kaufmann (*Untersuchungen ueber die sogenannte fœtale Rachitis*, Berlin, 1892), have been fortunate enough to be able to study a series of specimens, have done more to elucidate the whole subject; but even they have had the greatest difficulty with the nomenclature of fœtal bone diseases. Many names have been given and much confusion has reigned, for one observer, finding that his case did not exactly resemble one previously reported by another observer, has either coined a new name altogether, or has added a qualifying adjective to the original designation. A third observer, finding his specimen to be dissimilar to that of the second, gave to it yet another name; and perhaps a fourth might have a case which was really an exact reproduction of the first of the series, and yet he might coin still another term for it, not being aware of the connecting links. In this way, or in some other yet more complicated way, the terminology of fœtal bone diseases has become almost hopelessly confused, and out of this confusion have come the names, *fœtal rickets, so-called fœtal rickets, intrauterine rickets, micromelic rickets, annular rickets, chondritis fœtalis, pseudo-chondritis, osteogenesis imperfecta, achondroplasia, chondrodystrophia fœtalis, chondromalacic micromely, congenital cretinism, cretinoid dysplasia, osteoporosis, osteopsathyrosis, periosteal aplasia with osteopsathyrosis, defective endochondral ossification*, and *rachitis congenita*. So great is the confusion that has arisen, that I am not using exaggerated language when I maintain that it would be better if all the names were abolished, and a series of types, named A, B, and C, instituted in their place. For a careful study of the literature, and especially an inspection of the accompanying illustrations, shows beyond a doubt that the same name has been given to different pathological and clinical conditions, and different names to the same. "Fœtal rickets" is a most glaring example of this, and it, at any rate, must, I am convinced, be abandoned henceforth; "achondroplasia" is another instance, although, perhaps, it may be retained for its conciseness, and perhaps, also, for its indefiniteness (!).

Classification.

We have not yet reached the time when a scientific classification of fœtal bone diseases on pathological lines is possible; it is not yet clear, even, whether the various morbid conditions met with in the skeleton at the time of birth are different diseases or simply different stages in the same disease. If any name whatever is to be given to all the fœtal bone diseases as a group, it might be preferably "osteogenesis imperfecta," the denomination introduced by Vrolik (*Tabulæ ad illustrandam Embryogenesin*, Tab. xci. Amsterdam, 1849) in 1849, and used recently by H. Stilling (*Arch. f. path. Anat.*, cxv. 357, 1889), and others. If this were done, then under this single name would be assembled cases in which the defect was in the endochondral ossification (J. Symington and H. A. Thomson, *Proc. R. Soc. Edinb.*, xviii. 271, 1891), others in which it affected the periosteal (S. Müller, *München. med. Abhandl.*, 2 R., Heft 7, 1893), and others in which there was apparent excess in formation of some parts of the skeleton (J. W. Ballantyne, *Edinb. Med. Journ.*, xxxv. 1111, 1890). Kaufmann, in his large monograph (*op. cit.*), employed the general term "chondrodystrophia fœtalis," and grouped under it four varieties of altered growth of cartilage: (1) a softening of it, constituting chondrodystrophia malacica; (2) an arrestment of its growth, chondrodystrophia hypoplastica; (3) a growth unaccompanied by increase in length of the bones; and (4) an active but entirely irregular growth of it, chondrodystrophia hyperplastica. I believe it will eventually be found to be possible to group the fœtal bone diseases in classes according to the period in antenatal life when they were developed; at the one end of this series might be the changes in the bones which occur at the close of the intrauterine life, and which resemble infantile rickets; at the other end would be the changes which are evidently teratological, and which are doubtless initiated in the embryonic epoch; while in the middle would be a number of cases in which could be traced some resemblances to infantile rickets along with alterations which could only be regarded as malformations or deformities. In the meantime, and for lack of knowledge, I propose to describe certain types under the headings of Type A, Type B, etc.: this plan may be unsatisfactory, but at least it avoids the coining of new names, and the alteration of the meaning of old ones.

Fœtal Bone Disease (Type A).

It will be convenient to take, as Type A, that form of fœtal bone disease which there is some reason to regard as rickets. It resembles as closely the form of rickets which develops in the second year of life, as any antenatal disease can resemble any postnatal one; for, as has been pointed out already several times, the intrauterine environment must modify the manifestations of disease occurring before birth, and produce in it characters dissimilar to those developing after birth. If I were to adopt any special name for this disease, it should be "congenital rickets," but I simply denominate it Type A.

The characters are due to abnormal softness of the bones, and are to be recognised in a state of craniotabes (often very marked), and in considerable curving and shortening of the long bones. The disease cannot be diagnosed by simple inspection of the infant, but requires palpation and careful mensuration. I believe that sometimes the only evidence of the disease is to be found in the state of the cranial bones, although I admit that if this conclusion be accepted it becomes very difficult to separate these cases from syphilis. In 1899, Dr. Jas. R. Watson of Hamilton sent to me for examination a male infant, six weeks old, who showed very marked imperfect ossification of the cranial bones. In fact, the cranial vault felt as if composed of a number of Wormian bones. The history of the case was interesting. The mother, age 27, 1-para, had suffered greatly from vomiting in the last two months of pregnancy, and had been very weak at the time of her confinement. She had internal strabismus of the right eye. The labour was characterised by almost complete uterine inertia; Dr. Watson delivered by means of forceps; and there was some third stage hæmorrhage. The craniotabetic condition of the infant was recognised during the labour, and it was quite marked at the time of birth; it had not got any worse, in fact there had been some hardening up of the bones at the time when I saw the child. There was no hydrocephalic enlargement, and the occipito-frontal circumference measured 15½ inches. The occipital protuberance was very prominent, and the palate had a high arch anteriorly. The hands and feet were well formed. There was some snuffling during suckling, but no history of syphilis was elicited (I interviewed both parents). I am inclined to regard this case as an example of Type A. It is an interesting fact that on account of the vomiting the mother should have been so ill nourished at the close of her pregnancy. At the present time (November 1901) the cranial bones are ossified, but the fontanelles still remain open, but show signs of closing. The child has developed a squint resembling that in the mother. The intelligence is very good.

If we regard this case and others resembling it as examples of rickets present at birth and developing during the last trimester of pregnancy, then the question of frequency arises. In respect to this matter the greatest divergence of opinion would appear to exist. According to F. Schwarz (*Med. Jahrb.*, Wien, n. F., ii. 495, 1887), of 500 new-born infants at the Second Vienna Obstetric Clinic, 80·6 per cent. showed rachitic changes in the skull or in the ribs, or in both skull and ribs; the mothers had nearly all been under bad hygienic conditions during pregnancy. According to F. Fede and E. Cacace (*Pediatria*, viii. 41, 1900), on the other hand, congenital rickets is comparatively rare. These observers made a series of very careful measurements of the length of the body and of the cranial and thoracic circumferences in 500 new-born infants in Italy. They employed a special measuring instrument or brefomacrometer; and they made observations, also, on the sutures and fontanelles. Only one case out of the five hundred showed all the clinical features of rickets, and only four others exhibited craniotabes. Even if the

cases of craniotabes be admitted as rachitic, it follows that only in one per cent. of infants born in maternity practice is there evidence of congenital rickets. Irregularities in the sutures and fontanelles were frequent; but Fede and Cacace did not regard these as signs of incipient rickets, but as evidence of a retarded development. So far as my own experience goes, it agrees with the estimate made by Fede and Cacace rather than with that furnished by Schwarz.

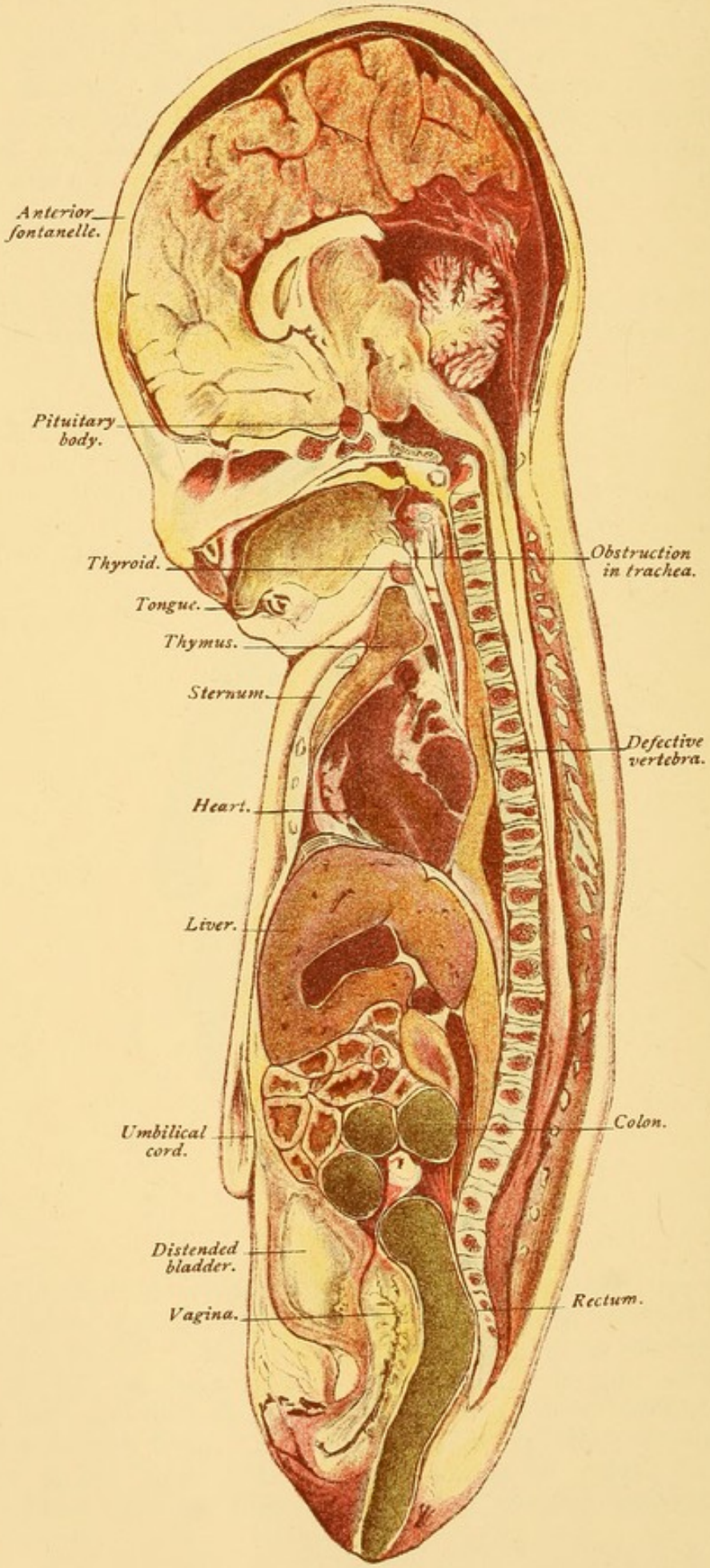
Fœtal Bone Disease (Type B).

As an example of Type B, I take the specimen of bone disease sent to me by Dr. Samuel Davidson (Fig. 47) in 1893. The fœtus

Fig. 47.

was the result of the seventh pregnancy of a woman, age thirty-two, who had enjoyed good health, but who had been married when only fifteen years old. All her pregnancies had gone to the full term, all the infants had been born alive, and all had been fed at the breast. One child had died at thirteen months from "convulsions," and one at one month from "bowel-hives." During the pregnancy which ended in the birth of the diseased fœtus, the mother had suffered more from vomiting than on any other occasion, and had not felt

PLATE XI


Anterior fontanelle.
Pituitary body.
Thyroid.
Tongue.
Thymus.
Sternum.
Heart.
Liver.
Umbilical cord.
Distended bladder.
Vagina.
Obstruction in trachea.
Defective vertebra.
Colon.
Rectum.

fœtal movements so strongly. There was hydramnios; the infant was dead when born, but must have died during delivery, as fœtal movements were felt at the beginning of the labour. The umbilical cord was only a foot in length. There was partial placenta prævia, which caused considerable hæmorrhage during labour, and was probably the cause of the infant's death. The father was a healthy man, but much addicted to the use of alcohol in excess. There was no family history of bone disease. The fœtus, a female, weighed 2160 grms., and its length with the lower limbs in the position seen in Fig. 47 was 38 cms.; the distance from finger-tip to finger-tip with the arms extended was 32 cms. The occipito-frontal circumference of the head was 33 cms., and the occipito-mental, 37 cms. It was evident at a glance that the infant was abnormal. The lower limbs were fixed in an unnatural position; the thighs were sharply abducted and passed outwards almost at right angles to the pelvis, the legs were partly flexed, and showed a marked concavity on the inner aspect, and the feet were turned sharply inwards. Both the lower and upper extremities seemed slightly shorter than is normal, and on both there seemed to be some deepening of the natural flexures. The head was broader than usual, and the nose short and somewhat flattened, with a depressed bridge; the eyelids were thick, and the cheeks prominent; there was a very evident double chin. The abdomen was prominent; and the whole body had a plump appearance, due to the presence of a thick layer of subcutaneous tissue. Palpation revealed a soft and imperfectly ossified cranium; the limbs could be moved with difficulty, and when this was done a creaking sensation was felt at all the joints. During manipulation the femora were fractured, indicating the presence of fragility.

A frozen section of the fœtus was made, and the appearances found are represented in Plate XI. The bladder contained more than 60 c.c. of non-albuminous urine, and the stomach (not seen in Plate XI., which shows only the right side of the body) was distended with over 200 c.c. of albuminous fluid (liquor amnii?). The section may be usefully compared with that shown in Fig. 17 (p. 102). The thinness of the bones of the cranial vault is to be noted, as is also the normal ossification of the basis cranii. There was absolutely no indication of hydrocephalus, a fact which lateral sections demonstrated more clearly than this mesial one. The internal organs, including the thyroid and thymus, had their normal appearances and relations. A plug of mucus (?) was seen blocking the larynx and upper part of the trachea. The ossification of the sternum was not far advanced; and although there was the normal number of vertebræ, some of those in the dorsal region were evidently defective. The spinal column exhibited the usual antero-posterior curves seen at this age; but there were some lateral bends in the dorsal region which are pathological. The conclusion to be drawn from a study of the sectional appearances is, that save in the ossification of the sternum, the cranial vault, and the vertebræ, there is nothing abnormal in the anatomy of the head and trunk. The limbs, however, were obviously abnormal, for in addition to their curvature

and to the fragility of the bones, there was some actual shortening, each arm measuring 14 cms., and each leg 13 cms., in a stretched out position. The length of the trunk and head from vertex to perineum was 33·5 cms. There was no marked epiphysial enlargement of the long bones. The fractures were situated about the middle of the shafts, and were not "green-stick" in character.

It may be asked whether this case and those that resemble it are instances of rickets or of some other malady, and I think the answer must be that it is quite possible that this malady is rickets. Perhaps, also, it may be regarded as rickets beginning at an earlier date in intrauterine life than in Type A. If, however, any separate name is to be given to it, then the term "osteogenesis imperfecta" would be not unsuitable. Possibly several of the many cases collected together by J. P. Crozer Griffith (*Amer. Journ. Med. Sc.*, cxiii. 426, 1897), under the name idiopathic osteopsathyrosis, may have been examples of Type B. Vrolik's case (*loc. cit.*) seems to have been an instance of it, as were also probably those of G. Barling (*Birmingham Med. Rev.*, xxxi. 107, 1892), Porak[1] (*op. cit.*, p. 11), R. O. Mason (*Arch. Pediat.*, xi. 670, 1894), C. W. Townsend (*ibid.*, xi. 761, 1894), and many others. Connecting links between instances of Type A and Type B exist; they have not all the characters of B, while they have more than the characters of A. The reader who is specially interested in fœtal bone diseases may also study with profit H. Stilling's article (*Arch. f. path. Anat.*, cxv. 357, 1889) and H. Hildebrandt's (*ibid.*, clviii. 426, 1899).

Fœtal Bone Disease (Type C).

As an instance of Type C, I take the case published by me in 1889 (36). It was a specimen kindly lent to me for examination by Sir William Turner, to whom it had been sent, without clinical notes or sender's name, from the Isle of Man. The external appearances are represented in Figs. 48 and 49.

These drawings represent in a very faithful manner the peculiar and characteristic features which the specimen showed. The limbs are curiously contorted, and nodular swellings mark the position of the shoulder, elbow, wrist, hip, knee, and ankle joints. In the position of the coccyx is a tail-like projection. The fingers and toes are long, and are widely separated from each other. The head appears to be large in comparison with the body, the upper jaw is somewhat prominent, and the occipital region is flattened. There is on the face a peculiar senile look, quite foreign to the expression of the healthy new-born infant. The umbilical cord is seen to be attached to the abdomen, and shows no signs of having been tied. The attitude in which the fœtus lies is characteristic, and is most probably approximately that which it occupied in utero. The head is flexed upon the sternum, the arms are folded upon the chest, and the legs are flexed and curiously interlocked. The thorax is expanded at its base, and is narrow from side to side anteriorly. These are the appearances shown in the first drawing (Fig. 48); the second (Fig. 49) shows the peculiar

[1] Porak's first case, here referred to, does not seem to have been an instance of true achondroplasia, but of Type B.

deformities of the legs and the curious appearance of the external genitals and perineum. The swollen knee and ankle joints are very evident, as is

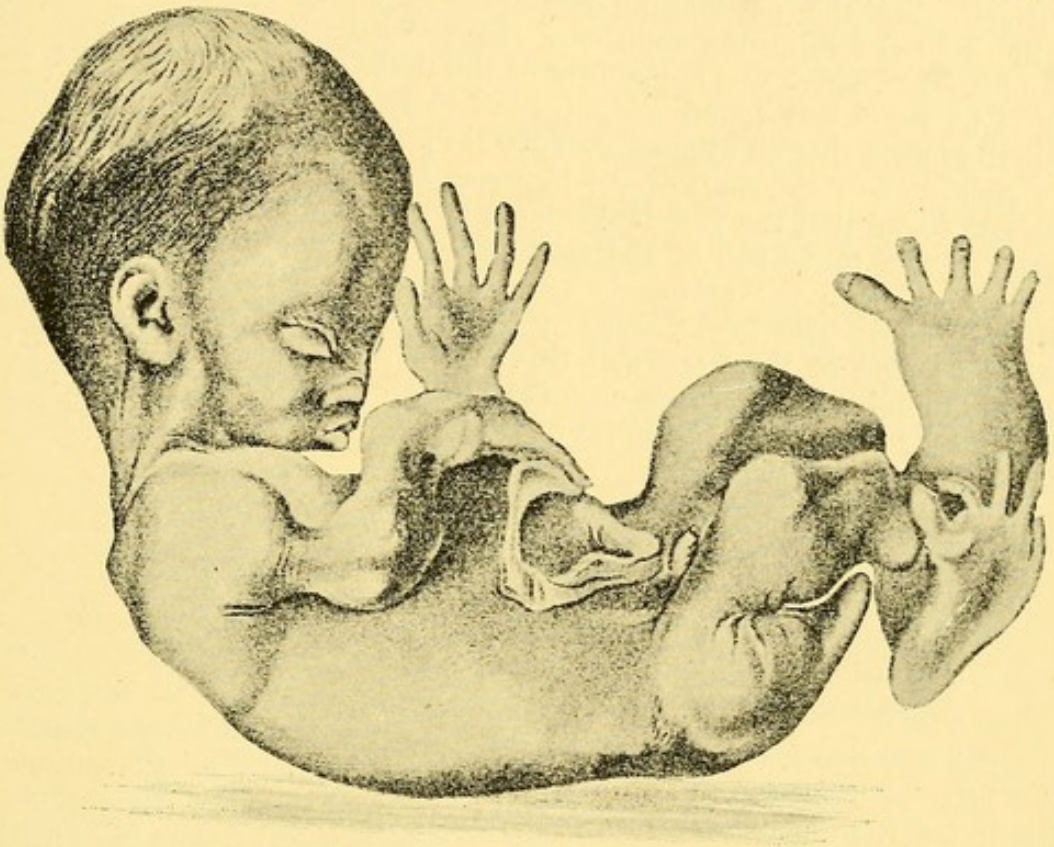


FIG. 48.

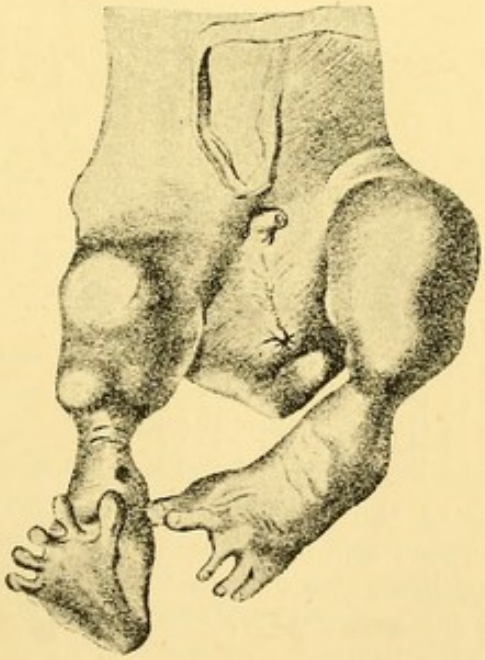


FIG. 49.

also the projection in the neighbourhood of the coccyx. A penis is present, but the scrotum is quite collapsed, and does not appear as if it contained testicles. A median raphe stretches from the root of the penis to the anus,

and the anal aperture is situated immediately in front of the coccygeal projection.

Such were the outstanding features which this specimen presented to the eye; the following additional characters became evident on closer examination. There was immobility of the limbs at the various joints, and the right thigh was found on palpation to be fractured. So firmly fixed were the joints, that an attempt to move the arm at the shoulder resulted in the separation of the shaft of the humerus from the head of the bone. It was also found that the vertebral column was rigidly fixed in a position of flexion. The lower end of the sternum was tilted sharply forwards, and through the skin the extremely contorted form of the scapule could be distinctly felt. The total length of the fœtus was 47 cms. (18½ inches), and the length of the head and trunk from the vertex to the tip of the coccygeal projection was 35·6 cms. (14 inches). The circumference of the body at the level of the ensiform cartilage was 23 cms., and at the level of the umbilicus 21·7 cms.

The head measurements were as follows:—

Diameter occipito-mentalis . . .	= 11·5	cms.
Diameter occipito-frontalis . . .	= 10·2	,,
Diameter suboccipito-bregmatica . .	= 8·9	,,
Diameter biparietalis	= 8·9	,,
Diameter bitemporalis	= 7·7	,,

The anterior fontanelle measured 5·1 cms. in an antero-posterior, and 3·8 cms. in a transverse direction. These measurements show that the head, far from being hydrocephalic, is rather below the average size as compared with the heads of healthy new-born infants of the same length as this fœtus. The anterior fontanelle is, however, much larger than is normal, and the sutures are wider than they are in healthy infants. The parietal eminences and the occipital protuberance were well marked, and the whole head had, as viewed from above, a somewhat polygonal outline.

The thorax had an antero-posterior diameter of 5·1 cms. superiorly, of 7·6 cms. inferiorly, and of 6·4 cms. at the level of the middle of the sternum. The transverse diameter of the chest at the level of the fifth rib was 5·1 cms. The swollen condition of the anterior ends of the ribs could be felt through the skin.

The measurements of the limbs were as follows:—

Circumference of the arm above the elbow	= 6·0	cms.
Circumference of the arm at the elbow .	= 8·7	,,
Circumference of the arm below the elbow	= 6·0	,,
Circumference of the leg below the knee .	= 5·1	,,
Circumference of the leg at the knee .	= 11·0	,,

The circumference of the leg at the knee was therefore more than twice that below the knee; and in the case of the arm the circumference at the elbow was half as great again as the measurement below or above that joint. These figures demonstrate very clearly the enormously swollen condition of the joints of the limbs.

The abdomen of the fœtus was opened, and there was found in the peritoneal cavity a small quantity of serous fluid; but there was no glueing together of the intestines or other sign of inflammation. The testicles, which had not descended into the scrotum, were found lying, one on each side, in front of the psoas muscle a little above the plane of the pelvic brim. The liver, spleen, and kidneys had a normal appearance, and the stomach

was empty and collapsed. In the thorax the lungs were found in an unexpanded condition lying posteriorly to the heart, and in the latter organ the foramen ovale was patent, as was also the ductus arteriosus. It may therefore be concluded that respiration was never established. Subcutaneous adipose tissue was found all over the body, but it was present in smaller amount than in a healthy full-time infant. The absence of the testicles from the scrotum served to explain the peculiar appearance of the perineal region.

I shall now describe with some fulness the appearances presented by the bones in this fœtus, for it was in the skeleton that the most remarkable characters were visible.

The Cranium.—Whilst all the fontanelles of the head, as well as the coronal, sagittal, frontal, and lambdoidal sutures, were wider than normal, yet the ossification of the cranial bones was irregular rather than defective; and indeed the bones of the base of the cranium and of the face showed a more advanced stage of ossification than they do in the healthy infant at birth. The parietal bosses were large and prominent, but the margins of the parietal bones were thin, flexible, and comb-like. The occipital bone was curiously deformed. It had the shape of a hook, the occipitals being bent at a sharp angle upon the supra-occiput, and the basi-occiput being acutely flexed upon the exoccipital portions of the bone. The margins of the supra-occiput were thin and flexible, and this part of the bone was flat, a fact which explained the flattened appearance of the back of the head already described. There was no trace of cartilage between the supra-occiput and the exoccipitals, and the ossification of the basi- and ex-occipitals was far advanced. Whilst the ossification of the supra-occiput was therefore somewhat defective, the ossific process was far advanced in the basi- and ex-occipital parts of the bones,—the parts, it will be remembered, which pass through a pre-cartilaginous stage before becoming bone. The frontal bone in the neighbourhood of its two eminences was ossified, but the two halves of the bone were separated by an inter-frontal suture, much wider than normal. The orbital plates of the frontal bone were thin and fragile. All the parts of the sphenoid were joined by osseous union, there being no cartilage between the basi- and pre-sphenoid portions of the bone. The rostrum of the sphenoid was of unusually large size, being nearly 2 cms. in length, and was articulated in the usual way with the vomer. The temporal bones, with the exception of the squamous portions, were well ossified, and the tympanic ossicles and annulus tympanicus were as well developed as they are in the new-born healthy infant. The ethmoid bone was normal in appearance. It was found that the two halves of the lower maxilla were well ossified, the condyles being even a little larger than they normally are at birth. The lower jaw contained the usual number of dental germs, and this fact is specially worthy of note, for it is well known from clinical observation that when rickets comes on during infancy there is marked retardation in the eruption of the teeth, and great irregularity in the mode of their appearance. The superior maxillæ, which also contained the usual dental germs, projected forwards in the middle line, and this projection I believe to have been caused by the unusually large size of the rostrum of the sphenoid. This peculiarity of the sphenoidal rostrum may serve to explain the beak shape of the upper jaw described by Fleischmann as common in postnatal rachitis. The malars and the other facial bones were well developed and fully ossified.

The Vertebral Column and Pelvis.—The spine in this case was curved, and fixedly curved both laterally and antero-posteriorly. There was a

convexity to the left side in the cervical and upper dorsal regions, a convexity to the right in the middle dorsal. The lower dorsal portion of the spine was straight, and there was a convexity to the left in the lumbar region. There was also a general anterior concavity of the whole spine. Such fixed curvatures of the spine are entirely absent in the healthy new-born infant. The sacrum had a marked promontory, and was well ossified. The coccyx was entirely cartilaginous, and was of enormous size, a fact which fully accounted for the tail-like projection. It consisted of the usual number of segments (four). The pelvic brim was contracted in its antero-posterior diameter, for the transverse diameter at the brim exceeded the antero-posterior by 5 mms. The iliac fossæ were slightly deeper than in the normal fœtus, and the crests of the ilia and the anterior iliac spines were thick and rounded. The ossification of the iliac bones was not so far advanced as it usually is at birth, whilst that of the ischial and pubic bones was much retarded. The pelvis, therefore, presented characters quite different from those seen in the normal fœtal pelvis, in which the antero-posterior diameter at the brim is equal to or greater than the transverse, and in which the iliac fossæ are very shallow. The pelvis, also, does not show all the characteristic features of a typical adult rachitic pelvis, although in some of its characters the resemblance is strong. The anterior wall of the pelvis has an appearance as if it had been compressed and driven backwards by the enormously large upper extremities of the femora.

The Clavicles and Scapulæ.—The clavicles were relatively long when compared with the rest of the bones. Their inner ends were enlarged, and the upper surface of the bones showed a marked concavity. The right clavicle was slightly longer than the left. It measured 3 cms.; the left measured 2·8 cms. The chin of the fœtus appeared to rest upon the upper concave surfaces of the clavicles. Both scapulæ were remarkably contorted. The infra- and supra-spinous fossæ were very deep, and the normal sub-scapular fossa was replaced by a convexity, upon which, however, was a small concavity corresponding in position to the region of the spine on the external aspect of the bones. The vertebral border of each scapula had a marked S-shape, and the lower angle was twisted forwards. The spine of the scapula had a distinct projection directed downwards about midway between its two extremities. The glenoid cavity was not well ossified.

The Sternum and the Ribs.—The manubrium sterni was very large, and the first three portions of the meso-sternum were well ossified. The ensiform cartilage was large, and its tip was turned forwards. There was a well-marked concavity on the anterior aspect of the sternum, with a corresponding convexity on its posterior surface. It may here be remarked that the heart showed a distinct furrow on its anterior aspect, marking the sharp bend which the sternum showed. A similar condition of the heart was observed by Bland Sutton in cases of rickets in monkeys (*Introduction to General Pathology*, p. 56, London, 1886), and the same author pointed out that marked thinning of the right ventricular wall resulted from the pressure to which it was subjected by the sharply-flexed sternum. In this case the thinning was not well marked, although the depression upon the anterior aspect of the heart was very evident. The ribs, which were rather slender at their vertebral ends, had distinct swellings at their sternal ends. The swelling on the anterior end of a rib was hollowed out into a little circular cavity from which a thin costal cartilage passed to the sternum. In the first three ribs the angle was very sharp, the fourth, fifth, and sixth ribs had no marked angle, whilst the lower ribs had an angle not nearly so well

defined as those of the upper three ribs. These characters of the ribs were seen to correspond to the convexity and concavity of the scapula. The lower margins of the middle ribs were very thin, and were distinctly notched. The anterior ends of the two upper ribs on each side were directed upwards. In the case of the other ribs they were directed downwards. The intercostal spaces were practically non-existent.

The Long Bones of the Limbs.—The long bones had this peculiarity in common, that whilst their ends were enormously large, the intervening shaft was small, short, straight, and nearly quite cylindrical. In the case of the femur there was a trace of the linea aspera, but in the case of the other long bones the shafts were quite smooth. The ends of the long bones were composed principally of cartilage greatly hypertrophied, and of softer consistence than is normal in the new-born infant; but at the line where the cartilage stopped and the bone began there was also a great thickening of the bone, so that the large ends of the bones were partly osseous, although principally cartilaginous. There was immobility of the joints and a certain amount of dislocation, especially in the case of the hip, shoulder, and ankle, and both the immobility and dislocation were apparently due to the enormous size of the opposing cartilaginous surfaces. Some of the characters of the individual long bones may be given here. The shaft of the humerus was straight, cylindrical, and short. The two extremities were greatly enlarged. The upper was somewhat round in form; the lower was broader transversely than antero-posteriorly. There were no ossific centres in the epiphyses. Taking the length of the humerus in the normal infant as 6 cms., it was seen that in this case the bone was shorter than normal. The left humerus measured 4 cms. in length, the right 3·9 cms. The upper end of each humerus had a circumference of 7 cms., whilst the circumference of the shaft was only 2·1 cms. The radius and ulna were of equal length, each measuring 3·2 cms., but the radius extended beyond the ulna below, and the ulna passed beyond the radius at the elbow joint above. The interosseous space was 6 mm. in width. The lower end of the ulna had a marked concavity inwards. The lower end of the radius had a circumference of 3·4 cms.; the upper end had one of 2·6 cms., whilst the shaft measured only 1·3 cms. in circumference. The upper end of the ulna had a circumference of 3·6 cms., the lower end one of 3·3 cms., whilst the shaft had one of only 1·4 cms.

The femur on both sides had a slight concavity inwards of its shaft. There was a distinct projection on the inner surface of the upper end corresponding in position to the trochanter minor, but the trochanter major was lost in the general cartilaginous mass. The head of the femur was no larger than a pea, but was ossified. The femur measured 4·5 cms. in length, the circumference at the upper end was 7·2 cms., at the lower end 8·0 cms., and at the middle of the shaft 2·1 cms. The tibia was 3·3 cms. in length, and its shaft had a circumference of 2·1 cms. The shaft was thicker than that of the fibula, which measured only 1 cm. in circumference. The tibia was displaced forwards on to the dorsum of the foot. The fibula was situated in a plane posterior to that of the tibia, and more markedly so than in the case of the normal infant. It had a curvature convex to the front and internally, and concave posteriorly and externally. There was a large elliptical interosseous space 9 mms. in breadth. The length of the fibula was 3·1 cms., and it reached to a level a little below that of the tibia. The patella was large and cartilaginous.

The Hand and Foot.—There was no point of ossification in the carpus, but the shafts of the metacarpal bones were large and well ossified, as were

also the first and second but not the terminal phalanges of the digits. The bones of the tarsus were cartilaginous, except the os calcis, which had a large ossific centre. The feet were distinctly clubbed (talipes varus). All the metatarsal bones were ossified. The first and second phalanges of all the toes were ossified; the terminal phalanges were cartilaginous. The hallux, like the pollex, had both its phalanges osseous.

Such were the characters of the component parts of the skeleton, and it may be stated in addition, that at the time when the fœtus came into Sir William Turner's possession there was a transverse fracture of the right femur in the upper third of its shaft. This fracture may have been intra-uterine; but I am more inclined to believe that it was produced at the time of birth or subsequently, for the long bones were very fragile, and during the process of dissection I myself accidentally fractured the other femur and the right humerus. In the case of the last-mentioned bones, however, what really occurred was a separation of the diaphysis from the epiphysis along the line where cartilage and bone met; whilst in the case of the right femur there was a true fracture of the bone itself. Each of the long bones presented on section very similar characters. The medullary canal was large, and was surrounded by friable spongy osseous tissue. Near the epiphyses there was a thick layer of hard bone, and the epiphysial extremities of the bone were composed of soft cartilage of an almost gelatinous consistence. The microscopic examination of the tissues and organs of this fœtus was not satisfactory, the specimen not being fresh when I made the dissection, but the swollen ends of the long bones and the whole of the coccyx seemed to be made up of large masses of cartilage cells with little or no intercellular matrix and no deposit of lime salts. The absence of the placenta and membranes of this fœtus is a circumstance much to be regretted, as is also the want of any clinical history of the case.

The remarkable case which I have adduced as an instance of Type C resembles in many of its characters Kaufmann's Case 8, but more especially his Case 13 (*op. cit.*, s. 60, 1892). It may be also of the same kind as those reported by W. Stoeltzner (*Jahrb. f. Kinderhlk.*, n. F., l. 106, 1899), in one of which the thyroid gland was much enlarged. If I were to adopt Kaufmann's nomenclature, this specimen would fall under the heading of *chondrodystrophia fœtalis hyperplastica*, for in it there is that extraordinarily exuberant overgrowth of the cartilaginous epiphyses of the long bones which is characteristic of the hyperplastic variety of fœtal chondrodystrophia. The diaphyses are very short, but the large size of the epiphyses almost makes up for the shortness of the shafts, and so the limbs are not so stunted as they would otherwise be. There is rapid but disorderly proliferation of cartilage, and the cartilage cells are not arranged in rows, and no bone formation takes place. The nose shows flattening, and at the base of the cranium the formation of the os tribasilare takes place (premature ossification of the bones of the base, namely, pre-sphenoid, basi-sphenoid, and basi-occiput).

At the present time the cause of the dystrophy which has been described above is unknown. It may be guessed that the conditions which produce rickets in postnatal life are active in a modified form or in a different degree here, and that they arrest the formation of bone from cartilage, while they allow the proliferation of the cartilage itself.

Fœtal Bone Disease (Type D).

Under the heading of Type D, I group most of the recorded cases of achondroplasia and chondrodystrophia fœtalis hypoplastica. This disease does not prove incompatible with postnatal life; consequently there are several well-recorded instances of adult achondroplasia, as it is often called. I have, however, to deal here with the malady as

FIG. 50.—Villa's case of fœtal bone disease.

it is met with in antenatal life. A complete and concise account of the disease, both as it occurs in adult and in fœtal life, is given by John Thomson in Green's *Encyclopædia Medica*, vol. i., p. 55, 1899. The external appearances are very characteristic, and most of the recorded cases bear a very striking resemblance to each other. In order to bring out this resemblance, the reader may compare together the cases of E. H. Sonntag (*Dissert.*, Heidelberg, 1844), N. F. Winkler (*Arch. f. Gynaek.*, ii. 101, 1871), A. Fischer (*ibid.*, vii. 45, 1875),

J. B. Borntraeger (*Dissert.*, Königsberg, 1877), J. Storp (*Dissert.*, Königsberg, 1887), A. Biskamp (*Dissert.*, Marburg, 1874), F. Hoess (*Dissert.*, Marburg, 1876), R. Rumpe (*Dissert.*, Marburg, 1882), G. Neumann (*Dissert.*, Halle, 1881), A. Schneider (*Dissert.*, Berlin, 1892), F. Villa (*Ann. di ostet. e ginec.*, xiii. 653, 1891), J. Symington and H. A. Thomson (*Proc. Roy. Soc., Edin.*, xviii. 271, 1890–91), E. Kaufmann (*op. cit.*), L. Spillmann (*Le rachitisme*, Paris, 1900), R. Cestan (*Nouv. iconogr. de la Salpêtrière*, xiv. 277, 1901), E. Apert (*ibid.*, p. 290, 1901), and F. Regnault (*Bull. et mém. Soc. anat. de Par.*, 6 s., iii. 178, 1901). The illustration given by Villa is reproduced here (Fig. 50). The first glance at such a fœtus suggests that the parts affected are the extremities, and exact measurements at once confirm what the eye has suggested. The arms and legs are shorter than normal; they may be only half the normal length; and the large quantity of the subcutaneous tissue, along with the lax condition of the skin, gives to the limbs the appearance as if the integument were redundant, and so emphasises the stunted character of the appendicular skeleton. The limbs look as if they had on garments too large for them, and they are often encircled by deep sulci. The long bones belie their name, for they are short and thick, and have relatively very large epiphyses; but their epiphysial ends do not attain to the enormous proportions seen in Type C. Their curves are exaggerations of those normally present. The hands show a curious anomaly in form: when, as J. Thomson first pointed out (*Edinb. Med. Journ.*, xxviii. 1112, 1893), the palm is flat the fingers do not lie parallel as in a normal hand, but diverge somewhat, two usually turning towards the radial and two towards the ulnar side. Good illustrations of "le main en trident" as it appears in postnatal life are given by R. Cestan (*loc. cit.*, p. 280). The shortness of the limbs is the character which has led several authors to name this malady micromelic rickets or fœtal rickets with micromely.

The trunk, unlike the limbs, is of normal length, but seems to be narrow on account of the costal and pelvic abnormalities. In size, the head also is normal, or slightly larger than normal; and it is somewhat prominent in front and at the sides. There is a sulcus at the root of the short, thick nose; and it appears to be deeper than it really is on account of the bulging frontal region. The tongue not uncommonly protrudes slightly from the partly open mouth. The skin, hair, and nails are commonly quite normal; but the disease may be associated with general fœtal dropsy (E. Kaufmann, *op. cit.*, s. 7).

The clinical history of many of these fœtuses extends beyond antenatal life, for although some succumb a few hours after birth, many survive and reach the adult state. In fact, their development seems little interfered with: they are intelligent and vigorous, and when married are not sterile. As has already been pointed out, a woman with this disease may give birth to an infant similarly affected (Porak, *op. cit.*). Her labours, however, are apt to be very dangerous from the existing pelvic deformity. In antenatal life, hydramnios, that frequent indication of the presence of fœtal disease and deformity, may be present, and labour often is somewhat premature.

The pathology of the disease is now much better known than formerly. The internal organs show little or no pathological change, and this remark applies to the thyroid gland as well as to the other viscera; in Symington and Thomson's case, however, a condition of acute desquamative catarrh was discovered in the thyroid. The parts at the base of the brain exhibit some anomalies, but these are due to the curious condition of premature ossification of the bones of the basis cranii, which results in their fusion into one bone, the os tribasilare (so called because it consists of the three nuclei—basi-occipital, post-sphenoid, and pre-sphenoid). There is thus a marked shortening of the base of the cranium anterior to the foramen magnum. The result is that the medulla and pons, which normally extend from the foramen magnum to the upper edge of the dorsum of the sella turcica, project above that level, and have a direction upwards and backwards instead of upwards and slightly forwards. There are or may be other changes in the relations of the parts of the brain produced in the same way, and of these Symington and Thomson (*loc. cit.*) give a good description. The depression at the root of the nose may be due to the premature ossification of the basis cranii; but it cannot be regarded as indicating with certainty the presence of the os tribasilare, for it may be found when there is no tribasilar bone at all (E. Kaufmann, *op. cit.*, p. 36). The pituitary body has been examined and found to be normal. Hydrocephalus has sometimes been described; but it is doubtful if it is at all frequent.

The chief pathological changes are in the skeleton, and in that part of the skeleton ossified in cartilage. The bones, therefore, which are formed in membrane are usually quite normal; such are the flat bones of the cranial vault. Further, it has been pointed out by Symington and Thomson (*loc. cit.*, p. 273) that those bones which, although formed in cartilage, remain entirely or mainly cartilaginous till an advanced period of fœtal life, and the growth of which therefore is independent of endochondral ossification, also show no abnormalities; such are the sternum, patella, costal cartilages, and tarsal and carpal bones. In a sentence, the skeletal changes are mainly due to defective endochondral ossification, and the bones affected are consequently the long bones of the limbs, the ribs, the innominate bones, and the posterior part of the base of the skull. The formation of the tribasilar bone has already been referred to; but, in addition to that synostosis, the lower part of the supra-occipital, the basi-occipital, and the ex-occipitals are smaller than normal, and the supra-occipital is not separated from the ex-occipitals by a cartilaginous hinge. The foramen magnum, therefore, is small. The lateral masses of the ethmoid are smaller than normal, as are the lesser wings of the sphenoid, and the petro-mastoid part of the temporals. The inferior maxilla is, as a rule, the only facial bone showing any abnormality; it is smaller than usual on account of smallness of its posterior part. The vertebral column is of normal length, but its antero-posterior measurements may be reduced; the thorax is small and flattened, a character due to arrested development of the

ribs, which may be less than one-half their normal length; the pelvis is contracted in all its diameters, but especially in the antero-posterior at the brim. The innominate bones are small, and almost entirely composed of cartilage. The diaphyses of the various long bones are from one-half to one-third their normal length, but the epiphyses are normal in size or increased. The shafts have a normal circumference, but they are markedly curved, the curves being an exaggeration of those normally present; they are firm, and the so-called fractures are generally due to separation of shaft from epiphysis rather than to a solution of continuity of the former. There is fixation, or very limited movement of the joints of the limbs, due to the large size of the opposed surfaces. The scapula and clavicle may be smaller than normal, and the sternum may be entirely cartilaginous.

The pathogenesis of this type of fœtal bone disease is hardly better understood than that of any of the other types. From the microscopical appearances of the bones, however, it is gathered that at the junction of the small wedge of endochondral bone and the terminal cartilage no normal ossification is going on; "there are" (to quote Symington and Thomson) "no parallel rows of cells, no progressive formation of medullary spaces by the projection of medullary blood vessels into the cartilage; there is an absence of vessels at the ossifying junction; and the typical organ-pipe arrangement of structures is either not recognisable at all, or only here and there, and that faintly." The large cartilaginous ends of the long bones consist entirely of hyaline cartilage, and the short shafts are made up almost exclusively of periosteal bone, in which a medullary canal is absent, or represented only by some inter-trabecular spaces, slightly larger than usual. In this way the growth of the medullary vessels towards the ossifying junction is prevented. Some endochondral bone may be found near the ends where it forms the small wedge referred to above; but it is non-lamellated, and simply consists of "a very irregular honeycomb, made up of branching masses, each of which contains a core of cartilage in the centre; it may have been formed by a direct conversion or metaplasia of the cartilage into bone." What the exciting or predisposing causes of this arrest of endochondral ossification are, is not known. A great deal of time has been spent over discussions as to whether the disease is a fœtal form of rickets or of cretinism; but such discussions must to a large extent be wasted labour, for it cannot be expected that the characters of rickets or of sporadic cretinism as they occur in postnatal life will be exactly reproduced in fœtal existence, and especially in the early part of fœtal existence bordering upon the embryonic state. The cases of Type D which survive birth certainly do not grow either into cretins or into rachitic dwarfs. That it may be due to morbid action of the thyroid gland is not by any means proven.

That Type D is closely related to Type C is evident, although in the latter there is a more marked overgrowth of the epiphysial cartilage which partly masks the resemblance. E. Kaufmann empha-

sizes this resemblance by calling the latter the hyperplastic form of fœtal chondrodystrophia, and the former the hypoplastic variety; but, to my mind, it is well to regard them as two types. They are morbid states which must arise near the beginning of fœtal life, possibly in the neofœtal period or even earlier; they verge upon the teratological, even if they are not actually to be regarded as monstrosities rather than diseases. The projection of embryonic pathology into fœtal pathology in them is very evident.

Finally, it may be noted as an interesting fact, that the disease evidently existed and was noted in very early times in the world's history,

Fig. 51.

for the gods Ptah and Bes were undoubtedly examples of it. Further, some of the historic dwarfs seem to have owed their dwarfism to this form of fœtal bone disease (Charcot et Richer, *Les difformes dans l'art*, p. 15, 1899; H. Meige, *Nouv. iconogr. de la Salpêtrière*, xiv. 371, 1901). The disease is met with also in some of the lower animals, as is seen in dachshunds and bassets.

Fœtal Bone Disease (Type E).

I do not regard type E, which is represented in Fig. 51, as a fœtal disease properly so called, for it is undoubtedly teratological

in its nature; but I describe it here in order to demonstrate that it is a still earlier stage of arrest of limb-formation than that seen in Type D. In the specimen represented in Fig. 51, I found, on dissection of the limbs, that their skeleton was represented solely by tiny pieces of cartilage having a certain resemblance in shape to the bones of which they were the only traces. They were embedded in a large quantity of adipose and connective tissue, for the muscles were feebly marked. This specimen was shown to the Edinburgh Obstetrical Society in 1888 (*Trans. Edin. Obst. Soc.*, xiv. 1, 1889) by Professor A. R. Simpson, who was kind enough to allow me to dissect it. The skin was afterwards stuffed, so as to preserve the external appearances, and it is now in the Obstetrical Museum in the University of Edinburgh. It was a Maternity Hospital case, and the mother had already borne several healthy children. There had been hydramnios. The head had presented, but the labour had been ended by version. The two halves of the frontal bone were widely separated, and the various parts of the occipital bone were prematurely ossified together and deformed, with the result that the foramen magnum was greatly reduced in size. The basi-occipital, basi-sphenoid, and pre-sphenoid were fused together into one bone (os tribasilare). There was only one artery in the umbilical cord.

As has been said, this fœtus was evidently teratological. In teratological classifications it would doubtless be grouped under the heading of phocomelus, although its characters do not quite agree with those of that type, for the hands and feet are not directly attached to the trunk, but through the intermediation of stunted upper arms and forearms and thighs and legs. The specimen is specially valuable as showing arrestment of limb ossification at an early period in antenatal life, at a time, in fact, when the organism is still in the embryonic, and has not yet reached the neo-fœtal epoch. It is a monstrosity, then; but it has to be remarked that it is connected by means of Types D, C, and B with Type A. It stands at the one end of a series of types which has simple imperfect ossification of the cranial vault bones at the other end. The ossification of the limb bones has been arrested, while the ossification of the bones at the base of the cranium has been prematurely accomplished with resulting deformity in each. This same coexistence in the one skeleton of arrested ossification and premature ossification is present also in Types D and C, although to a less marked degree. In Type B, it would appear that the cranial base is normally formed, although the limb bones and the vault bones show defect; while in Type A the vault bones alone would seem to be affected. At the one end of the series, then, is a monstrosity, and at the other a disease; and there are connecting links. Doubtless many of the differences are to be accounted for by the time in antenatal life when the morbid cause (or causes) came into operation; but it is also possible that they are to be in some measure explained by the action of essentially different causes. By this time it will have become evident to the reader that the

writer had good reason for the statement which he made at the beginning of this chapter; and the former will now, perhaps, be prepared to agree with the latter that fœtal bone diseases are disconcerting to the pathologist and discouraging to the nosologist. One is tempted to say about them, as has been said about the hydatid mole, that they are due to an "unknown something of the mother" (einen unbekannten Etwas der Mutter). I feel that I have not succeeded in introducing into this chapter any perceptible degree of lucidity and order, and in the face of what I recognise has been a failure I break through my rule, and append a bibliographical list of works on fœtal bone diseases, so that those readers who wish to explore this part of Antenatal Pathology further may at least have the literature at their command. May their success be greater than mine.

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PLATE XII.

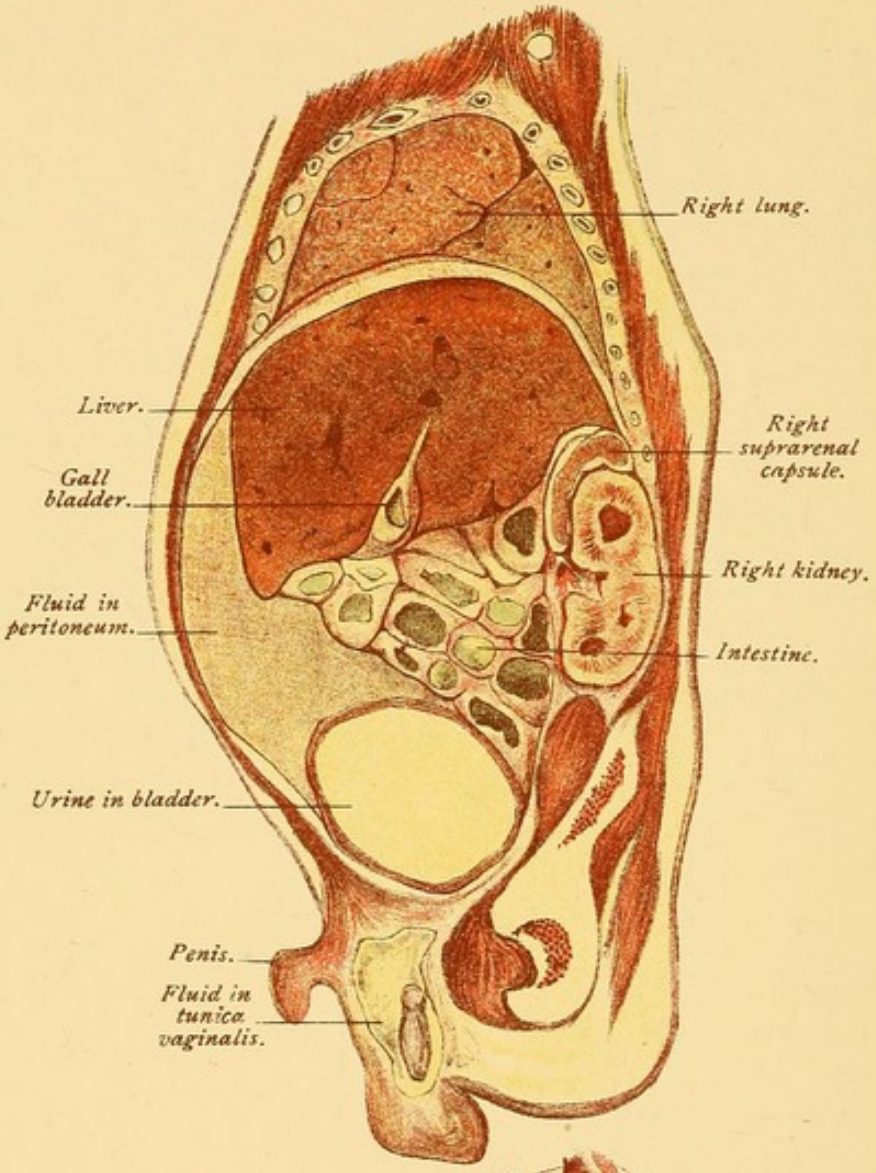
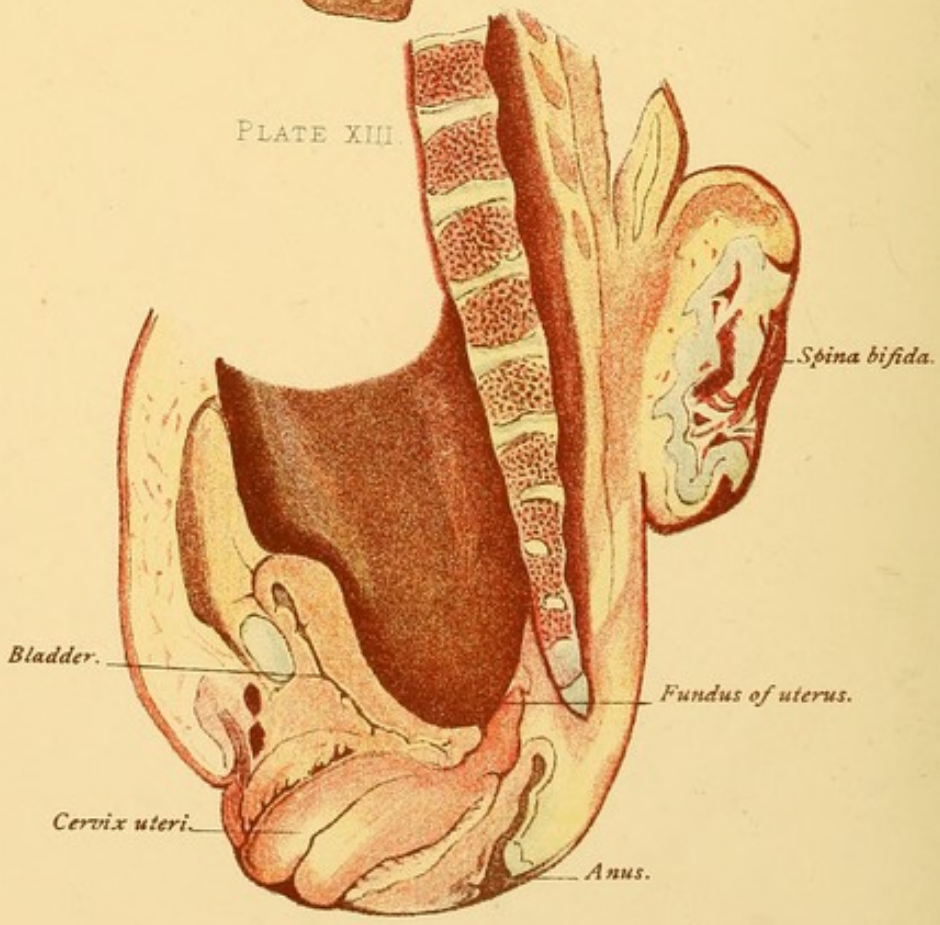


PLATE XIII.



CHAPTER XX

Types of Idiopathic Diseases of the Fœtus (*cont.*): Diseases of the Alimentary System: Fœtal Ascites, Definition, Clinical Features and History, External Appearances, Morbid Anatomy, Etiology, Pathology, Treatment; Fœtal Peritonitis; Congenital Obliteration of the Bile-Ducts, Definition, Clinical History, Symptomatology, Morbid Anatomy, Pathology, Diagnosis, Treatment; Congenital Hypertrophic Stenosis of the Pylorus, Definition, Symptomatology, Morbid Anatomy, Pathogenesis, Treatment.

LESS is known regarding the diseases which affect the internal organs of the fœtus than about those involving the skin or those of the skeleton; for the examination and dissection of infants that have died during or just before birth has not been common, and the attention of observers has been seized only by the more obvious external morbid states. As a consequence, almost the only antenatal maladies of the alimentary system about which anything is known are those which are so marked and so far advanced as to produce evident changes in the external configuration of the body, and so to interfere with the normal progress of parturition. Prominent among these is *fœtal ascites.*

Fœtal Ascites.

I have examined by the sectional method three specimens of fœtal ascites (58, 197, 221), and the appearances presented by a lateral vertical section of one of these are shown in Plate XII. I have also had an opportunity of examining the case recorded by W. Fordyce, and fully described by him in my journal (*Teratologia*, i. 61, 143, 1894). The following account of the malady is founded upon these four specimens, and upon a consideration of similar cases which have been reported by other observers. A good bibliography accompanies Fordyce's article (*loc. cit.*, p. 135), and on that account the text here will not be burdened with many references.

Fœtal ascites may be *defined* as the effusion of fluid into the peritoneal cavity, with consequent abdominal distension due to several different causes, accompanied by various lesions of the viscera, and leading usually to delay in labour and to intranatal or early postnatal death of the infant affected with it. It is, just as in the adult, a symptom or effect of different morbid processes rather than a disease *per se;* but the morbid processes which produce the antenatal form are almost certainly different from those which lead to the adult variety. Further, antenatal ascites reaches a far more deforming degree than the disease ever does when developed in postnatal life.

F. Mauriceau (*Traité d. mal. d. femmes grosses*, 3 ed., Paris,

1681) was one of the first to put on record a case of fœtal ascites, and he gives such a graphic account of the interference with the normal progress of labour caused by this antenatal malady, that Fordyce in his monograph (*loc. cit.*) translated the passage into English. I reproduce Fordyce's translation here, for it is well worth reading. Mauriceau writes:

"In the year 1660, when I was engaged practising midwifery in this place, it happened one day that a nurse, who was in attendance on a woman in her confinement, was unable to deliver more than the head of the child. Finding that it was impossible for her to extract the rest of the body, although she had exhausted herself in making strong traction on the head, she called in to her assistance an experienced midwife, who in turn did all in her power to extract the child by pulling on its head, but with no result beyond dislocating the cervical vertebræ. I was then summoned to their assistance. On my arrival, they at once requested me to examine the patient in order to discover the cause which had prevented them delivering the child, although they had pulled so strongly on its head and had made efforts which were more than sufficient to have delivered the shoulders, though these had been very large. I very soon concluded that the difficulty proceeded from some other cause than the shoulders of the child, for, when I had passed my flattened hand up to the entrance to the womb, as far as the shoulders of the child, I found they did not appear to be so large but what they could have been easily delivered. I introduced my hand further, carrying it in front of the chest of the child as far as the xyphoid cartilage, where I recognised that the abdomen was dropsical and full of fluid, so that it was impossible to extract it without having first punctured it in order to give a means of escape to the fluid which it contained. I had not, however, with me at the time a suitable instrument with which to do this, and was therefore obliged to send for a doctor from the Hôtel-Dieu. When this doctor arrived, I stated the case to him, and declared that, in order to deliver the child, it was necessary to puncture its abdomen, which was distended by fluid. He was, however, unwilling to agree with me, either because he thought perhaps he knew his work without my advice, or because he did not wish to or could not believe that the child was dropsical as I had told him. Whatever was the cause, he contented himself—without putting himself to the trouble of examining the case—with attempting delivery in his own way. He made traction once more on the head of the child, and separated it entirely from the rest of the body; for it was but slightly attached, owing to the excessive violence of the efforts of the midwives who had been first in attendance on the case. After that he introduced a blunt hook into the uterus and dragged away both the arms of the fœtus, the one after the other, and then some ribs, and then parts of the lungs and the heart. For three-quarters of an hour he employed himself in thus dragging away fragments of the fœtus (during which time he perspired freely, although the weather at the time was very cold), until at last, disheartened and exhausted, he was compelled to abandon the task and take a rest. The midwife,

meanwhile, succeeded in tearing away some pieces of ribs, using her hands only, for of course she could not have been allowed to use the blunt hook. A second time the doctor tried to extract the fœtus, pulling on the hook with all his strength, but without any success, because up to this time he had not punctured the abdominal wall or the diaphragm, not wishing to do it, as I kept telling him each moment that without this it was impossible to deliver the rest of the body.

"On seeing that all his efforts were, for a second time, useless, he at last gave me the blunt hook, saying that I might have an opportunity of tiring myself out as well as the others. I accepted it willingly and with pleasure, for I was very certain I could soon complete the operation, knowing very well that, instead of amusing myself as he had done, it was only necessary to puncture the abdomen of the child in order to let the contained fluid escape, after which delivery of the child would be easy. For this object I introduced my left hand right up to the distended abdomen, and, passing the blunt hook along it, I turned the point of the instrument towards the abdominal wall and forced the point into the abdominal cavity of the fœtus. Then I withdrew my hand, and at once all the fluid gushed out in a torrent. After this I drew out the rest of the body with one hand without any difficulty, to the great astonishment of the doctor, who had never been able to persuade himself that the child was dropsical. After delivery, I had the curiosity to fill the abdomen of the fœtus with water, in order to see what quantity it had contained, and what its size was when quite full. I was able to introduce, without exaggeration, more than five pints of our Paris measure. This I should have had difficulty in believing had I not seen it. I record here the full history of the case, in order that the accoucheur may know how to act on a similar occasion."

Mauriceau's case illustrates very well the difficulty introduced into parturition when the fœtus suffers from ascitic distension of the abdomen; nothing need be added to this part of the clinical history of such cases.

The pregnancy which ended in the birth of an ascitic fœtus was seldom quite normal in its symptomatology. According to Fordyce's statistics of sixty-three cases (*loc. cit.*), there were eight instances of syphilis and nineteen of hydramnios. In two of the three cases seen by me there was bad health of the mother; in one (58) there was gonorrhœa, with rupture of a pyosalpinx during labour, and death in the puerperium; and in another (197) there was a tubercular history. In the third case (221) the mother had been subject to the infection of measles, but had not apparently been affected; but there was great hydramnios. Not infrequently there was a history of pain in the abdomen. In thirty-six out of forty-three cases the pregnancy terminated prematurely. Sometimes the fœtal malady showed family prevalence, as in the cases reported by R. Virchow (*Monatschr. f. Geburtsk.*, xi. 161, 1858), by O. von Franqué (*Wien. med. Presse*, vii. 812, 1866), by Bruce (*Edin. Med. Journ.*, xvi. 167, 1870), and by Jilden (*Dissert.*, Würzburg, 1890).

To such a serious extent did the fœtal disease interfere with

delivery, that in four cases out of sixty-three the mothers died as the result of the prolonged labour and the operative interference (Fordyce). The fœtus usually died either during or very soon after its birth; but in Crandall's case it lived for nearly a month, and in Courmont's it recovered after the abdomen had been punctured and 500 grms. of fluid withdrawn (Fordyce). The prognosis for the infant, therefore, is not absolutely hopeless.

The *external appearances* of the ascitic fœtus are striking (Fig. 52): there is marked prominence of the abdomen, so great in some instances as to cause apparent dwarfing of the head and limbs. On palpation the fluctuation thrill can be easily elicited; and it is evident that the fœtal abdomen contains fluid. Very similar results on inspection and palpation are obtained in cases where the fœtal bladder is greatly over-distended, so that it is not always certain at first what the cause of the abdominal enlargement may be in any given case. The limbs and face are usually quite free from œdema. Sometimes the external genitals are malformed, as in Fordyce's case (Fig. 54). There was hare-lip in one of my cases (221).

The *morbid anatomy* has not been investigated so fully as could be wished, and in many of the recorded cases the obstetric interest seems to have been the only one which appealed to the observer. The fluid in the abdominal cavity has varied in amount from a few grammes up to twelve or fifteen litres (!); probably two to four litres has been the average quantity. It was generally a clear serous fluid, but sometimes it was described as brownish red or turbid, with flakes of lymph floating in it. In a few cases it was analysed: in Truzzi's (*Gaz. med. ital. lomb.*, 8 s., vi. 139, 1884) it was rich in albumin, alkaline in reaction, and had a specific gravity of 1002; in C. Jany's (*Klin. Beitr. z. Gynaek.*, ii. 240, 1864) it was alkaline, and contained chlorides but no urea; and in one of my cases (197) it had a specific gravity of 1007, an alkaline reaction, and it contained albumin and globulin, and a distinct trace of oxyhæmoglobin.

In about half the recorded cases in which a *post-mortem* examination was made, the peritoneum was diseased; it showed the signs of inflammation, sometimes acute, but generally chronic, which caused a thickened or granular state of the membrane, with adhesions between the various viscera, retraction and thickening of the mesentery, etc. The microscopic appearances of the abdominal wall in Fordyce's case are shown in Fig. 53; the endothelium was entirely destroyed, and the sub-endothelial connective tissue greatly thickened. Enormous hypertrophy of the pancreas was referred to in one case (E. Martin's specimen, *Monatschr. f. Geburtsk.*, xxvii. 28, 1865). It is a remarkable fact that lesions of the liver and spleen seem to have been rarely noted, a striking occurrence when the pathology of ascites in the adult is borne in mind. The bladder is sometimes found in an over-distended condition; and I have elsewhere (58) gathered together records of seventeen cases in which this association of fœtal ascites and distension of the bladder was observed. In some cases there was also dilatation of the ureters and hydronephrosis. Sometimes there was a urethral septum or valve to account for the vesical

Fig. 52.—External appearances of fœtus with ascites. Photograph from water-colour sketch made shortly after delivery (reduced by about one-half).

distension, but sometimes there was no such structure. In Fordyce's case (*loc. cit.*) and in some others the genital organs were malformed, as were also the lower part of the large intestine and the rectum; in the former there was a double uterus and vagina, and a tubercle which probably represented the clitoris (Fig. 54), and in Olshausen's specimen (*Arch. f. Gynaek.*, ii. 280, 1871) the bladder communicated with the uterus, and the clitoris was absent.

I have grouped this fœtal morbid state among the idiopathic diseases, and, therefore, it may be gathered that I regard its *etiology* as unknown. At the same time, there are some cases in which it seems fair to regard the ascitic condition as the result of fœtal syphilis arising from maternal (or paternal) infection, and consequently as a transmitted disease, or as one of the manifestations of

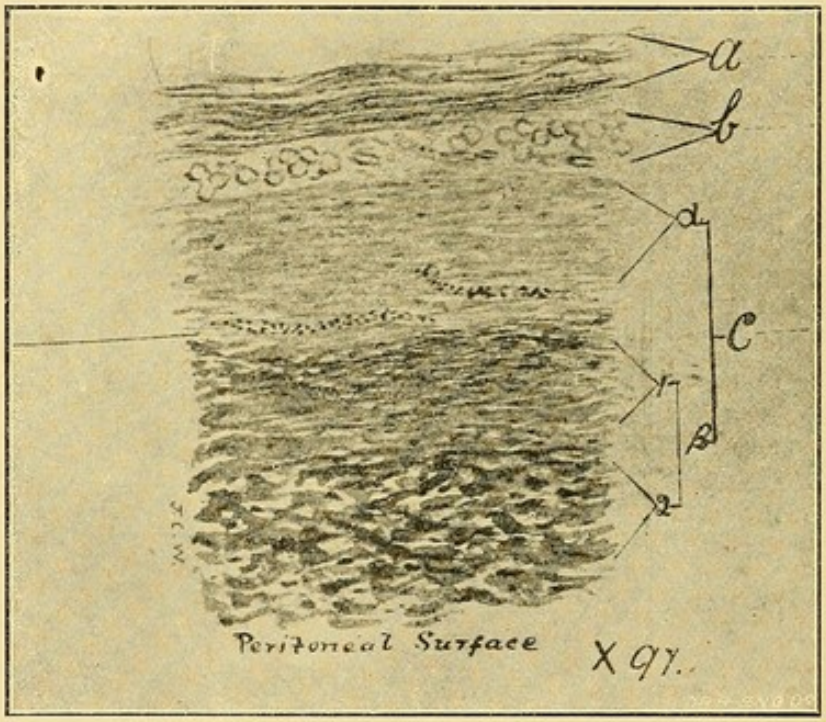


FIG. 53.—Microscopic appearances of section of Abdominal Wall internal to the Muscular Layer, stained with logwood and eosin, × 97. *a*, Muscular tissue; *b*, Areolar tissue; *c*, Connective tissue.

a transmitted disease. If, however, the syphilitic cases be excluded, and they are not numerous, there remain many in which the ascites must still be regarded as originating in the fœtus apart from maternal states. These may yet be traced to diseased states of the mother, but this stage in our knowledge has not yet been attained.

In considering the *pathology* and *pathogenesis* of the malady, one naturally thinks first of hepatic lesions and disturbance of the portal system; but it has already been stated that morbid alterations of the liver in such cases have been very rarely noticed. It would seem that ascites due to causes in the portal system is not, therefore, common in the fœtus, a state of matters not so difficult to understand, if it be remembered that this part of the vascular system is then comparatively inactive on account of the quiescent condition of the

gastro-intestinal canal. In Herman's case, however, the cause seems to have been pressure on the portal vein by a large tumour of the right supra-renal capsule (*Med. Times and Gaz.*, ii. 731, 1881). But, with few exceptions, the ascites seems to have been due to peritonitis,

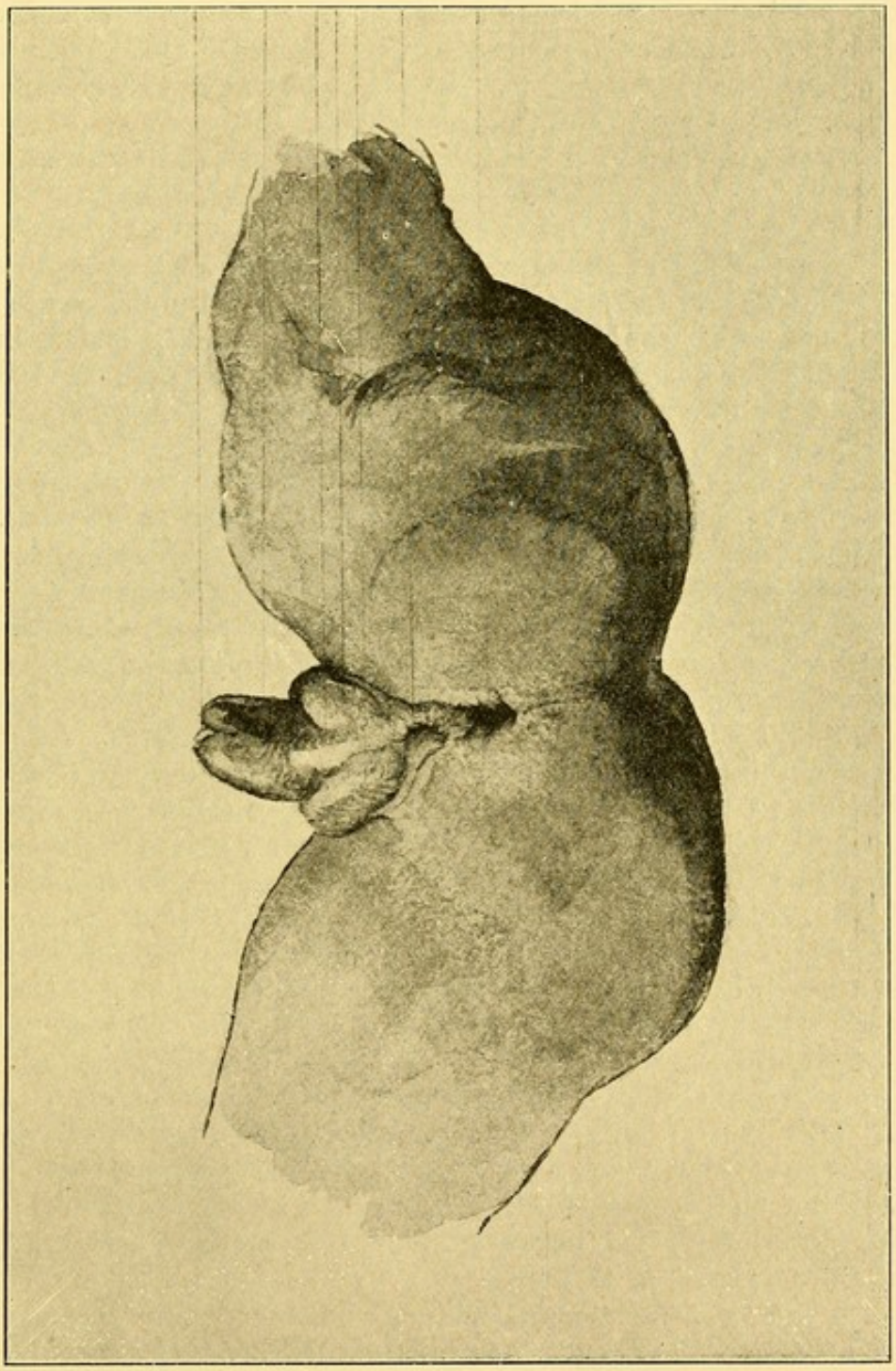


FIG. 54.—Appearance of External Genitals in case of Fœtal Ascites.

a conclusion which appears to be warranted by the morbid anatomy of most of the specimens. What the cause of the peritonitis may have been is not well known, but in one case (Olshausen's, *loc. cit.*) it was the escape of urine into the peritoneal cavity. In Fordyce's specimen (*loc. cit.*) the peritoneum had lost its normal endothelial covering, and great thickening of the subendothelial connective tissue

had taken place, with degeneration of some of its superficial layers (Fig. 53). Hardouin and Moreau (*Rev. obstét. internat., suppl.*, i. 184, 1895) report a case in which the fœtus exhibited ascites, hydrothorax, slight hydropericardium, along with cleft palate and cardiac malformations; the authors regarded the ascites as due, in this case, to the anomaly of the heart (absence of complete interventricular septum). It is necessary, then, to keep in mind that fœtal ascites, like general fœtal dropsy, may be due to several causal factors; at the same time Porak and Sevestre (*Bull. Soc. anat. de Par.*, 4 s., i. 314, 1876) and Fordyce give the first place in the pathogenesis to peritonitis.

There seems to be no reason why aspiration of the abdomen should not in some of these cases give relief; if this procedure were carried out during labour as soon as the cause of the delay was ascertained, not only would the confinement be quickly ended, but the infant might be born alive and survive (as one case at least has already demonstrated).

Fœtal Peritonitis.

As has been shown in the preceding paragraphs, peritonitis is one of the pathological causes of fœtal ascites, but I set apart here a few lines to the consideration of fœtal peritonitis itself, both with and without effusion of fluid into the peritoneum. On this subject J. Y. Simpson long ago wrote fully and most suggestively (*Obstetric Works*, ii. 152–205, 1856; *Edinb. Med. Surg. Journ.*, i. 390, 1838). That antenatal peritonitis may occur without ascites is proved by an observation (131) which I made some years ago. It was that of a female infant born in the Maternity Hospital, Edinburgh, after a somewhat prolonged and instrumental labour; the infant died thirty-two hours after birth, with a considerably distended abdomen. I found that the large and small intestines were distended with gas, and that the coils were glued to each other, to the under surface of the liver, and to the pelvic viscera. On separating the opposed surfaces, it was seen that the peritoneal aspect of the bowel had a markedly granular appearance; but there was no fluid in either the abdominal or pelvic peritoneal sacs. There was, therefore, a recent dry peritonitis, which might, it is conceivable, have arisen during the short postnatal life of the infant; but in the pelvis were signs of an older peritonitis, which had produced adhesions between the Fallopian tube and broad ligament and the cæcum.

It is easily understood that comparatively few cases of fœtal peritonitis without effusion have been recorded, for the condition does not lead to abdominal distension, and to consequent delay in labour, and so attention is not focussed upon the infant. Even among the cases which are described as *peritonitis*, and not as ascites, it is usually found, as in the observation of G. Palazzi (*Ann. di ostet. e ginec.*, xviii. 139, 1896), that there has been fluid in the peritoneal cavity. Doubtless the dry form is often overlooked; sometimes also it may not cause early death, but be to a large extent recovered from, and

only be detected later by the effects to which it has given rise. It has been a common practice to ascribe most of the malformations of the abdominal and pelvic organs to fœtal peritonitis and to the adhesions resulting from it; no doubt there is a measure of truth in this theory of causation, but it is only under certain circumstances that it can be accepted. If the peritonitic adhesions form before the malformed organ is fully developed, or during its development, it can be understood that the peritonitis may have been instrumental in its pathogenesis. Since the genital organs are late in developing, it is very probable that many of their anomalies (absence of fusion of the Müllerian ducts, etc.) may be due to peritonitic bands and adhesions. Anomalies in the position of the intestines and other abdominal organs may possibly be due to the same cause; but it is very doubtful whether the *situs inversus viscerum* which existed in Gessner's case (*Centrlbl. f. Gynäk.*, xx. 279, 1896) can be so explained. Perforation of the intestine has been met with (G. Resinelli, *Ann. di ostet. e ginec.*, xxi. 89, 1899), but whether as cause or effect of the peritonitis is not known. It is impossible to foretell how far-reaching may be the effects of fœtal peritonitis upon postnatal life, especially if the generative organs come to be affected; but this is a subject to which I have already referred (*vide* p. 25). Among the many changes which have been traced, with some show of probability to antenatal peritonitis, is congenital obliteration of the bile-ducts; and to that interesting pathological state I must now devote a page or two.

Congenital Obliteration of the Bile-Ducts.

Among the services which John Thomson has rendered to a proper understanding of the diseases of infancy must be reckoned his work on congenital obliteration of the bile-ducts (*Trans. Edinb. Obst. Soc.*, xvii. 17, 191, 1891–2; Allbutt's *System of Medicine*, iv. 253, 1897). What follows is almost entirely a presentment of his views.

Congenital obliteration of the bile-ducts may be *defined* as an antenatal lesion of the bile-ducts, of practically unknown origin, leading to obliteration of their lumen, and accompanied by biliary cirrhosis of the liver, causing the supervention of jaundice early in neonatal life, and entailing early postnatal death. Eighty cases or so have been recorded, and with regard to them all the physician has been compelled to confess therapeutic failure.

There is little or nothing that is special in the *clinical history* of the pregnancy which ends in the birth of an infant with this anomalous state of its bile-ducts. The mother does not seem to have suffered in any way. The father also has usually been healthy. There is an exception, however, to the above general statement, namely, the occurrence of family prevalence, often to a very remarkable degree; for as many as seven or even ten cases of infantile jaundice due to this lesion of the bile-ducts have been observed in one family.

The *symptomatology* is at the time of birth practically *nil;* but in a few days jaundice of a more marked and persistent type than the

ordinary icterus neonatorum sets in, and soon the stools are observed to be white in colour, the preceding motions having consisted of normal dark meconium. Sometimes it would seem that the stools were white from the beginning. The jaundice often becomes very deep, and usually persists till the fatal termination of the case. There may be hæmatemesis or melæna or omphalorrhagia; and in other cases the hæmorrhagic tendency is revealed by the occurrence of subcutaneous ecchymoses, or of epistaxis. The hæmorrhage may be the cause of early death, but, if the infant pass this danger safely, life is usually prolonged for some months, and then is terminated not infrequently by an accidental complication. There is some emaciation (although often this is inconsiderable) before the close, and convulsions may also occur. There is deep bile-staining of the urine, and constipation is the rule.

The *morbid anatomy* of these cases is extremely interesting. The liver is usually enlarged; it has an uneven surface and a tough consistence; and it is of a dark olive-green colour. Bands of fibrous tissue form a network throughout it; and on microscopic examination the lesions are found to be those of biliary cirrhosis. Many of the lesser bile-ducts are plugged with inspissated bile. The large bile-ducts and the gall bladder are nearly always markedly affected, but the degree of the affection varies greatly. In one group of cases (usually those in which death has occurred early) the ducts may seem to the naked eye to be little if at all involved, but thickening of their walls is the rule, and complete obliteration of the lumen of the duct, with fibrous tissue formation around it, is far from uncommon. In the most advanced examples all that can be seen of the duct may be a strand of fibrous tissue. The exact site of the obliteration varies greatly. The gall-bladder may contain colourless mucus, or very thick bile, or a gall-stone; or its lumen may be almost obliterated by the thickening of its walls. The blood-vessels of the liver are generally normal; the spleen is enlarged; but the peritoneum is usually unaffected, save in cases with a syphilitic history, and in them there are adhesions in the neighbourhood of the bile-ducts.

The *pathology* of the disease, for the reasons so often stated (peculiarities of antenatal environment, ignorance of antenatal physiology, etc.), is obscure. It would seem that in some cases chronic progressive inflammation of the gall-bladder and ducts must have begun very early in fœtal life (third month of antenatal existence); these are the cases in which no coloured meconium is passed. In others, the same process cannot have led to blocking of the ducts till much later, if we are to account for the presence of normal meconium in the bowel. It may be that a malformation of the ducts caused narrowing of the available lumen, and so started the whole morbid process by preventing the escape of the bile; then, on account of its retention, or by reason of irritating properties possessed by it, the bile sets up inflammatory changes in its containing vessels with resulting biliary cirrhosis of the liver. Again, it is possible that the irritating character of the bile may be the starting-point of the chain of morbid changes. H. D. Rolleston

and L. B. Hayne (*Brit. Med. Journ.*, i. for 1901, p. 758), keeping in mind the fact that poisons reach the fœtal economy and primarily the liver by the umbilical vein, believe that on this account some of the irritating material (toxin, poison) will at once set up ordinary portal or multilobular cirrhosis, and that the rest of it will pass by the ductus venosus into the general circulation. Some of the poison will, however, also reach the liver by the hepatic artery, be excreted into the intra-hepatic bile-ducts, and set up cholangitis and monolobular cirrhosis. In this way, according to Rolleston and Hayne (*loc. cit.*), a mixed portal and biliary cirrhosis is set up; the cholangitis descends to the larger ducts, and gives rise to an obliterative cholangitis; thus the primary changes are in the small intra-hepatic ducts. What the poisons are that thus reach the fœtus is not known, but there is some evidence that they are not syphilitic. The marked occurrence of family prevalence would seem to show that they are poisons which may be reproduced in several successive pregnancies. There is nothing improbable in the view that such poisons, if they come into action in the neofœtal or embryonic period, may produce primary defective development of the bile-ducts, while if they act later they may set up first a cirrhosis and then subsequent obliteration of the ducts.

The *diagnosis* of the disease is hardly ever made until some days after birth have passed, when the persistence of what was regarded at first as transient icterus neonatorum excites suspicion, a suspicion which the colourless motions and bile-stained urine, and latterly the spontaneous hæmorrhages, serve to confirm. The *prognosis* is always of the gravest kind, and with regard to treatment it must be confessed that it is nil—*therapia nulla.* Manifestly, if the whole process be due to poisons reaching the fœtus from the mother, the only hopeful line of treatment will consist in preventing the formation of these poisons or in hindering their transmission; and for this we must look to the as yet undiscovered "placental tonic" and to other forms of antenatal therapeutics. It would in the meantime be of great importance to find out the nature of the transmitted poisons about which so much speculation has taken place.

A bibliography of the subject up to 1896 is given by John Thomson (*loc. cit.*), and some recent references have been added by Rolleston and Hayne (*loc. cit.*).

Congenital Hypertrophic Stenosis of the Pylorus.

Congenital Hypertrophy of the Pylorus (or Congenital Gastric Spasm) is another antenatal condition towards the elucidation of which John Thomson has materially contributed. Besides reporting three cases, he has advanced an ingenious and very probable theory of their pathogenesis, and has published a good bibliography of the subject (*Scott. Med. Surg. Journ.*, i. 511, 1896; *Edinb. Hosp. Rep.*, iv. 116, 1896).

The morbid condition of the pylorus and of the neighbouring part of the stomach wall undoubtedly exists during fœtal life; but on

account of the principle of potential morbidity then existing it gives rise to no symptoms till after birth has taken place, and the gastro-intestinal tract taken on greater functional activities. Under the name of "scirrhus of the stomach, probably congenital," T. Williamson of Leith seems to have described hypertrophy of the pylorus as long ago as 1841 (*Month. Journ. Med. Sc.*, Edinb., i. 23, 1841), and since then, but more particularly during the last twelve years, more than thirty cases have been reported by various observers.

With regard to *symptomatology*, it has to be noted that at birth the infant shows no signs of illness and has a well-nourished appearance, for the pathological state, although in existence, has not begun to produce its dire effects—*latet anguis in herbâ*. There is a record, in some cases, of maternal suffering in pregnancy, but this is not constant. The infant begins to vomit in from two or three hours to two or three weeks after birth; at first the vomiting occurs at comparatively long intervals, but these soon diminish, and then every attempt to swallow even a teaspoonful of fluid suffices to cause the emptying of the stomach. The ordinary causes of vomiting are absent. The matters brought up are simply the swallowed fluids mixed with mucus, and they are not bile-stained. The emesis may be accomplished with great force, and this seems to be more markedly the case when a large quantity of fluid is given. Ordinary gastric sedatives produce no good effect, although gavage may cause only a temporary amelioration. The fluid being prevented from passing from the stomach into the duodenum, lies there unabsorbed. There is usually constipation, and the motions are scanty. By abdominal palpation the hard hypertrophied pylorus can sometimes be left in the epigastric region as a movable swelling, for the abdominal walls are lax and the intestines collapsed. Finkelstein (*Jahrb. f. Kinderhlk.*, xliii. 105, 1896) was able to make out this physical sign of the disease. Infants suffering from hypertrophy of the pylorus live as a rule not longer than three months; but there is a growing belief that recovery sometimes (F. E. Batten, *Lancet*, ii. for 1899, p. 1511) occurs, and that for treatment, therefore, there may perhaps exist some little spark of hope—*lateat scintillula forsan*.

The *morbid anatomy* is practically limited to the pylorus and the stomach wall. The stomach is somewhat enlarged, and its wall is thin at the cardiac end, and greatly thickened everywhere else. The pylorus feels almost solid, and has a fusiform or even an oval shape. The pyloric opening seems closed, although a probe can be passed through; and the narrowing is due to the hypertrophied muscle. The mucous membrane is thrown into folds. In most of the cases the circular muscular bands were those most affected by the hypertrophy, but in one instance at least the longitudinal layer was very markedly thickened. The mucous and submucous coats may be quite normal; but sometimes the latter was thickened (*e.g.*, in G. F. Still's third case, *Trans. Path. Soc. Lond.*, l. 88, 1899).

The *pathogenesis* of this antenatal disease is of course difficult to understand: that scarcely requires saying. It would seem that we must consider the dilatation of the stomach and œsophagus, as well as

the hypertrophy of the pylorus and adjoining gastric wall, to be due to increased but disorderly functional activity of this part of the alimentary tract; it would also appear to be necessary to postulate the occurrence and the continuance of this over-action for some time before birth. As Thomson (*loc. cit.*) points out, there is no evidence that the spasm of the pylorus is due to a local lesion, such as an ulcer of the mucous membrane, nor is there much, if anything, to support the view of the presence of an irritating fluid in the stomach during antenatal life. That the liquor amnii is swallowed by the fœtus and in large amount, can hardly be doubted (*vide* p. 153); but that its chemical constitution is ever so altered as to make it a slow irritant poison to the fœtal stomach, while it is of course possible, is exceedingly improbable. We are, therefore, led to accept John Thomson's explanation, that the nervous mechanism of the stomach is at fault, and that an antagonistic spasm of the gastric and the pyloric muscles is set up with resulting hypertrophy of both, with stenosis of the pylorus, and with loss of power of absorption of the stomach. To say that the congenital hypertrophy is a developmental overgrowth, is really to say nothing at all, nothing at any rate save what has been inferred in the name of the disease. The acceptance of Thomson's theory that here we have to do with a "functional disorder of the nerves of the stomach and pylorus leading to an ill co-ordination, and therefore an antagonistic action of their muscular arrangement," introduces some novel speculations into the realm of Antenatal Pathology. Of course it is possible that the functional nervous disorder may in its turn be due to "faultly development," yet the theory, if accepted (and I do not see how one can do otherwise than accept it), introduces the idea of functional disorders into antenatal pathology. The idea thus introduced may have far-reaching consequences; for it is obvious that it may be applied to some of the cardiac malformations, to hypertrophy of the urinary bladder and walls of the colon, and even to enlargement of certain groups of skeletal muscles. Further, it may not only tend to clear up doubtful questions of pathology and pathogenesis, it may also suggest new methods of *treatment*, and instil fresh courage into the fainting therapeutist, and rekindle that wonderful "scintillula" of hope. Batten (*loc. cit.*) indeed has already fanned the "scintillula" into a flame, albeit a small one, by suggesting that in congenital gastric spasm the infant be fed by a nasal tube so as to avoid the starting of peristalsis by deglutition. W. Abel (*München. med. Wchnschr.*, xlvi. 1607, 1899), also, has recorded the first case treated successfully by gastro-enterostomy (Wölfler's method).

There are other antenatal diseases of the digestive organs to which reference might be made, such as congenital hypertrophy of the colon, congenital volvulus, etc.; but it is impossible to find space for more than the four types given above, viz. ascites, peritonitis, jaundice, and gastric spasm. Of these the first is a good instance of a fœtal disease which leads to great delay in labour; the second is important on account of its possible bearing upon the

production of malformations of the generative organs; the third is an example of that potential morbidity of the fœtus which becomes so real after birth; and the fourth has an interest peculiarly its own because of its probable functional origin. Accompanying the fourth type, also, is that little spark of hope that bespeaks a possible method of successful treatment. Let us leave this part of the subject with that "scintilla" shining cheerily; may it prove to be no ignis fatuus or Will-o'-the-wisp!

CHAPTER XXI

Types of Idiopathic Diseases of the Fœtus (*cont.*): Diseases of the Circulatory Apparatus: Fœtal Endocarditis — Relation to Congenital Cardiac Anomalies, Frequency, Etiology, Characters, Diagnosis, Associated Malformations, Treatment; Antenatal Atheroma; Congenital Goitre, Definition, Illustrative Cases, Morbid Anatomy, Clinical Results, Treatment, Pathology, and Etiology; Diseases of the Respiratory System.

AMONG the idiopathic diseases of the fœtus must be reckoned certain maladies of the heart, vascular system, blood glands, and lungs, such as fœtal endocarditis, congenital atheroma, congenital goitre, and fœtal pneumonia. Several of the diseases included in this group will, no doubt, yet find their way into the division of the transmitted morbid states; about others almost nothing has been securely ascertained; and, taking the group as a whole, it must be confessed that even more than the usual obscurity belonging to antenatal matters hangs round it. Nevertheless the attempt must be made to set forth our ignorance, if we have nothing else to offer.

Fœtal Endocarditis.

Fœtal endocarditis is a condition to which reference is so constantly made, more especially in connection with congenital cardiac anomalies and malformations, that it may be supposed that behind these multiple references must lie a large number of well-ascertained facts. But this is very far from the truth. Many and careful indeed have been the reports of cases of congenital malformations of the heart, and fœtal endocarditis is referred to in connection with nearly all of them; but a scrutiny of the facts leaves the reader impressed with the indefiniteness of the references and with the hypothetical nature of many of the most confident assertions which are made. Let us see whether anything can be done to throw light upon this matter.

From the neofœtal period on to the very end of antenatal life, the *formation* of the heart may be said to be in abeyance; it is nearly as well formed at the beginning of the second month of pregnancy as it is a day or two before birth. During this long period it grows in size and weight, and is very active in sending the blood round the circulation, but it develops scarcely at all; no great changes are seen in it, for all the great antenatal developmental processes have been completed before the end of the second month. The auricles have been shut off from the ventricles save at the mitral and tricuspid openings, and the right side of the heart from the left

save at the foramen ovale; the pulmonary artery and the aorta have been differentiated and have taken on their separate functions; and the valvular apparatus is complete. Developmentally the heart is as perfect at the second month as at the ninth. Therefore it is extremely difficult to understand how endocarditis supervening between these two dates can produce malformations which are evidently arrests of formative processes which are anterior to the first of these dates. On the other hand, it must be remembered that a part of the embryology of the heart is left until antenatal life is over, and is accomplished in the first days of postnatal existence; I refer to closure of the interauricular communication and to obliteration of the ductus arteriosus.

Now, let it be supposed that endocarditis attacks the heart at some time between the second month and the full term of antenatal life. The affection of the endocardium, it may be readily admitted, will so injure the vitality of the heart that after the infant is born there may be a delay in the normal closure of the foramen ovale and the ductus arteriosus; in this way, it is quite conceivable, may be produced the ordinary form of congenital cardiac anomaly—a patent foramen and a pervious ductus. Perhaps it may be necessary to admit that the endocarditis shall have specially attacked the margins of the foramen ovale and the walls of the ductus; but the assumption is not at all an improbable one. Sometimes, also, it may be supposed that the inflammatory process will lead to premature closure of the foramen or ductus—a matter already referred to (*vide* pp. 235, 293). But, it may be asked, is endocarditis coming on in fœtal life not instrumental in producing any other of the malformations of the heart met with at birth? It is conceivable that it may interfere with the rate of growth of the various parts of the heart, although its supervention may be too late to interfere with their actual formation In this way may be produced "congenital stenosis of the pulmonary artery and aorta." It is also conceivable that endocarditis coming on very early in fœtal life (neofœtal period) may interfere with the normal completion of some of the last of the truly formative or embryogenetic parts of the development, and so lead, for instance, to persistence of the interventricular communication or to anomalies in the separation of the great vessels at the base of the heart. Malformations due to the persistence of embryogenetic phases anterior to the neofœtal period, can hardly be ascribed to fœtal endocarditis, unless, indeed, it can be proved that this disease exists or can exist in these early periods.

It must not be forgotten that there is another aspect of this relation of fœtal endocarditis to cardiac malformations. It must be regarded as probable that inflammation will be more liable to attack a malformed than a well-formed heart. The presence of malformations will predispose to fœtal endocarditis, "Le vice de structure crée la vulnérabilité" (Moussous, in Grancher's *Traité de mal. de l'enfance*, iii., p. 601, 1897).

There are, therefore, two more or less opposed theories regarding congenital cardiac anomalies—the teratological and the pathological.

According to the one, they are instances of "errors" in formation; according to the other, they are the results of fœtal endocarditis. But the degree of opposition between these views has been exaggerated; indeed, the two theories are not incompatible. The structural defects and malformations and the signs of fœtal endocarditis may have a common origin, and may exist side by side as evidence of a common cause which has begun to act in the embryonic period of antenatal life, and has not ceased to do so in the fœtal period.

The subject of congenital cardiac anomalies and of the cyanotic condition (*morbus cœruleus*) which so often accompanies them is very large, and can only be touched upon here. The *literature* is given with considerable fulness by H. Vierordt (*Die angeborenen Herzkrankheiten*, Wien, 1898); to this work the reader who wishes to explore this interesting department of medicine is referred. I have tried to indicate the relation which exists or probably exists between fœtal endocarditis and these congenital heart cases, and in a strict sense this is the only point at which *Fœtal* Pathology and the "Congenital Hearts" come into contact. For it must be borne in mind that an open foramen ovale and a pervious ductus arteriosus are not abnormal but normal during fœtal life, and that many of the cardiac malformations which are present in the fœtal period of antenatal existence are truly embryonic in origin, and were already present when the embryo became a fœtus. From my present standpoint, therefore, which is that of Fœtal Pathology, the subject is very considerably narrowed down. At the same time it is necessary to refer, but with brevity, to certain of the anomalies, neonatal as well as embryonic in origin, with which fœtal endocarditis is associated.

It would appear that fœtal endocarditis is relatively common, if one accepts the evidence afforded by the presence of white or yellow thickenings on the endocardium, of contraction of the openings or cavities of the heart, and of pathological states of the valves. Theoretically, there is no cause to doubt the frequency of fœtal endocarditis, any more than that of antenatal hepatic cirrhosis; for if it be granted that these diseases are due most often to microbes, toxins, and poisons coming from the mother to the fœtus through the placenta, then the two organs first reached by them will be the liver and the heart, and it is reasonable to look for lesions in these viscera. In this way, as I have already shown (*vide* pp. 182, 198, 208, etc.), fevers, tubercle, syphilis, alcoholism, and other morbid states in the mother reaching the fœtus through the umbilical vein set up cardiac and hepatic lesions in the latter. It is possible, also, that some cases of fœtal endocarditis arise from bacilli and toxic products manufactured by and in the fœtal organism itself; indeed, if we hold the infective theory of causation of endocarditis, it is necessary to accept this supposition, for in many instances the mother's health in pregnancy has been good, and there has been no chance of a microbic or toxic invasion of the fœtal tissues by way of the placenta. Some of the cases, therefore, are really of the nature of transmitted maladies, while others are idiopathic. If the parts in the heart are affected according to the order in which the toxic or microbic products reach

them, it will follow that the foramen ovale, the mitral valve, the aortic orifice, the tricuspid valve, the pulmonary artery, and the ductus arteriosus will be attacked in that order. About this matter, however, there can be little more than speculation in the present state of our knowledge. Certainly, narrowing of the pulmonary artery would appear to be the most commonly observed congenital cardiac anomaly, and instances of lesions affecting the tricuspid valve are not wanting (*e.g.*, Brindeau, *Ann. de gynéc.*, xlv. 79, 1896; Zariquiey, *Rev. mens. d. mal. de l'enf.*, xii. 620, 1894); but it must be borne in mind that the former of these is not admitted by all or even by many writers to be caused by fœtal endocarditis. Nevertheless the statement is made with apparent confidence that the right side of the fœtal heart is more often affected with inflammation than the left. The confidence may be justified; but it ought at any rate to be borne constantly in mind that the fact that the right side of the heart has as thick walls as the left does not prove hypertrophy of the former (*vide* p. 111). The two ventricles may have walls of equal thickness and yet be normal in antenatal life. This fact and others like it are too often forgotten or neglected in drawing conclusions as to the effects of fœtal endocarditis. F. P. Weber (*Trans. Path. Soc. Lond.*, xlviii. 51, 1896–7), in describing the heart of an adult showing calcification of the tricuspid valve, stated his belief that it was due to intrauterine endocarditis, but he wisely inserted the word "probably" in the statement; it would be well if other writers were equally guarded and made more use of "probably," and also, perhaps, of "possibly."

Fœtal endocarditis stands out prominently among the other maladies of antenatal life, by reason of the fact that it has been diagnosed before birth. H. Padgett (*South. Practitioner*, Nashville, xvi. 318, 1894), for instance, detected a harsh systolic murmur during auscultation of the fœtal heart in pregnancy; he made the diagnosis of mitral heart disease of the unborn infant, and confirmed his diagnosis by the examination of the infant after birth. Bellot (*Bull. Soc. anat. de Par.*, 5 s., ix. 757, 1895) heard a murmur before birth; the infant was born in a state of cyanosis, and died on the fourth day; at the autopsy a single vessel (aorta) was found arising from the base of the heart (from the right ventricle). J. N. Hall (*Arch. Pediat.*, xiv. 905, 1897), in his communication, also gave details of cases reported by Barth, Hennig, and Christopher; in the example reported by himself, the lesion seemed to have been a roughening of the lining membrane of the ductus arteriosus, for the murmur which affected the first sound disappeared ten days after birth. In estimating the value of the antenatal diagnosis of fœtal heart murmurs, the possible fallacy of the uterine souffle must not be forgotten; but there seems to be sufficient evidence to justify the hope that along this line advances may be made in the investigation of fœtal maladies. After the birth of the infant the diagnosis of the state of its heart is made, of course, by the ordinary clinical methods; and the symptomatology and physical signs of congenital heart disease and malformation have now been well established, and are to be

found in most text-books of medicine and diseases of children. The cyanosis (early or late in appearing), the curious polycythæmia or return of the blood to the fœtal state as regards the number of the erythrocytes, the dyspnœa and palpitation, the hypothermy, the clubbing of the fingers and the cardiac murmurs (usually systolic), all combine to form a clinical picture which is easily recognisable. It must be borne in mind that these signs and symptoms are mostly due not to the endocarditis, but to its results or supposed results, the cardiac malformations. Difficulties arise when the attempt is made to diagnose the exact malformation or combination of malformations which are present in any case; but even in this difficult department of medicine considerable progress has been made. The discussion of these questions, however, would lead me outside the scope of this work.

It is a noteworthy fact that congenital cardiac anomalies, and therefore also endocarditis (if we accept the inflammatory origin of some of these anomalies) are often found associated with malformations of other parts of the body. Thus, to quote from a recent contribution, John Thomson and W. B. Drummond (*Edinb. Hosp. Rep.*, vi. 57, 1900) found, in a series of nine cases of congenital heart disease, that in three of these there were such malformations as hare-lip, cleft palate, imperforate anus, malformation of external ear, and horse-shoe kidney; in another case, there was "Mongolian" imbecility, and it is a remarkable fact, noted also by A. G. Garrod and others, that this type of imbecility should be often associated with congenital cardiac anomalies. All these fragments of evidence go to support the view that cardiac anomalies, fœtal endocarditis, and malformations of other parts of the body are the results of the action of a common cause, and that the differences in the nature of the results are due to the fact that the cause acts at different times, and consequently upon an organism in different stages of development. *Series implexa causarum*—an involved chain of causes!

I was recently consulted about the case of a woman who had given birth to an infant suffering from congenital heart disease (patent foramen ovale, etc.), which survived its birth eleven months; the father was strongly alcoholic at the time of the infant's conception and for two years previously, but the woman herself was practically a total abstainer. She was again pregnant (seven weeks), and I was asked regarding the probable prognosis as regards the offspring. The husband's habits had shown distinct signs of improvement, and on this account, and because the mother was practically an abstainer, I gave a more hopeful but guarded forecast for the infant. I have recently (November, 1901) heard that this child was healthy and free from cardiac trouble.

While little has been done towards the antenatal treatment of congenital cardiac anomalies, it is an interesting fact that apparently they are sometimes recovered from after birth. Evidence supporting this conclusion is supplied by John Thomson's case (*Arch. Pediat.*, xviii. 193, 1901); possibly similar instances might be found if carefully looked for; possibly, also, antenatal recovery may not be rare.

Antenatal Atheroma.

Little is known regarding diseases of the blood vessels in fœtal life, save in connection with the changes which they undergo in syphilis (*vide* p. 230). Certainly we should not expect to find morbid conditions which are characteristic of old age in antenatal life, nevertheless Durante (*Bull. Soc. anat. de Par.*, 6 s., i. 97, 1899) has recorded a case of atheroma in the infant at birth. The child was born at the seventh month, and died a fortnight later with signs of general œdema and peritonitis. The heart showed no lesions, and there was no pericarditis. The pulmonary artery, however, had hard walls with patches of considerable density, such as are found in the senile aorta; its inner surface was white and smooth. The aorta felt unusually rigid. The microscopical examination of the heart (endo-, peri-, and myocardium) gave normal results; but in the deeper portions of the middle coat of the pulmonary artery there was marked fatty degeneration and calcareous infiltration. The aorta showed similar but less evident changes. In neither vessel was the intima affected. The changes could hardly have occurred after birth, and the absence of signs of endocarditis precluded the idea of postnatal infection. We are driven, therefore, to the conclusion that atheroma of the aorta and pulmonary artery may occur in antenatal life.

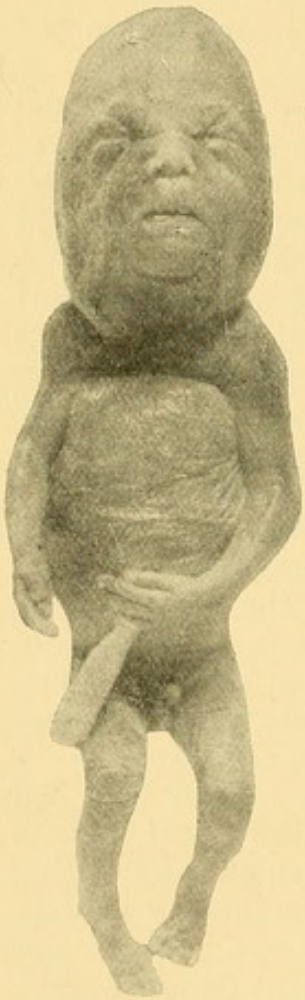


Fig. 55.

Congenital Goitre.

Under the name "struma congenita" have been described various swellings of the neck found in the infant at birth. Along with its synonyms, "intrauterine goitre" and "intrauterine bronchocele," it has been made to include not only enlargements of the thyroid gland and parathyroids, but also cervical hygromata, cervical spina bifida, and ranula. The name, if it is to be retained at all, ought to be reserved for swellings of the thyroid gland alone; but it is not a good term, and might be abandoned altogether with more of profit than of loss. I met with a specimen of this morbid state in 1894, which is represented in Fig. 55; it was a fœtus weighing 178 grms., born between the fourth and fifth months, and showing a general congestive enlargement of the tissues of the neck between the lower jaw and the manubrium sterni; the case occurred in the practice of Dr. E. Coleman Moore, and the parents were free from any cervical enlargement. I have recently examined another case of large cystic swelling in the neck, but it was evidently a congenital hydrocele or hygroma, and not at all of the same nature as Dr. Coleman Moore's case.

During the last fifty years a considerable number of observations of congenital enlargement of the thyroid gland have been published. In Edinburgh, A. Keiller (*Edinb. Med. and Surg. Journ.*, lxxxii. 31, 1855) reported a case in which there was a large irregularly lobulated swelling in the region of the thyroid gland in a new-born infant; the child had presented by the forehead, for, on account of the cervical tumour, the normal flexion of the head could not take place; neither the mother nor any of her relatives were goitrous. A somewhat similar case was described by J. Y. Simpson (*Month. Journ. Med. Sc.*, xx. 350, 1855); it was the tenth child of a non-goitrous woman; it was born somewhat prematurely, and, on account of the compression of the trachea, died in eight hours; the thyroid gland was nearly as large as a hen's egg, and caused delay in labour and an abnormal presentation (forehead); all parts of the thyroid were equally affected, and the gland surrounded the trachea almost entirely; its vesicular cavities seemed not only increased in number but enlarged in size also, and the septa between them were considerably thickened; and the thymus gland and adrenals appeared to be normal. A. R. Simpson (*Glasgow Med. Journ.*, 3 s., i. 181, 1866–7) also met with an instance of congenital "goitre" in a case where the mother had been taking chlorate of potash in pregnancy, with a view to the prevention of miscarriages and premature labours; the anterior fontanelle presented and labour was delayed; the thyroid seemed to be equally enlarged in its isthmus and lateral lobes; at first there was difficulty in respiration and deglutition, but at the age of four months the tumour was much shrunken and the child (a male) appeared healthy.

In addition to these cases, published in Edinburgh and Glasgow, there have been others reported, more especially on the Continent. Among these may be mentioned the observations of R. W. Crichton (*Edinb. Med. Journ.*, ii. 149, 1856), of F. Betz (*Ztschr. f. rat. Med.*, ix. 233, 1850), of A. Besnard (*Med. Cor.-Bl. bayer Aerzte*, viii. 806, 1847), of Diener (*Schweiz. Ztschr. f. Med. Chir. u. Geburtsh.*, Zürich, 455, 1848), of Malgaigne (*Rev. méd. chir. de Par.*, ix. 368, 1851), of Danyau (*Gaz. d. hôp.*, xxxiv. 78, 1861), of Béraud and Danyau (*Bull. Soc. de chir. de Par.*, 2 s., ii. 108, 1862), of O. Spiegelberg (*Würzb. med. Ztschr.*, v. 160, 1864), of Fröbelius (*St. Petersb. med. Ztschr.*, ix. 175, 1865), of L. Porta (*Gior. di anat. e fisiol.*, iii. 37, 1866), of W. Müller (*Jenaische Ztschr. f. Med. u. Naturw.*, vi. 454, 1871), of Pflug (*Deutsche Ztschr. f. Thiermed.*, i. 349, 1875), of L. Mayer (*Beitr. z. Geburtsh. u. Gynäk.*, iii. 86, 1874), of H. Löhlein (*Ztschr. f. Geburtsh. u. Gynäk.*, i. 23, 1875), and of others. C. Taruffi (*Sulle strume congenite della tiroide*, Bologna, 1892) gathered together a great many of the published cases and considered the whole subject, as did also R. Demme (in Gerhardt's *Handbuch der Kinderkrankheiten*, Band iii., Heft ii. 388, 1878), Schenk (*Dissert.*, Heidelberg, 1891), and some others.

The enlargement of the thyroid varied much in different cases, being sometimes of the size of a hen's egg and sometimes as large as a fœtal head (A. Billig, *Dissert.*, Heidelberg, 1892); its weight has exceeded 100 grms. The enlargement may affect all the parts of the

gland, but cases have been reported in which one lobe only was affected. In structure the tumour may be (1) of an adenomatous type, but that is not the commonest form; (2) it may be made up of an increase in the vesicular substance of the gland (parenchymatous type), and may then show colloid or true cystic changes; and (3) it may be of the congestive type. Sometimes there is a concomitant enlargement of the thymus (F. Weber, *Beiträge z. path. Anat. der Neugebornen*, Lief. ii. 84, Kiel, 1852); sometimes, also, the thyroid tumour contains cartilaginous or myxomatous tissue.

The effects of fœtal goitre become apparent as soon as pulmonary respiration is rendered necessary, for the swelling usually compresses the trachea so as to impede breathing, or else produces a similar result by pressure on the nerves in the neighbourhood. Before birth the life of the fœtus is not threatened; but an abnormal presentation (forehead, face) may be produced, and so delay, and possibly infantile death during labour be brought about. After birth, if the first dangers from difficulty in establishing respiration are overcome, the swelling in the neck tends to diminish in size, and may almost entirely disappear. This tendency to wither away must be taken into account in estimating the result of treatment, as in the case reported by A. Mossé and Cathala (*Bull. Acad. Méd.*, 3 s., xxxix. 420, 1898), in which a goitrous mother who was nursing her goitrous infant was treated with dry thyroid extract with an apparently beneficial effect upon the infant. A more radical method of treatment was that adopted by Polosson and reported by Genevet (*Lyon méd.*, xcii. 303, 1899): the infant was the child of a goitrous mother, and was born in a state of apparent death; it was resuscitated with great difficulty, and still showed marked dyspnœa and noisy respiration; a tumour was discovered in the neck of doubtful nature; an incision was made in the middle line and a fairly large goitre was exposed; the tumour was pulled gently out of the wound (exothyropexy), and left outside without any dressing to atrophy; and Polosson intended to hasten this process if necessary by punctures with the thermo-cautery. In Brosin's case (*Centrlbl. f. Gynäk.*, xviii. 1170, 1894) operative treatment did not succeed.

In considering the etiology and pathogenesis of so-called congenital struma, we meet with two well-ascertained facts: one is the birth of goitrous infants by goitrous mothers, and the other is the occurrence of cases in which the infant has an enlargement of the thyroid gland, and yet neither the mother nor father nor any other relative suffers or has suffered in a similar manner. This morbid state, therefore, would appear to have an equal claim to admission among the transmitted and the idiopathic diseases of the fœtus; or rather, if the statistics of Demme (*op. cit.*) are had regard to, the malady would be placed with those that are transmitted. The condition would seem to be most common in the localities in which goitre is most common; in Switzerland, for instance, Demme reported 642 cases, and 53 of these were congenital. Among the 53 congenital cases there were 14 in which both parents were goitrous, 23 in which the mother alone was affected, and 16 in which both parents were exempt from the malady. The congenital cases differ from those in

the adult in showing a preference for the male rather than for the female sex. It is, after all, absolutely necessary for us to know more about the pathogenesis of goitre in general before we can hope to solve the problem of its transmission or non-transmission from parent to child. Possibly some of the cases in which there is no history or evidence of a family tendency to goitre may be really instances of cystic enlargement of other structures in the neck (*vide* C. Taruffi, *op. cit.*).

It is not my intention to give any space here to the consideration of the idiopathic diseases of the lungs and pleura in the fœtus. I have already referred to the state of the lungs in sepsis (p. 217), in syphilis (p. 234), and in tubercle (p. 208); and after one has named these occasional morbid conditions, as well as the pneumonia which arises from pulmonary infection during labour, it may indeed be doubted whether there are any diseases of the fœtal lungs which are really to be regarded as idiopathic.

CHAPTER XXII

Types of Idiopathic Diseases of the Fœtus (*cont.*): Diseases of the Urinary Apparatus: Fœtal Nephritis, Distension of the Bladder, Hypertrophic Dilatation of the Bladder, Hydronephrosis, Cystic Degeneration of the Kidneys: Diseases of the Genital Organs: Congenital Prolapse of the Uterus; Diseases of the Nervous System: Hydrocephalus; Little's Disease; Congenital Chorea; Friedreich's Ataxia; Thomsen's Disease; Congenital Clouding of the Cornea.

In this Chapter I gather together some of the remaining types of idiopathic disease in the fœtus, although it must be freely admitted that they are scarcely "typical," and that they are only doubtfully idiopathic. About some of them very little is known, and about others the information which we possess is chiefly obstetrical, and arises from the delay in labour which they cause by the alteration in the size of the fœtus which they produce. A short chapter is therefore all that need be set apart for their consideration.

Diseases of the Urinary Apparatus.

I have already (p. 162) adduced evidence to show that the urinary organs are functionally active during fœtal life; and it may therefore be concluded that they will be subject to diseases during this period. Cases, also, are actually on record which demonstrate this. Some of these produce dystocia by reason of the abdominal distension which they give rise to, and about them a good deal of information is forthcoming; others do not cause any special enlargement, and have been little investigated. In the latter group fœtal nephritis must be placed. Some few facts, however, are known with regard to it, and these may now be stated.

Fœtal Nephritis.

Allusion has already been made to the changes in the kidneys in fœtal syphilis, and it has been stated that possibly in some instances of general fœtal dropsy the starting point of the morbid process may have been a renal inflammation; but there is some evidence also that nephritis may arise in antenatal life in an idiopathic fashion. In a case which I examined and reported on some years ago (*Diseases of the Fœtus*, ii. 15, 1895), the premature infant of a woman suffering from bronchitis and pneumonia developed œdema of the lower limbs and trunk within a few hours of birth, and died

in two days; during his brief life he passed no urine so far as could be ascertained. At the post-mortem a condition of intense congestion of the kidneys, and more especially of their cortex, was found; under the microscope, cloudy swelling of the cells of the urinary tubules and small cell infiltration of the Malpighian bodies was discovered, changes which pointed to tubular and glomerular nephritis. Of course it is possible that, in this instance, the renal alterations were entirely postnatal; some evidence in favour of an antenatal origin of the nephritis was present, but it was not conclusive. Stronger proof, however, is forthcoming, for in March of the present year (1901) I received from Dr. Henry Ashby of Manchester the notes of a case which seemed to have been one of undoubted fœtal nephritis. The case was that of an infant, twenty-one days of age, intensely dropsical in the face, limbs, and abdomen; it died in uræmic convulsions; and the post-mortem examination revealed the presence of kidneys showing marked chronic or subacute nephritis in the "small white" stage. Under the microscope the organs, which presented the fœtal lobulations very plainly, showed blood and fibrinous casts, dilated convoluted and straight tubules, fatty epithelium, and commencing fibro-cellular changes around the glomeruli and between the tubules. The mother was a healthy woman, who had not suffered from nephritis, and there was no history of alcoholism, syphilis, or any form of poisoning. During the life of the child little urine was passed; the dropsy appeared on the second day of life. I agree with Ashby that it is very probable that this was an instance of fœtal nephritis; further, in the absence of any other evidence, it must be regarded as *idiopathic* fœtal nephritis.

As has been already pointed out, albuminuria in the new-born sometimes occurs even when the mother has not suffered from nephritis or eclampsia; and this neonatal albuminuria apparently does not always or often signify permanent renal lesions. It may mean nothing more than an imperfect development of the renal epithelium. On this question Hugo Ribbert's article (*Arch. f. path. Anat.*, xcviii. 527, 1884) may be consulted with profit. Nevertheless, the occasional occurrence of nephritis which has begun in the fœtus while still in utero cannot, I think, be doubted. Along this line most useful pathological investigations upon still-born infants might be made. The relation of the fœtal renal lesions to placental morbid states is also well worthy of study.

Distension of the Bladder.

Many cases are on record in which labour was delayed by an enlargement of the fœtal abdomen caused by an enormously distended urinary bladder. These cases must, I think, be separated from those in which the bladder is hypertrophied as well as somewhat dilated. In the former the morbid state is evidently a distension of the fœtal bladder on account of grave malformations of the urethra and external genitals; in the latter no such explanation is feasible, and the condition is rather to be compared with con-

genital hypertrophy of the pylorus and enlargement of the colon. A few words are all that are necessary with regard to the former anomaly.

The distension of the bladder with urine may reach a truly enormous degree, so that the head and limbs of the fœtus appear as insignificant appendages to the large globular trunk. The striking deformity thus produced was very evident in the specimens of F. Fabris (*Ann. di ostet.*, xvii. 329, 1895), C. Taruffi (*Mem. d. r. Accad. d. sc. d. Istit. di Bologna*, 5 s., iv. 73, 1894), V. Frascani (*Atti Cong. gen. d. Ass. med. ital., Siena*, xiv. 538, 1891), G. Schwyzer (*Arch. f. Gynaek.*, xliii. 333, 1893), A. Mueller (*ibid.*, xlvii. 130, 1894), W. Westphal (*Dissert.*, Königsberg, i. Pr., 1896), Kristeller (*Monatschr. f. Geburtsk. u. Frauenkr.*, xxvii. 165, 1866), and many others. In Fabris' case, for instance, the fœtus, which was born at the ninth month, measured 45 cms. in length, and had a greatly enlarged abdominal circumference (exact measurement not given). The bladder contained 2½ litres of fluid. The umbilical cord appeared to be normal, and was inserted upon the greatly distended abdomen in the usual way. There were no traces of external genital organs, and there was also atresia ani; from coccyx to pubes the skin was unbroken by any depressions, fissures, or elevations. In the abdominal cavity was a large sac with a circumference of 40 cms.; in its upper part the sac was adherent to the diaphragm, liver, and stomach; its walls were rather thick when contrasted with the thinned out abdominal parietes. On the inner aspect of the sac (the bladder) could be seen the openings of the two ureters which were pervious, but there was no indication of the internal orifice of the urethra save a slight depression. The rectum ended blindly in an enlargement which adhered to the left side of the distended bladder. The kidneys and ureters had their normal appearances. There were no traces of vesiculæ seminales, vasa deferentia, prostate, urethra, and internal genitals. The liquid found in the bladder was clear, transparent, limpid, and had a specific gravity of 1007. There was marked hydramnios in this case, and the labour was delayed and had to be terminated artificially by forceps and puncture of the abdomen.

The above case may be taken as a type of this variety of fœtal disease, although in several of its details it differs from other instances. Sometimes, for example, there is scarcity instead of abundance of liquor amnii, and there are also sometimes other kinds of concomitant malformations, *e.g.* anomalies of the limbs, horseshoe kidneys, hypospadias, ureteral dilatations, etc. In Schwyzer's specimen (*loc. cit.*) the fluid in the fœtal bladder is said to have reached the large amount of 6½ litres. In these cases the distension of the fœtal bladder is evidently the result of the concomitant malformations; they are not, therefore, strictly to be regarded as diseases, but as morbid conditions due to teratological states. In this respect they differ from the cases now to be referred to.

Hypertrophic Dilatation of the Bladder, etc.

In 1894 I received from Dr. W. Cardy Bluck a fœtus, which showed very clearly a state of hypertrophic dilatation of the bladder and ureters along with hydronephrosis (176). The mother was 37 years of age and a 6-para; and the five previous children were all alive, but delicate and rachitic. In the present instance, labour came on at the eighth month; the presentation was the vertex, the position L.O.A.; the labour lasted eight hours, and the pains were infrequent and feeble; the amount of liquor amnii was estimated at not more than one fluid ounce (oligohydramnion). The father was a strict vegetarian, and confined his family chiefly to milk and bread. The infant, a male, was still-born; it weighed 5½ lbs., and had talipes varus of both feet and drop-wrist of the right hand. A rounded tumour could be felt on the left side in the abdomen. When the abdomen was opened the bladder was seen to be greatly distended, as were also the ureters; in fact, the latter were enormously dilated and convoluted. There was also bilateral hydronephrosis, but the renal change was more marked on the left than on the right side. Fluid regurgitated easily from the bladder into the left ureter, but not into the right. The urethra was found to be occluded near to the meatus urinarius. Further examination showed the left ureter to be sacculated; it was impossible to pass a probe along it, on account of a series of at least nine folds of the mucous membrane which had free edges and formed pouches. The right ureter showed similar but less marked changes. The left kidney contained numerous small cysts, but its pelvis was not dilated. The bladder wall was thick.

I have had an opportunity of examining another specimen not unlike the above. Notes of this case were published by Dr. C. Mabel Blackwood (*Edinb. Med. Journ.*, xli. 919, 1896). The mother of the infant was healthy, and had given birth to two healthy children. In her third pregnancy the labour was tedious from uterine inertia, and there was less liquor amnii than usual. The placenta had several succenturiate lobes. The child, a male, was with difficulty resuscitated, but lived thereafter for twelve days in an apparently healthy condition, although it was noted that the abdomen was unusually large. After the twelfth day he began to be ill (vomiting, crying, difficulty in passing water), and died on the sixteenth day. The kidneys were of normal size, but in both the capsules could only be stripped off with difficulty; their substance was dense, and the pelves not dilated. In size and appearance the left ureter resembled the large intestine rather than a ureter. It showed a series of dilatations which were larger near its vesical end; its walls were much thickened, and on one side were longitudinal bands. On opening the ureter, it was seen that the mucous membrane was arranged in folds at the points corresponding to the external constrictions; in this way great narrowing of the lumen was produced. The right ureter presented similar but less marked changes. The bladder was enlarged and its walls hypertrophied. In yet another specimen, which is in the possession of Dr. David Waterston (who

is also investigating anew the two previous specimens), the bladder walls were so enormously thickened as to cause that viscus to simulate closely the uterus, while the kidney substance was reduced to nearly nothing; there was no occlusion of the urethra.

I have already referred to cases of fœtal ascites complicated with distension of the bladder (p. 358), and it will be remembered that in one of these there was a membranous obstruction in the urethra near the root of the penis (197). It may therefore be supposed that both in the cases with ascites and those without it there was distension and hypertrophy of the bladder (with dilatation of the ureters and commencing hydronephrosis), on account of the block in the urethra preventing the exit of urine from the bladder. There are, however, recorded instances in which no obstruction (membranous or valvular) was found in the urethra, and yet the bladder showed dilatation and hypertrophy (*e.g.*, the cases of Lefour, *Progrès méd.*, 2 s., v. 413, 1887, and O. Saintu, *Journ. de méd. de Par.*, 2 s., viii. 332, 1896, and others). In C. Mabel Blackwood's case (*loc. cit.*), also, there was permeability of the urethra. Another very striking instance was that reported by Couvelaire (*Bull. Soc. anat. de Par.*, 6 s., ii. 287, 1900). The mother was a 1-para, aged 24 years, who had some albuminuria when labour supervened between the eighth and ninth months. Parturition was delayed, and even after the head had been born the trunk could not be extracted; during attempts at extraction one arm was fractured, and the infant succumbed; it was only when the abdomen had been tapped and 550 grms. of fluid (clear, lemon yellow, highly albuminous) had been drawn off that the fœtus could be fully born. The placenta, membranes, and cord showed no anomaly. The infant, a female, measured 48 cms. in length, and weighed (without the fluid) 2900 grms. The fluid had come from the peritoneal cavity, for on exploring the abdomen the tensely filled and globular bladder was discovered reaching to the umbilicus. Its walls were very thick, and the mucous membrane congested. The urethral canal was normal at both ends, and a stylet passed through it easily; there was no block nor valve in any part of the urethra. The ureters were slightly dilated; the kidneys were a little larger than usual, and showed dilatation of the pelves and calyces, the renal tissue being reduced to a strip nowhere more than 4 mm. thick. In cases such as these, we are forced to seek some other explanation of the state of the bladder and ureters than is found in the presence of a block or valve in the urethra. John Thomson has suggested (*vide* C. M. Blackwood's paper) that a disturbed nervous mechanism may require to be invoked. Certainly this explanation becomes more feasible in view of the discoveries that have been made regarding congenital hypertrophic stenosis of the pylorus. For some reason the contractile force of the bladder meets with resistance from the sphincteric fibres, and as a consequence of prolonged antagonism (lasting, perhaps, during a considerable part of fœtal life) hypertrophy of both sets of muscles takes place. It is, of course, taken for granted that some urine is being secreted by the fœtal kidneys, and doubtless some is expelled from

the bladder now and again; it seems necessary to suppose this in order to account for the great hypertrophy of the bladder walls sometimes met with. At the same time, it must be admitted that in some of the cases in which the urethra is altogether absent, and in which there is no exit for the urine at all, the vesical walls still exhibit the greatest thickening (*e.g.*, in a specimen described by Opitz, *Ztschr. f. Geburtsh. u. Gynäk.*, xl. 316, 1899).

The chances of survival in postnatal life in such cases as have been described above are not necessarily nil. It is quite probable that certain instances recover. Unfortunately it is also more than probable that some cases in which the obstruction to urination is slight become worse after birth, on account of the greater activity of the kidneys then prevailing; the ureters become much dilated, and hydronephrosis more and more marked, until death supervenes. A case which was in all probability of this nature I saw in consultation with Dr. W. Stewart of Leith in 1900. There was difficulty in the birth of the child, a male, on account of the large size of the abdomen. A swelling was found in the abdomen chiefly on the left side, apparently cystic in character. It did not extend under the margin of the ribs. Micturition was not impossible, but it was not free. The child died some days later, and no post-mortem examination was allowed. I formed the opinion that we had to do with an instance of dilatation of the left ureter and hydronephrosis; but it may, of course, have been a cystic kidney or a tumour of some other organ, or even an included fœtus. Surgery may yet devise effective means of dealing with many of these cases.

It is not my intention to describe here the various antenatal pathological states which produce *hydronephrosis*. They are nearly all of the nature of malformations situated in the ureter (absence, imperforation, stenosis from kinks, valves, or compression by other structures, abnormal communication with other organs) or in the urethra (absence, imperforation, stenosis). Hydronephrosis, therefore, is generally the result of teratological states rather than a true disease. H. Brinon (*Thèse*, Paris, 1896) points out that the presence of a supernumerary ureter may explain some of the anomalies in symptomatology and prognosis which are met with in connection with congenital hydronephrosis.

Cystic degeneration of the kidneys is another antenatal morbid state which may cause delay in the delivery of the infant thus affected (L. Burckhardt, *Indiana Med. Journ.*, xiv. 295, 1896). The condition has been met with in association with a cystic state of the liver, as in the case shown by Porak and Couvelaire at the meeting of the *Société d'obstétrique, de gynécologie, et de pédiatrie* of Paris in January 1901; it has also been found combined with hydrocephalus, as in Fin Holmsen's case (*Norsk Mag. f. Lægevidensk.*, lxi. 411, 1900), and with other anomalies. It may be due to sclerosis affecting the uriniferous tubules specially in the neighbourhood of the papillæ ("papillitis"), and so causing retention of urine in the kidneys; but recent researches rather go to show that it is of the nature of an

adenomatous degeneration. If the latter be the correct view, the condition must be regarded as a neoplasm. In M. H. Fussell's case (*Med. News*, lviii. 40, 1891) the heart was much hypertrophied; it was about three times the normal size, and felt like a solid mass of flesh; the ventricles were small in size; and the valves were normal. What bearing, if any, the cardiac condition had upon the renal is not clear.

Diseases of the Genital Organs.

It is chiefly on account of the fact that the full development of the genital organs does not take place till after birth, that diseases of these parts are not met with in the fœtus. The genitals are in an embryonic state during nearly the whole of fœtal life; they afford a very clear illustration of the projection of the embryonic into the fœtal period. The morbid states, therefore, which are met with in them at the time of birth are malformations and not diseases. In regard to the female organs, it is true, it is stated that vaginal septa are regarded as due to adhesive vaginitis occurring in fœtal life; but there is reason to doubt the accuracy of this explanation, and to look upon the stenosis as produced by incomplete canalisation of the vaginal *anlage*. Among the transmitted diseases, syphilis, it is believed, affects the testicles and produces a congenital syphilitic orchitis; it may have a similar effect on the ovaries. But, with these exceptions, if, indeed, they be exceptions, diseases of the genital organs are very rare in antenatal life; this is what the principles of Antenatal Pathology would lead us to expect. There is, however, one morbid condition, at least, which may perhaps be called a disease, which is occasionally met with, and about which some words of description may here be given. I refer to congenital prolapsus uteri.

Congenital Prolapsus Uteri.

Congenital prolapse of the uterus has been very seldom reported; but it probably occurs more frequently than the list of published cases would seem to show; for since 1897, when John Thomson and I recorded our two cases (23), the number of observations has nearly doubled. Our attention was drawn to our first case by Dr. Alexander Macdonald of Edinburgh, and to our second by Dr. C. M'Vicar of Dundee. The notes of the former of these were as follows:—

The patient, a girl, was six days old when first seen by Thomson and myself. She was the youngest of five children, and the others were healthy and strong. During pregnancy the mother had suffered from no accident or injury. The child was born at full term on December 15, 1896, and, with the exception of the spina bifida and double club-foot, appeared healthy. The urine was passed freely and the bowels were regular, although the digestion seemed very feeble. On December 17, the spina bifida burst, and on the next day (third day of life) prolapse of the uterus was seen for the first time; it seemed to cause continual pain and straining. After it appeared it remained constantly down. On December 21, we saw the child for

the first time, when we found the following noteworthy conditions (*vide* Plate XIII.):—

(1) In the lumbar region there was a large spina bifida, which had burst; its base measured about $1\frac{1}{2}$ inch in diameter. (2) Protruding for about $\frac{3}{4}$ inch from the vulva was a red mass closely resembling prolapsed bowel. This, on closer examination, was found to be hypertrophied cervix uteri and the adjacent part of the vaginal wall. A quantity of clear, gelatinous secretion exuded from the os uteri. A sound was passed within the os and entered easily for $1\frac{3}{4}$ inch; it could also be passed into the vagina at the side of the prolapse for about one inch all round. The prolapse went back readily on slight pressure, but came down again very soon unless the surrounding parts were held together. (3) The anus projected unusually, and its orifice was somewhat patent; a finger passed within it was not grasped at all. (4) There was extreme talipes varus on both sides. The patella was absent on the right side, but present on the left. No abnormality of the head or of the thoracic and abdominal organs was found, but the infant was evidently very weak. The prolapse was returned and the buttocks kept in close apposition by means of plaster and a pad of cotton-wool. The child seemed in less pain after this, but she got gradually weaker and died the next day (seventh day of life).

At the post-mortem examination, the heart, lungs, liver, spleen, kidneys, stomach, and intestines were found to be normal. The pelvis and the lower part of the spine were removed for further investigation; they were placed in a freezing mixture, the prolapse having been previously reproduced. A vertical mesial section was then made, and the appearances of the right slab are shown in Plate XIII. The appearances may be usefully contrasted with those seen in Fig. 22 (p. 118). There could be no doubt the uterus was really prolapsed, for its fundus lay at the level of the coccyx instead of well above the pelvic brim. The cervix distended the vulva, and protruded slightly from it; but the degree of protrusion was much less than during life. The direction of the uterine axis contrasted markedly with that in the normal state. The bladder, whose cavity on section had a Y-shape, was situated lower in the pelvis than usual; and there was also a certain degree of prolapse of the vaginal walls. The rest of the pelvis was occupied by the rectum and the intestinal coils. The sacrum showed no indication of a promontory, and the lower part of the spinal column was perfectly straight save for a slight bending back of the tip of the coccyx. The defect in the posterior wall of the spinal canal affected the last lumbar and the first two or three sacral vertebræ, and the cauda equina was seen spread out over the inner surface of the spida bifida sac. A distinct perineal body of a triangular shape existed, the vaginal rugæ were well marked, and the distended vulvar orifice showed an unruptured annular hymen. Dissection of the pelvic contents revealed the ovaries and Fallopian tubes lying slightly above the level of the fundus uteri at the sides of the pelvic cavity. The broad and round ligaments were greatly stretched and thinned. The connective tissue in the pelvis seemed

to be smaller in amount than normal, but the infant herself was not at all plump. The urethra was patent. The diameters of the false pelvis were below the normal, while those of the true pelvis, both at the brim and outlet, were distinctly above the average. The total length of the uterus was 3·2 cms., of which 2 cms. belonged to the cervix and 1·2 cm. to the body. The transverse diameter at the fundus was 1·5 cm., and the antero-posterior only 0·5 cm.; the cervix had an antero-posterior measurement of 1·2 cm. and a transverse of 1·0 cm. Save for a certain but not a great degree of cervical enlargement, these uterine diameters did not differ much from those in normal infants. The distance between the anal and vulvar apertures was 1·0 cm.

The second case that Thomson and I reported was somewhat similar. As in the first, the presentation at birth was by the vertex. The spina bifida sac had burst during delivery in this instance. There was double talipes varus, and no patella could be felt on either side. Dr. M'Vicar noticed the prolapse of the uterus on the day following the birth of the infant. There was also slight eversion of the rectal mucous membrane. The child died in five days. In other details, clinical as well as pathological, the two cases were very similar.

Previous to the publication of these two cases, there had been records of six instances of congenital prolapsus uteri. These were those of Schultz (*Verhandl. d. Ver. pfalz. Aerzte*, 1856, Kaiserslautern, 48, 1857), of N. Qvisling (*Norsk Mag. f. Laegevidensk.*, 4 R., iv. 265, 1889; *Arch. f. Kinderh.*, xii. 81, 1890–1), of O. Schaeffer (*Arch. f. Gynaek.*, xxxvii. 244, 1890), of K. Heil (*Arch. f. Gynaek.*, xlviii. 155, 1894), of S. Remy (*Arch. de tocol.*, xxii. 904, 1895), and of L. Krause (in Neugebauer's article in the *Gazeta lekarska*, xvi. 1223, 1896). Since then cases have been published by Hansson (*München. med. Wchnschr.*, xliv. 1040, 1897), by Radwansky (*München. med. Wchnschr.*, xlv. 53, 1898), by A. Doléris (*Gynécologie*, iii. 220, 1898), and by H. R. Andrews (*Trans. Obst. Soc. Lond.*, xlii. 169, 1900). From the account which has been given of the cases reported by Thomson and myself, and from a consideration of the literature of the subject, the following conclusions may be arrived at:—

There is an evident and real downward displacement of the uterus which occurs soon after or at birth; this is not the same as congenital hypertrophic elongation of the cervix, although there may be a certain degree of cervical enlargement present, and in the case of Doléris the two anomalies were combined. The pregnancy and labour which preceded the birth of an infant suffering from prolapsus uteri seem generally to have been uneventful; but in the cases of Qvisling (*loc. cit.*) and Hansson (*loc. cit.*) the presentation was by the breech. The infant was always born alive, but died, with one exception, some days later. In Krause's subject (*Centrlbl. f. Gynäk.*, xxi. 422, 1897) the prolapse was apparently present at the moment of birth, and may have been in existence in fœtal life; but in the other cases the displacement occurred from a few hours to several days after birth. In Schultz's case (*loc. cit.*) it did not appear for ten weeks, and therefore

this observation perhaps ought not to be grouped with the others. In all the recorded instances the prolapse was easily replaced, and in none had the uterine displacement anything to do with the death of the child. The concomitant malformations were eversion of the rectal mucous membrane, talipes, spina bifida, and (in Krause's case) hypertrichosis.

It is a most remarkable fact that in nearly every case there should have been concomitant spina bifida of the lumbo-sacral region. At the time when Thomson and I published our two cases, there were eight cases on record, and in seven of these there was the spinal defect, while in the eighth it is possible that it was also present although not referred to. In Hansson's observation there was also spina bifida. It was therefore with great interest that I perused Andrews' report of a case in which this commonly associated defect was not present. In this instance the swelling at the vulva was noticed a few hours after birth; it bled when handled; and it consisted of the much swollen cervix uteri. The anus admitted the tip of the finger, but the rectum was imperforate, necessitating inguinal colotomy. The child died on the twelfth day of life, and before this time the uterus could be retained in position without strapping. It is noteworthy that in this case, although there was no spina bifida, yet there was another associated malformation, namely, rectal imperforation. In a letter which I received from Dr. Andrews, dated May 29, 1900, it is stated that the post-mortem examination revealed nothing abnormal save the imperforate rectum. In Radwansky's case also (*loc. cit.*) there seems to have been neither spina bifida nor hydrocephalus; in that instance the prolapse was present at birth, and the protruded mass measured 4 cms. in length; there was some ulceration of the exposed cervix uteri; great improvement followed replacement and retention; and at the end of six months the infant was still living and the prolapsus was feebly marked. The cases of Radwansky and Andrews demonstrate that the association of congenital prolapsus uteri with spina bifida in the lumbo-sacral region cannot be looked upon as constant; at the same time this association existed in nine out of twelve cases, and must be regarded as too frequent to be a mere coincidence. It is no longer justifiable to say that congenital prolapsus uteri is always a symptom of lumbo-sacral spina bifida; but it must still be looked upon as sometimes such a symptom. This leads me to discuss the pathogenesis of congenital uterine prolapse.

It is natural that most of the observers who have had to deal with congenital prolapsus uteri have been struck by the presence of lumbo-sacral spina bifida, and have given it a place in their theories of pathogenesis. Further, in several of the cases there was a semi-paretic condition of the lower limbs, a circumstance which seemed to favour the idea of a nervous origin of the prolapse. Possibly the spina bifida causes defective innervation of the pelvic ligaments and viscera, with a general condition of laxity of the tissues; the association of slight rectal prolapse favours this view. But it is evident that the whole causation of the displacement cannot be thus ex-

plained, for while spina bifida is comparatively common, congenital prolapse would appear to be very rare. Other contributing causal factors may be found in defective development of the connective tissue of the pelvis, in enlargement ol the pelvic inlet and outlet by the straight character of the lumbo-sacral part of the spine, in narrowing of the false pelvis, in enlargement of the cervix (although this is far from constant), and in increased intra-abdominal pressure (due to down-bearing and straining efforts made by the infant).

It is noteworthy that the condition is not invariably fatal, for Radwansky's subject was alive at six months. In the absence of the spina bifida (there was none in Radwansky's case) there seems then to be the double chance of survival of the infant and of cure of the displacement. Even when the displacement is associated with the defective state of the spinal canal, there seems to be no reason always to anticipate a fatal termination, for spina bifida is sometimes successfully operated upon.

In connection with the above description of congenital prolapsus, I may mention that I have seen (in consultation with Professor Annandale) a case of congenital rectal prolapse in a female infant, two years of age. There was great defect of the perineum; indeed, the infant's external genitals resembled very closely those of a woman who had had a bad labour, with a nearly complete laceration of the perineum. There was, however, no evidence whatever of uterine prolapse. There was no spina bifida and no other malformations. The prolapse of the rectal wall was anterior and on the left side.

Diseases of the Nervous System.

In attempting to describe even very briefly the idiopathic diseases of the nervous system which are present in fœtal life, one is met at the outset by two very considerable difficulties. One of these is the interposition between antenatal and postnatal life of the short traumatic interval of intranatal life during which the head of the infant and other parts also are suffering from pressure in the birth canals. There seems to be little doubt that during this intercalary period many of the so-called obstetrical paralyses occur, and that they are due to intracranial hæmorrhages; but it has to be borne in mind also that intracranial and even intracerebral effusions may be the result of fœtal morbid states prior to the advent of labour, as has been proved by Osler's case (*Teratologia*, ii. 13, 1895), to which reference has already been made (p. 201). At present we know of no certain method of distinguishing between and of disentangling the one set of maladies from the other. The other difficulty is due to the fact that during fœtal life the nerve centres are still in the embryonic stage, and that therefore the morbid affections which may occur in them are more of the nature of malformations than of diseases. That these malformations may give rise after birth, and sometimes long after birth, to diseases in the ordinary acceptation of the word, is undoubted; but then these diseases cannot accurately be described as existing in the fœtus. They are potentially

present in it, that is all. To some of these maladies the term "congenital" is affixed, and to some others that of "hereditary"; the former expression has been used very loosely to signify any condition which is either actually present or only predisposed to at the time of birth, and the latter, if taken in its correct sense, indicates that the morbid state which develops after birth was present already in the impregnated ovum before embryogenesis commenced or ever fœtal life began. Most of the "congenital" diseases of the nervous system are antenatal only in the sense of being potentially present at birth; they are the results of malformations whose effect becomes evident after birth. Some are doubtless "hereditary" also, in the sense that the tendency towards the malformation of certain parts of the nervous system is transmitted from parent to child. From all these facts it follows that it is practically impossible to select for description any types of truly *fœtal diseases* of the nervous system. The most that can be done is to refer to certain morbid states of the brain and cord in order to demonstrate how impossible it is to find any types. The conditions to which I allude might perhaps be called "teratological diseases" potentially present before birth; but the expression is rather of the nature of a contradiction in terms.

For instance, there is *congenital internal hydrocephalus.* Are we to regard the distension of the cerebral ventricles in this morbid state as a fœtal disease, as an embryonic malformation, or as a disease due to a precedent malformation? Is it due to an inflammatory change in the lining membrane of the cerebral ventricles and of the central canal of the spinal cord, to an inflammation of the ependyma? Is it, on the other hand, purely a malformation of the brain? Is it primarily a malformation which predisposes to inflammatory or other pathological changes which induce effusion of fluid into the ventricles? The pathologist who would venture to answer any of these queries definitely might be bold, but it is doubtful if he could claim justification for his boldness. Personally I incline to the third view. The fact that the parents of hydrocephalic infants not infrequently are syphilitic or alcoholic, does not greatly clear up this question, although otherwise it is a fact of very considerable importance; for, as we have seen (pp. 239, 276), both syphilis and alcoholism in the parents may be revealed in the progeny either by disease or malformation. Neither does the fact of the frequent coexistence of various malformations in cases of hydrocephalus prove that the latter is a malformation, although this fact also is interesting. Hydrocephalus, therefore, must be left as an indefinite morbid state of the fœtus, likely to produce delay in labour and danger even to the mother, but with a pathology and pathogenesis as yet unexplained. The careful investigation of early stages in the evolution of the morbid state would most probably yield results of great value; the pathologist ought to be on the outlook for slight hydrocephalus in cases in which there may be spina bifida, but in which there is as yet no cranial enlargement.

Again, there is *Little's disease,* or congenital spastic rigidity, or

congenital cerebral paralysis. In this malady the infant shows contractures of various muscles, with paraplegia or monoplegia. The child begins to walk late, and develops the peculiar spastic gait with marked cross-legged progression. The deep reflexes are exaggerated, and squinting is common. There is usually a great deal of mental disturbance, amounting sometimes to imbecility and idiocy. The name "congenital" is generally applied to these cases; but there is good reason to believe that most of them are due to the traumatism of birth (pelvic or forceps pressure on the head), causing meningeal hæmorrhage, followed by sclerosis and porencephaly. At the same time there are some instances which are hardly to be explained in this way, and which, therefore, suggest a truly antenatal as well as an intranatal factor in the pathogenesis of the cerebral paralysis; but the condition, like hydrocephalus, although for another reason, cannot be regarded as a typical fœtal disease of the nervous system.

Congenital chorea is another so-called congenital malady of the nervous system. In some instances the choreic movements have been noticed at birth. There is an absence of rigidity, although some writers would apply the name "congenital chorea" to the cases in which there is concomitant spastic rigidity. The pregnancy has generally been abnormal; the mother may have suffered from injuries, from frights, from prolonged or instrumental labour, or from some disease; and in a few remarkable cases the mother as well as her infant has had chorea. There may be a family history of alcoholism or epilepsy. Birth is often premature. The infant may be difficult to resuscitate at birth, but if successfully treated shows even within a few hours marked choreic movements and grimaces, which cease during sleep. He is late in walking, but ultimately walks well save for a slight unsteadiness; in this respect the malady contrasts strongly with Little's disease. He is backward in his mental development. Here then is a disease which may perhaps be taken as a type of the maladies of the nervous system which are produced during fœtal life; but when the etiology and pathogenesis come to be inquired into, its typical character soon disappears. Vignaud Dupuy de St.-Florent (*Thèse*, Paris, 1895) has summarised our knowledge on these points. It would appear that congenital chorea may be transmitted directly from mother to fœtus; in one case, that of Rieder (*München. med. Wchnschr.*, xxxvi. 603, 1889), the transmission was from grandmother to mother, and then from mother to daughter. This may be explained either as a transmission of the morbid state directly to the fœtus in utero, or as a hereditary handing down through the germ prior to impregnation. If the former view be accepted, the explanation of the pathogenesis becomes practically impossible through lack of facts; if the latter view be maintained, it may be argued that here we have to do with a *congenital* form of Huntingdon's chorea which is evidently hereditary. It seems, however, to differ in several particulars from the markedly hereditary instances of tremor (some of them being congenital) which were described by C. L. Dana (*Internat. Journ. Med. Sc.*, xciv. 386, 1887). Probably, or possibly, the three conditions (Huntingdon's chorea, congenital chorea, and hereditary tremor) are

all essentially different. At any rate, they do not throw much light upon each other, even although they agree in being transmitted from ascendants to descendants. St.-Florent (*op. cit.*) looks for an anatomical or functional anomaly of development of the fœtal brain to explain congenital chorea; in other words, he regards it as a disease due to a teratological state, but includes under the latter term the idea of a *functional malformation*, so to say. He also, however, seems to look to traumatism in labour as the primary cause of the cerebral malformation. It is, therefore, abundantly evident that congenital chorea, no more than Little's disease or hydrocephalus, can be taken as a type of the fœtal diseases of the nervous system.

Friedreich's ataxia has sometimes been termed "congenital ataxia" and "family ataxia," but "hereditary ataxia" is a name which better indicates its nature; for it is never observed in the first months of life, and it is not a constant occurrence that it affects several members of the same family. Even if the term "hereditary" be adopted, it must be borne in mind that it is rare for the heredity to be direct and similar. Further, it is a slowly developed disease; there is nystagmus, loss of muscular power, and sometimes of the patellar reflex, speech disturbance, and mental impairment; all these changes appear in late childhood, and are established slowly. It is due to a chronic inflammatory (?) degeneration of certain parts of the spinal cord (posterior columns, lateral and cerebellar tracts, columns of Clarke, etc.); and it has been thought that this degeneration has been predisposed to by an arrest of development of the cord in fœtal life. In it, also, is seen the association of a disease with a malformation; perhaps we may call it a "teratological disease," if we keep in mind that such an expression is in large measure an indication of ignorance.

Of *Thomsen's disease*, or myotonia congenita, or muscular ataxia, I need say little. It is often transmitted from ascendants to descendants; it begins in early childhood; and it is characterised by the fact that during voluntary movements the muscles respond slowly to the will, being late in contracting and slow in relaxing again. It has been regarded as a "congenital" affection of the muscular fibres, a primary myopathy; it has also been looked upon as representing a congenital antagonism between the muscular and nervous systems with ultimate predominance of the former. Clearly, however, it also falls into this group of mysterious pathological states, the so-called fœtal diseases of the nervous system.

The same characters of indefiniteness and of confusion between malformations and diseases extend to the antenatal morbid states of the organs of special sense. An instance of this is met with in the condition known as "*congenital clouding of the cornea*," which may be due to "an arrest in development" or to an "intrauterine inflammation." It has been ascribed to syphilis, but has been met with in the lower animals, and cannot, therefore, always be syphilitic even if it occasionally be so.

I offer no apology for the vagueness of the descriptions of the nervous diseases of the fœtus. It was late in the history of medicine

before the adult maladies of the nervous system began to be understood; even now they constitute a most difficult part of medicine. It is not to be expected that the part of Antenatal Pathology which deals with the morbid changes in the brain, spinal cord, and organs of special sense, will be less difficult or less late in being elucidated. Two matters have led to great obscurity: the inter-relation of the malformations and the diseases of the fœtal nervous system, and the intrusion into the subject of the idea of antenatal functional disorders. But these complications and obscurations must, I think, be accepted as inevitable. To minimise the difficulties is to retard real progress; short cuts to conclusions are, in Antenatal Pathology at least, too often nothing but blind alleys; the way has to be retraced, and valuable time has been lost. It must be slowly that progress is accomplished; it must be by careful observing and accurate reporting of cases, with full details of the phenomena of the first weeks and months of life and of the events of pregnancy; and complete post-mortem examinations will have a paramount importance. Since many of the maladies are hereditary, and show family prevalence, we may yet learn much from the post-mortem examination of still-born infants, or of relatives who have died without necessarily showing any symptoms of the particular disease, for in them the predisposing malformations which are of so much pathogenetic importance may perchance be found. Manifestly the matter is beset with difficulties; therein lies our stimulus to work: other matters have been no less difficult, but have become the commonplaces of the text-book; herein exists our encouragement.

With the end of this chapter I close the part of this work which deals with the idiopathic diseases of the fœtus. It is an unsatisfactory part; for all the while that we are considering these maladies we are wondering whether they really are idiopathic, whether indeed they are not transmitted from parent to child, if not in the fœtal period of life at any rate in the germinal. No doubt some of them will yet be transferred to the group of the transmitted maladies. At the same time it is a most suggestive part of the work, for it has introduced to us the idea of functional antenatal maladies in connection with hypertrophic stenosis of the pylorus, and with some of the morbid states of the nervous system. Further, it has illustrated the interesting albeit most difficult question of the inter-relation of malformations and diseases, and of the projection of the embryonic into the fœtal period of antenatal life, with all the consequences which flow therefrom. About many of the questions which have arisen in the preceding chapters, I have been forced to give judgment in the unsatisfactory form of *non liquet;* but although "it is not clear" now and to me, yet there may be illumination soon and for another. To have put down the difficulties and the scanty facts in black and white is something, and marks at any rate a stage, or at least a new starting point. *Vox emissa volat—litera scripta manet.*

CHAPTER XXIII

Traumatic Morbid States of the Fœtus: Fœtal Fractures, Wounds, and Dislocations; Congenital Amputations; Diseases of the Fœtal Annexa; Placental Hæmorrhages; Fibro-Fatty Degeneration of the Placenta; Morbid States of the Umbilical Cord; Hydramnios—Definition, Clinical History, Symptomatology, Physical Signs, Diagnosis, Prognosis, Pathology, Pathogenesis, Treatment; Oligohydramnion.

In the classification of fœtal morbid conditions given on page 175, I gave places to neoplasms and traumatic morbid states; but I indicated that it would probably be necessary to exclude the former, as their origin in the fœtal period was more than questionable. The tumours, like the monstrosities and most of the malformations, are, so to say, handed on into the fœtal period from the embryonic and germinal epochs of antenatal life; the fœtus, as it were, carries them with it through the rest of intrauterine existence into the light of day, and they are then recognised for the first time, but their origin lies far away back in embryonic or germinal life. The more one studies the so-called traumatic morbid states of the fœtus, the more one is forced to believe that they also anticipate the truly fœtal period. If we exclude the fractures and dislocations, and wounds and lacerations and avulsions, which occur at the time of birth in consequence of grave disproportion between the size of the maternal pelvis and that of the fœtus passing through it, we are left with a group of enigmatical morbid states which, on a superficial examination, suggest the idea of intrauterine injuries of various kinds. A more careful examination of these conditions (fractures, dislocations, wounds, and amputations), however, at once raises doubts as to their traumatic character, if, at least, "traumatic" be understood in its ordinary sense. Let us consider some of these morbid states.

Fœtal Fractures.

By "fœtal fractures," we mean not so much the fractures met with at birth which have evidently been recently produced, and to explain which some manifest traumatism has occurred during the course of the confinement; the name is or ought to be reserved rather for the morbid states which have been regarded as badly united or ununited fractures. When one meets with a bone, such as the femur or clavicle, which shows an irregular swelling or a sharp bend of its shaft, or which exhibits a fracture with two rounded fragments lying close together but not united, it has often been maintained that here was an instance of a fracture which had been produced during fœtal

life by external violence or by strong uterine contractions. The separate fragments had not been brought into exact apposition, and consequently had united at an angle, or much callus had been thrown out, producing the nodular swelling on the shaft; or, in some instances, the two segments had been too far apart or had been so mobile that no union at all had occurred, and in time the ends had become rounded and a kind of false joint had been produced. When there was no history of traumatism during labour, or of excessive muscular action, the supporters of the above theory of causation were compelled to suppose that the fœtal skeleton had been unusually brittle, or that it had at one period of fœtal life passed through a stage of abnormal fragility. There is reason to believe that in some exceptional instances such a chain of causal factors has really existed, as, for example, in the case reported by Paul Linck (*Arch. f. Gynaek.*, xxx. 264, 1887), in which the expulsion of the infant took place in little more than one pain, and in which there were over thirty fractures (old and recent) in the limbs, sternum, ribs, etc.; or in those put on record by Chaussier (*Bull. Fac. de méd. de Par.* (1812–13), iii. 301, 1814), in which labour was easy, and yet from fifty to a hundred fractures were counted after birth. The exceptional brittleness of the bones has in these cases been attributed to true rickets, to "fœtal rickets," and to an "unknown intrauterine disease of the fœtal skeleton" (Linck). In the great majority of the so-called fractures, however, it is practically impossible to accept such an explanation as that given above. The difficulties have been recognised by many writers, who have attempted to explain them away by affirming that the membranes have ruptured, letting the liquor amnii escape, that the solution of osseous continuity has been due to *contre-coup* and not to direct violence, or that stormy contractions of the fœtal muscles have been active in producing the fractures. But these explanations are all more or less unsatisfactory, and they fail more particularly in the not infrequent cases in which the fractures are accompanied by various malformations. Max Sperling (*Ztschr. f. Geburtsh. u. Gynäk.*, xxiv. 225, 1892) has recognised this, and has gone boldly in quite another direction to find an adequate pathogenesis; to this matter reference will immediately be made. It has been noted that many of the so-called fractures are represented at birth by sharp bendings on the bones, and that over the angle thus formed are cutaneous cicatrices; it has also been observed that there have existed coincident malformations, such as the absence of one or more digits (R. L. Swan, *Med. Press and Circ.*, n.s., xxvii. 160, 1879; Danyau, *Bull. Soc. de chir. de Par.*, iv. 271, 1853–4; Sachse, *Journ. d. pract. Heilk.*, xi. 3 St., 107, 1801), and sometimes of the fibula as well (Danyau, *loc. cit.*; Ithen, *Dissert.*, Zürich, 1885), absence of some of the tarsal bones, imperfect formation of bones contiguous to the fractured one, hare-lip, cleft palate, hydrocephalus, club-foot, club-hand, median fissure of the nose, congenital amputations, amniotic adhesions, syndactyly, etc. It is not possible to imagine that these various malformations can have arisen from traumatism, and yet their frequent association with the so-called fractures must be explained in some way. The

way that Sperling (*loc. cit.*) takes is as follows: He points out the frequency of the coexistence of the so-called badly united fractures and other malformations, and indicates that in most instances the malformations cannot be regarded either as the causes or the results of the fractures; he looks for a cause which shall be common to both the malformations and the fractures. In order to find this common cause, he goes back to the first and second months of intrauterine life, to the embryonic period in fact, and finds there an explanation in defective formation of the amnion. He shows that the cicatrices occasionally found near such fractures, as well as the so-called wounds (*vide* absence of skin, p. 328) and the various concomitant malformations, can all be accounted for by the action of amniotic adhesions or defective developments. I think it is necessary, as Sperling indicates, to regard most of the so-called fœtal fractures as originating before the truly fœtal period of antenatal life, and possibly by the mechanism of amniotic adhesions or pressure (although it must not be forgotten that in the human subject the development of the amnion has not yet been elucidated); but, in cases such as Linck's and Chaussier's, it seems sufficient to regard the multiple solutions of continuity as the result of extraordinary fragility of the bones, accompanied perhaps by excessive fœtal movements or stormy uterine contractions. Hence it comes about that, in order to explain the origin of the so-called fœtal fractures, it is necessary to invoke the aid of embryonic pathology or to postulate the existence of a fœtal bone disease.

Fœtal Wounds and Dislocations.

Under the heading of "Congenital Absence of the Skin" (p. 328), I have already considered fœtal "wounds," and have pointed out their probable amniotic origin. Doubtless in rare cases, and specially in grave maternal traumatisms, the fœtus may be wounded in a more direct fashion; but, to explain the so-called wounds or areas showing absence of skin, the same mechanism has to be invoked as for fœtal fractures, namely, imperfect development of the amnion (*vide* F. Ahlfeld, *Eine neue typische Form durch amniotische Fäden hervorgebrachter Verbildung*, Wien, 1894). The question of the fœtal dislocations is less easy of solution. The reader is referred to the paragraph dealing with "Dislocations in the New-born Infant" (p. 49) for a statement of the views that have been held regarding the causation of fœtal dislocations, and more especially of congenital dislocation of the hip. In these morbid states the intranatal factor is often with difficulty excluded, and, according to a theory which still can count supporters, it is by traumatism during delivery that congenital dislocation of the hip is produced. If we admit that it may sometimes be thus produced, it must also be maintained that it is certainly not always so; for both in the case of the hip and in that of the other joints there are frequently present morbid or malformed states of the articulation which certainly arose long before the supervention of labour. Of course, it may be argued that the malformations indeed were present, but that the actual dislocation of the articular surfaces

did not occur till the process of parturition had commenced; but this view is hardly tenable when the condition of the parts immediately after birth is taken into account. With regard to the possible occurrence of dislocations in fœtal life due to violence, and taking place in articulations not previously malformed or diseased, it is very difficult to speak with assurance; they are possible, but I do not think that many fœtal dislocations arise in this way. It is very probable that it will be found necessary to explain most of the dislocations as we explain most of the fractures in utero, by supposing that they occur in the first two or three months of antenatal life, and that imperfect development of the amnion is the most important pathogenetic factor in their production. They are, therefore, traumatic only in the limited and peculiar sense of being due to possible pressure of a long-continued kind brought to bear upon the joints by the attached or apposed amnion. They also, therefore, are teratological rather than traumatic; we might perhaps say that they are teratologically traumatic, if such an expression be permissible.

Spontaneous or Congenital Amputations.

It is long since the idea of the truly traumatic origin of the so-called congenital or spontaneous amputations came to be doubted. The notion that fracture of one of the limbs occurred in utero, and that thereafter there was sharp flexure of the part with ultimate separation of it from the trunk, cannot be accepted at the present time. It is necessary to find some other explanation for the cases in which an infant is born minus a hand, a foot, some fingers or toes, or even a whole limb, and in which there is a well-formed surgical stump with occasionally some little projections on the surface of it, which have been regarded as rudimentary, reproduced digits. At first it was thought that a sufficient explanation had been found in the constricting effects of the umbilical cord, and the idea of funic pressure produced by the coiling of the cord round a limb or a digit was advanced and maintained. It was thought that in early fœtal life the tissues of the part and even the bone would ultimately yield before the long-continued pressure of the umbilical cord, that an ever deepening groove would be produced, and that finally actual separation of the distal part would take place. Cases were found in which a groove existed, and in which the cord was found occupying the groove, and these were at once accepted as intermediate stages in the production of the amputation. The amputations were traumatic, therefore, but it was an umbilical or funic traumatism that was understood. Gradually, however, it began to be recognised that there were grave difficulties in the way of the acceptance of the above view, such as the softness of the umbilical cord, the absence of the amputated part, etc. There was in process of time a modification of the theory, according to which the traumatic pressure was supplied by amniotic adhesions or bands. This was and still is a popular theory of origin of the congenital amputations. There is no doubt whatever of the occurrence of these amniotic bands; they are

frequently found associated with congenital amputations, and in many respects they fulfil the requirements of the case. It is true that they are also often absent when amputations are present, and that they are also associated with all kinds of malformations and monstrosities; but it was possible to explain away these difficulties. The bands might have been absorbed after they had performed their amputating effects, and so on. Gradually the idea arose that perhaps the amniotic bands set up special pathological changes in the skin of the constricted part in the position of the constriction, and that the pathological changes led to annular amputation; it was thought that a sort of epidermic dactylitis was set up, and that the disease and not the amniotic band cut its way through the tissues of the limb. Ainhum was adduced as a disease which, occurring in the adult, produced similar constrictions and amputations, and did so by means of changes in the skin of the part. Soon a slight modification of the theory came to be adopted, and in the case of congenital amputations it was no longer thought that the amniotic bands were essential, but it was maintained that the morbid alterations in the skin were eminently so. Jeannel (*Arch. de tocol.*, xiii. 774, 1886), for instance, held this view; for he found it difficult to understand how the amniotic adhesions were produced, and he could not explain why the depressions were always circular and not spiral, and why the amputations were not multiple; he thought it more probable that the grooves and the amputations were both trophic lesions of a sclerodermic nature. L. Raynaud (*Journ. de mal. cutan. et syph.*, 2 s., vii. 193, 1895) held similar views; but J. Rouget (*Thèse*, Paris, 1889) and De Brun (*Semaine méd.*, xiv. 397, 1894) thought that ainhum and congenital amputations had nothing in common. As a matter of fact, it cannot be said that any satisfactory explanation of the production of the so-called spontaneous amputations has yet been advanced. I believe that they are produced or initiated before the truly fœtal period of antenatal life, and that they are connected with maldevelopment of the amnion; further, I am hopeful that when new light is thrown upon the exact mode of origin of the amnion in the human subject, the whole question of the teratogenic effects of anomalies in its development will receive illumination.[1] Till that time come, we must be content to speak somewhat vaguely of amniotic action, adhesions, bands, and the like. At the same time, congenital amputations must, I think, be regarded as teratological rather than traumatic in their origin, as belonging to the pathology of the embryo rather than to that of the fœtus.

[1] If, for instance, Berry Hart's idea, stated at a meeting of the Edinburgh Pathological Club (November 1901) prove to be correct, much that is at present difficult of explanation will become perceptibly easier; he is of opinion that the amniotic cavity is formed by the ingrowth and subsequent breaking down of a plug of epiblast in the embryonic area of the blastodermic vesicle.

Diseases of the Fœtal Annexa.

In various parts of this work reference has been already made to the morbid states of the fœtal annexa (the placenta, umbilical cord, chorion, amnion, and liquor amnii) which occur in association with various diseases of the fœtus. I have, for instance, spoken of placental tuberculosis and syphilis, of the state of the placenta in maternal leukæmia and in general fœtal dropsy, of hydramnios, and of oligohydramnion. There can be no doubt that this association of the fœtal morbid changes with those of the annexa is the correct plan to adopt in order to understand the pathology of the fœtus, for, as has already been emphasised, the placenta and membranes are organs of the fœtus as much as its intracorporeal viscera, at any rate a large part of the placenta certainly is so. In order to obtain a complete representation of the pathology of any fœtal disease, it is, therefore, necessary to consider together the morbid anatomy of both the fœtus and its annexa. In process of time it will no doubt be possible to state what morbid changes in the placenta are commonly associated with the various transmitted or idiopathic diseases, toxicological states, and ill-defined toxinic conditions of the fœtus, as well as the maladies which are accompanied by hydramnios or by oligohydramnion. Unfortunately it is at present quite impossible so to do, and the changes in the fœtal annexa are commonly discussed as if they were independent lesions. Sometimes, perhaps, they are independent; sometimes, also, they are due to maternal conditions, and are effective in producing fœtal diseases; but very often they are so intimately bound up with the pathology of the unborn infant as to be inexplicable apart from it.

It is not my purpose here to consider all the morbid states of the fœtal annexa. Some are evidently of the nature of malformations, and will be described under the Pathology of the Embryo; others have been already described under the various diseases of the fœtus (*e.g.*, syphilis, tuberculosis, general anasarca), and under the maternal maladies which have prejudicial but ill-defined effects on the fœtus (*e.g.*, eclampsia); others arise during the earliest part of antenatal life, and belong to Germinal Pathology; while yet others will fall to be dealt with in the next chapter under the subject of Fœtal Death. There remain some morbid states of the annexa, and more especially of the placenta, which require a passing notice.

Placental Hæmorrhages.

Placental hæmorrhages or "apoplexies" occur either in the form of diffused effusions of blood into the tissue of the placenta, or in that of more or less circumscribed hæmorrhages in more or less well-defined cavities. These effusions may be found either on the fœtal or on the maternal surface of the placenta, or at various depths in its substance; they may be numerous, although it is unusual to find more than two or three; they vary from microscopic dimensions up to the size of a hen's egg or even larger; they are more or less round in shape; and

they may consist of recent blood, recent clot, old clot, fibrous tissue, or even of calcareous material. Sometimes blood in various stages of alteration may be found in the same hæmorrhagic patch. The bleeding has most often been from the maternal vessels, and the villi with their vessels are compressed thereby; possibly, however, it sometimes comes from the fœtal vessels. It is commonly stated that the chief causes of the placental apoplexies are maternal traumatism and maternal disease, and under the latter head are grouped renal and cardiac maladies and the fevers. Their microbic or toxinic origin has lately been much insisted upon by S. Satullo (*Arch. di ostet. e ginec.*, v. 193, 399, 518, 577, 1898), and F. Caruso (*ibid.*, vi. 129, 1899), and it is probable that they often are produced in this way, for bacteria are not uncommonly found in them. They may thus have a very considerable influence upon the transmission of maladies from mother to fœtus, or from fœtus to mother; but in all probability they themselves are simply incidents in systemic infections affecting the mother or the fœtus or both. They may lead to the immediate expulsion of the uterine contents, or they may kill the fœtus which is expelled later, or they may produce effects, the nature of which is little known, upon the nutrition of the fœtus, or they may apparently cause no evil consequences at all. The result will depend upon many circumstances, such as the amount of blood poured out, the area of the placenta affected, the condition of the fœtus, and the like. Sometimes it is very puzzling to account for anomalous cases in which large effusions have caused no visible bad effects, or in which small hæmorrhages have apparently had far-reaching consequences. It has always to be borne in mind that a limited view of the subject will give no trustworthy results. I have often insisted upon the necessity of examining the placenta in all cases of fœtal disease; but it is, of course, equally or more important to examine the infant and mother in all cases of placental disease. It is only by making a broad survey of such phenomena that one can arrive at satisfactory conclusions.

Under the name of *fibro-fatty degeneration* of the placenta have been described certain changes more particularly affecting the chorionic villi, which lead to the formation of yellowish white patches in the placental substance. These are not infrequently found in the full time placenta in small numbers and of limited size; they are then regarded as physiological or as signs of placental senility. When, however, they are numerous, or when they occupy a large part of the substance of the afterbirth, they are admitted to be pathological. In this respect they resemble the placental hæmorrhages, for they also, when small and limited in number, have been looked upon as preparatory changes to make easy the separation of the afterbirth at the time of labour. They consist in a fibrous transformation of the villi of the chorion, with diminution in the size of the vessels, and consequent atrophy of these villi. Here and there fatty changes are produced. It may be that these changes are the results of the hæmorrhages which have been described above,

but all authors do not admit this. It is sometimes very surprising to find to what a large extent the placenta may be transformed into this fibro-fatty material, and yet the infant be born alive, healthy, and well nourished. In a recent case at the Edinburgh Maternity Hospital, I noted that fully two-thirds of the placenta were thus altered, and yet the child not only survived birth, but throve well. Calcareous deposits on the uterine surface of the placenta have no pathological significance; so at least it is commonly believed.

Various *morbid conditions of the umbilical cord* have been described, although it is doubtful how far any of them can be looked upon as diseases. Excessive torsion has been met with in which the cord has become thread-like at the twisted part. The fœtus is then usually dead; but the torsion is not now admitted to be of necessity the cause of death, for it has been suggested that it may be the result of it on account of the exaggerated mobility in utero of a fœtus which dies about the mid-term of pregnancy. The cord may be coiled round the infant in various ways, and even many times. In a fœtus which occurred in the practice of Professor J. A. C. Kynoch of Dundee (*Trans. Edinb. Obst. Soc.*, xx. 1, 1895), there were six coils round the neck. When the unborn infant slips through such a loop or through several loops of the cord, knots of various degrees of complexity may be produced, and sometimes apparently these knots may be drawn so tight as to interfere with the continuance of antenatal life. In the case of twins in a common amniotic cavity, some exceedingly curious entanglements have occurred between the two cords and the two fœtal bodies (*vide* E. Fricker, *Ueber Verschlingung und Knotenbildung der Nabelschnüre bei Zwillingsfrüchten*, Tübingen, 1870).

Hydramnios.

Hydramnios, or excess of the liquor amnii (more than two pints at full term), is so commonly associated with fœtal morbid states, as to suggest by its presence the existence of one or other of these states. At the same time it has to be noted that it may be met with when neither the fœtus, nor the fœtal annexa, nor the mother herself, shows any sign of a pathological process. Reference has already been made to hydramnios in this work; for it may occur in conjunction with nearly every one of the maladies (transmitted, toxinic, idiopathic, traumatic) which have been described. Special attention was called to its presence in syphilis; but it is met with also in general fœtal dropsy, in fœtal ichthyosis, in fœtal ascites, in fœtal bone disease, etc. etc. So often is it a concomitant of fœtal maladies, that it cannot be regarded as pathognomonic of any special one of them. Further, it is very frequent in connection with the manifestations of embryonic and germinal pathology, for it is found associated with all kinds of monstrosities and malformations, and with twins and triplets. It is also met with in grave maternal states, such as albuminuria and hyperemesis, but whether as effect, or symptom, or cause, cannot yet be securely determined.

Its very frequency, then, is a hindrance to our understanding of its origin and significance. Like pain in adult maladies, like convulsions in infants, hydramnios in antenatal life may indicate many different conditions of varying degrees of gravity, and apparently it may in some instances exist as itself the sole pathological manifestation. The liquor amnii is the immediate environment of the fœtus, it is indeed the fœtal hydrosphere; and variations in its quantity come to be the most delicate tests of the inter-relation between the maternal and fœtal economies. Of variations in its quality little can be said; with the exception of some few observations upon the presence of sugar and drugs in it, and of fairly numerous records of cases of fœtal death in which it was stained with meconium, our knowledge of the qualitative anomalies of the liquor amnii is *nil*. I have met with a case in which it was opaque and white like milk, and yet the infant was born alive and healthy; under the microscope it had the appearance of diluted pus!

The *clinical history* of cases of hydramnios varies within the widest possible limits. The mother may apparently have enjoyed perfect health up to the time of her pregnancy; she may, on the other hand, have suffered from syphilis, anæmia, heart disease, or renal disease. There may be no history of the previous occurrence of hydramnios in the reproductive life of the mother (C. E. Stokes, *Brit. Med. Journ.*, i. for 1895, p. 73), or there may be a record that it has repeatedly complicated pregnancy. There may be a good family history or a bad. With regard to the *symptomatology* of the pregnancy complicated by hydramnios there is also some difference in details. There may be the history of an abdominal traumatism, followed by the sudden development of a high degree of hydramnios; on the other hand, there may be no record whatever of any injury or blow, and the excess of amniotic fluid has apparently been slowly produced. The condition may occur early in pregnancy (as early as the second month), or it may come on late; but mid-term (fifth month) seems to be the period of predilection. It may be accompanied by hyperemesis, by dropsical conditions, by the symptoms of albuminuria, by fever, by constipation and jaundice, by neuralgias and insomnia, by dyspnœa, by palpitation and syncope, and sometimes by diarrhœa. The more rapidly the hydramnios is produced the more marked are the symptoms caused; as a matter of fact, fever is probably absent save in the more acute cases. The degree of distress may become quite unbearable, and it may sometimes be necessary at once to diminish the quantity of liquor amnii in the uterus.

The *physical signs* are usually quite distinctive. The abdominal enlargement is too great for the period of pregnancy arrived at; thus at the fifth month the size of the abdomen may correspond with that usually attained at the full term. The swelling also is more globular than usual, and occupies the middle line of the abdomen; there is dulness on percussion over it, but the flanks give a tympanitic note, and the area of dulness does not change its position when the patient turns on her side. Palpation generally at first suggests fluid in an ovarian cyst or free in the abdominal

cavity; but now and again contractions sweep over the surface of the distended uterus, giving it a temporary hardness and affording a valuable diagnostic indication. Fluctuation is usually obtained easily, and ballottement (both vaginal and abdominal) may be elicited, but not with the facility that the presence of a small fœtus in a large amount of liquor amnii would suggest. It is often very difficult, either by abdominal palpation or by the bimanual examination, to recognise the head and other parts of the fœtus, a result due in part to the elusiveness of the unborn infant, which in its large hydrosphere slips away so quickly out of the hands of the obstetrician. Auscultation may give negative results, but sometimes both the fœtal heart and the uterine souffle can be heard. The mother may herself be quite unconscious of fœtal movements. It may be noted further, although the signs are of less importance, that the abdominal walls are either very thin or are markedly œdematous, that dropsical swelling of the labia and of the lower limbs is common, and that circulatory troubles, such as varicose veins and hæmorrhoids, are often met with. Albuminuria may be met with, but is not, of course, pathognomonic.

From the symptomatology and physical signs the obstetrician attempts to form his *diagnosis*. He is at once met with difficulties. In the first place, he is led by the absence of many of its signs and symptoms to doubt the existence of pregnancy at all, and to think rather of an ovarian cyst or of ascites. A careful examination ought usually to exclude the latter: for in ascites the abdomen is more flattened, being distended laterally, and the dull area changes with changes in the position of the patient; the intermittent uterine contractions are absent; and there is usually some cause (*e.g.* maternal heart disease) to account for the fluid effusion into the peritoneal cavity. In the case of an ovarian cyst, there is often a much longer history of development, and there is sometimes the record that the swelling was unilateral at first; intermittent hardening of the swelling is absent; and a careful bimanual reveals the uterus, little enlarged, lying to one side of the tumour. The second diagnostic difficulty is met with after the obstetrician has made up his mind that pregnancy exists. He is fairly sure that he is dealing with pregnancy and with a morbid pregnancy; but he is at a loss to determine what form of anomalous gestation it is. Is it pregnancy complicated by ascites or ovarian cyst? Is it, perhaps, a plural pregnancy, or a hydatid mole, or simply a very large infant, or a fœtus enlarged by some malformation? A careful consideration of all the facts will lead him out of several of these difficulties. In the case of the hydatid mole the uterus is somewhat pear-shaped rather than globular, fluctuation is not evident, and there is often a history of repeated vaginal discharges consisting of blood. When there is simply a large fœtus (and placenta), or a large and grossly malformed infant, he must rely upon accurate palpation of the abdomen, the slow rate of the fœtal heart beat, and the absence of fluctuation and ballottement. When twins are in the uterus, it is sometimes possible to be sure of their presence by the shape of the organ,

by the palpation of two fœtal heads, one at the pelvic brim and the other at the fundus or at the side, by the hearing of two fœtal hearts, each with its own rate and position of maximum intensity, and by the recognition of numerous small parts. But, in the diagnosis of twins, it is possible with the greatest care to go far astray. When the pregnancy is complicated by an ovarian cyst lying in the abdomen, it will often be possible to detect the two tumours (the ovarian and the uterine), which differ in consistence and shape, and to note that one of them is more or less central in position, and rises out of the pelvis; when the cyst is in the pelvic cavity, in whole or in part, a very careful bimanual will be needed, and even then it may be impossible entirely to exclude an extrauterine pregnancy. By some such process of diagnostic exclusion the obstetrician may be able to state that the gestation is one made abnormal by reason of hydramnios. Finally, however, a third diagnostic difficulty, and that an almost insuperable one, arises when there is hydramnios in association with twins, or with ascites, or with an ovarian cyst, or in an extrauterine gestation sac. Under these circumstances the best methods in the best hands will often fail to differentiate the associated morbid states. Not until labour commences, and the cervix begins to dilate, will the intrauterine mystery be revealed. But all cases do not belong to the last category; and it must be remembered that it is often easy to diagnose hydramnios, and that having diagnosed it we ought immediately to suspect a morbid state of the unborn infant.

The *prognosis* of hydramnios, stated in a very few words, is a delayed labour with a malpresentation, a dangerous third stage (on account of uterine inertia), and a deformed, diseased, dead, or at least a puny infant. These results, however, are by no means constant. Even the small bulk of the fœtus is not always noted; indeed, G. Barbezieux (*Thèse*, Paris, 1889) found that out of 232 cases of hydramnios, there were only 81 infants which were below the normal minimum in weight (the normal minimum being regarded as 2500 grms.). It must also be taken into account that in many cases hydramnios means premature labour. At the same time, and making allowance for this, it must still be admitted that excess of the liquor amnii is the great indication of pathological conditions inside the pregnant uterus.

The *pathology* of hydramnios is very imperfectly known. Victor Guillemet (*Thèse*, Paris, 1876) says that hydramnios has not, properly speaking, any pathological anatomy: "l'hydropisie de l'amnios n'a pas, à proprement parler, d'anatomie pathologique." In a certain sense this is quite true, for, as has been pointed out, there is no special state of the fœtus or of the mother which can be regarded as the constant cause (or effect) of hydramnios. There are, however, some facts regarding the state of the placenta and membranes which must be referred to. Sometimes, as in the specimen which I showed to the Edinburgh Obstetrical Society in 1894 (170), the placenta exhibits hypertrophy; sometimes it is also œdematous (*vide* p. 294), or affected with syphilitic changes (*vide* p. 230); and sometimes it is

adherent or the seat of fibro-adipose degeneration. But none of these changes is constant. Sometimes the umbilical cord is longer than usual, much coiled round the fœtus, or showing marked torsion; sometimes, also, its vessels, and especially the vein, may be more or less narrowed; but in other cases these changes are absent. Sometimes the capillary network ("vasa propria") described by Jungbluth (*Arch. f. Gynaek.*, iv. 554, 1872), which lies under the amnion on the fœtal surface of the placenta, has been noted to be very evident—so-called persistence of the vessels of Jungbluth—but in many cases these vessels are not to be seen. Sometimes the amnion and chorion are thickened; but sometimes they are not. It is quite evident that these facts regarding the placenta. membranes, and cord do not throw much light upon the pathology of the disorder; indeed, they deepen the shadow in which the subject lies. Neither do observations on the characters and chemical composition of the liquor amnii itself help us very much, for they are very few in number; sugar may be present (*vide* p. 223), and E. Opitz (*Centrlbl. f. Gynäk.*, xxii. 553, 1898) has experimentally shown the presence of an irritating (lymphagogue) substance in the amniotic fluid in cases of hydramnios; but there is great need for much more investigation of this important part of the subject. The quantity of the liquor amnii varies from a little more than two pints up to such enormous amounts as seven, twelve, seventeen, and even twenty litres. The pathology, therefore, of the placenta, membranes, cord, and liquor amnii is not known with any certainty; and the same remark applies to that of the fœtus and mother in these cases, for the fœtus may exhibit practically any, all, or none of the various diseases and deformities by which it may be affected, and the mother's health may vary from very good to very bad.

It cannot, then, be expected that our knowledge of the *pathogenesis* of hydramnios will be in any measure exact or sufficient. Further, the reader will remember that even the origin and source of the liquor amnii in normal pregnancies are matters of uncertainty and of great difference of opinion (*vide* p. 152, *et seq.*). Some writers hold that the amniotic fluid has a purely fœtal origin, some a purely maternal, and some that it arises from both fœtal and maternal processes. Similarly, when the fluid is in excessive amount, the same different theories of origin have been advanced. On this subject Paul Bar's *Thèse* (Paris, 1881) is still well worth consulting, although now twenty years old. There is, for instance, the idea that the liquor amnii is fœtal urine, and that hydramnios indicates increased renal activity; but the kidneys may show no pathological changes, the urethra may be occluded or absent altogether, and there may even be entire absence of the kidneys, and yet the fluid be present in excessive amount. Then there is the theory that various skin diseases of the fœtus may be the source of the hydramnios, and a few cases in which pemphigus or nævus or other morbid states have coexisted with hydramnios have been cited; but the evidence is very slight, and the coexistence only occasional. A more probable theory looks to increased pressure in the umbilical vessels (from various morbid

changes in the fœtus or cord) as the probable mode of origin of hydramnios. According to this view (to which reference has already been made, p. 232), the hydramnios of antenatal life is equivalent to the hepatic ascites of adult existence; the pressure in the umbilical vein may be raised by morbid conditions in the liver, heart, or lungs of the fœtus, and increased transudation of fluid take place. Again, it has been supposed that the excess of the liquor amnii is due to a secretion from the cerebro-spinal canal of the fœtus, and cases in which that canal is open by reason of grave malformations have been adduced in support thereof; but, of course, such malformations are often absent when hydramnios is present. It has been affirmed that the flaky deposits sometimes seen on the surface of the amnion in cases of hydramnios indicate the occurrence of inflammation of that membrane (Sentex, *Mém. et bull. Soc. de méd. de Bordeaux*, 204, 224, 1869), and that the "amniotitis" thus produced has caused excessive secretion from the membrane in some such way as pleurisy with effusion takes place. This explanation has been specially advanced in cases where the hydramnios has followed a blow or fall, and it has been alleged that the traumatism was the exciting cause of the "amniotitis" with effusion. There are difficulties in the way of accepting this view, such as the non-vascular character of the amnion; but there is some reason to regard the explanation as sufficient in certain cases (acute). Further, the structure of the amnion permits the supposition that lymph may pass easily enough through it by the stomata. It is, therefore, not impossible that in some of the chronic cases, also, there may be a transudation of serum from the maternal vessels through the membranes into the amniotic cavity, *e.g.*, in instances of maternal nephritis, anæmia, etc. But, again, in twins, and especially in uniovular twins, hydramnios may occur in association with one but not with the other; this is an occurrence which has been explained by some writers as due to the weaker heart of the fœtus with hydramnios, an explanation found difficult of acceptance, since that fœtus may apparently have the stronger heart of the two.

One might, however, write much on the various pathogenetic theories which have arisen round the subject of hydramnios, and yet do little or nothing to simplify the problem. I shall content myself with making two statements, and then closing the discussion, so far at any rate as the pathology of the fœtus is concerned. In the first place, it has to be borne in mind that hydramnios is simply the persistence of a state which is normal in the early months of pregnancy, for at the fourth month the liquor amnii weighs more than either the fœtus or the placenta and membranes. We may then regard hydramnios as the persistence or reproduction of a relationship between the fœtus and its hydrosphere, which is normal in early fœtal life, and perhaps also in neofœtal existence. In the second place, the frequent association of hydramnios with so many different manifestations of both fœtal and embryonic pathology, shows that it must be due to a factor which is common to these different morbid states, or else to a very large number of different causes. I

am inclined to accept the latter alternative, and to look upon hydramnios as a symptom of antenatal pathological conditions, and to regard it as having origin in several different ways. It may sometimes be due to a chemical irritant coming from the mother or formed in the fœtus which excites a flow of lymph or serum; it may be caused by increased pressure in the umbilical vein and its branches, arising from various fœtal diseases and deformities; it may be the result of changes in the maternal blood which allow increased transudation; or it may possibly represent fœtal urine or cerebro-spinal fluid. Possibly the new method of investigating fluids by the difference in their freezing point may throw light upon the origin both of the normal liquor amnii and of the amniotic fluid in excess. G. Resinelli (*Ann. di ostet. e ginec.*, xxiii. 1029, 1901) has already published the results of researches on the osmotic pressure of the maternal and fœtal blood and of the liquor amnii; he has found that it is less in the maternal and fœtal blood at birth than in the non-pregnant adult, and that it is constantly less in the liquor amnii than in the maternal or fœtal blood. Further, in a case of twins, the freezing point of the liquor amnii of the one fœtus may differ from that of the other. It is, therefore, quite possible that cryoscopy (as this method of research is called) may yet help to clear up certain problems regarding the formation of the liquor amnii both in normal and abnormal amount.

The *treatment* of hydramnios has generally taken the form of tapping the membranes through the cervix, but somewhat high up, so as to allow some of the fluid to escape, and thus to relieve the suffering caused by the over-distended state of the uterus. Chloral and morphia have been used as sedatives. It is possible that dietetic or medicinal measures may yet prove successful in arresting the over-secretion of the amniotic fluid. Mercury and iodide of potassium have been used. In one instance I gave saline purgatives with this end in view; but, since a few days later labour supervened and twins were born slightly prematurely along with a great excess of liquor amnii, one could not say whether the salines had any effect upon the quantity of fluid, although they may have hastened the advent of labour. It has been advised that only the smallest quantity of fluid be given with the food in cases of hydramnios; but of course it will always be difficult to judge of results. In an interesting case of early (third month) hydramnios, reported by A. A. Scott Skirving (*Edinb. Hosp. Rep.*, vi. 387, 1900), in which the abdomen was opened on the mistaken diagnosis of ovarian cyst, the hydramnios slowly disappeared after the abdomen had been closed again, and at the full term or near to it the patient was normally delivered of a living infant, there being then no sign of hydramnios. From such a case we are led to believe that reabsorption of an excessive amount of liquor amnii occurs, and is perhaps to be hoped for.

Oligohydramnion.

By oligohydramnion is meant the absence or marked deficiency of liquor amnii. It would seem to be rarer than hydramnios, if the

number of recorded cases be taken into account. My own experience agrees with this; but it is probable that more cases of oligohydramnion escape recording than of hydramnios. The anomaly varies in degree; sometimes only a drachm or two of thick, viscid material may be found representing the amniotic fluid.

It might be hoped that a study of the cases of oligohydramnion would throw some light upon the causes and pathogenesis of hydramnios; possibly it does, if we were only acute enough to perceive it, but the light is not evident to us as yet. For it is found on investigation that oligohydramnion is associated with very much the same fœtal diseases and monstrosities that hydramnios is. For instance, in 1895 I reported a case (176) of dilatation of the urinary bladder and ureters with hydronephrosis in which there was oligohydramnion; yet in other cases in which similar anomalies are present there may be hydramnios. W. W. Jaggard (*Amer. Journ. Obst.*, xxix. 433, 1894) also reported a somewhat similar case, in which the bladder was greatly hypertrophied, the urethra obstructed, the right kidney cystic, the left kidney as well as the rectum and anus absent, both hip-joints dislocated, and the left sterno-mastoid muscle wanting. Sometimes the fœtus would seem to be normal and is born alive; sometimes, on the contrary, it is the victim of various morbid alterations, including fractures (Linck, *Arch. f. Gynaek.*, xxx. 264, 1887), club-foot, polydactyly, encephalocele (Strassmann, *Ztschr. f. Geburtsh. u. Gynäk.*, xxviii. 181, 1894), hydrocephalus and scoliosis (Bonnaire, *Arch. de tocol.*, xxi. 157, 1894), sympodia, spina bifida, and exomphalos (*Arch. di ostet. e ginec.*, i. 41, 1894), club-hand and various ankyloses (E. Apert, *Bull. Soc. anat. de Par.*, 5 s., ix. 767, 1895), absence of lower jaw and external ear (A. W. Addinsell, *Trans. Lond. Obstet. Soc.*, xxxvii. 204, 1895), etc. etc. The only malformation which would seem to be more common in oligohydramnion than in hydramnios is ankylosis of joints. Further, the conditions present resemblances in other directions: in uniovular twins, one fœtus (perhaps an acardiac one, as in H. Schiller's case, *Ztschr. f. Geburtsh. u. Gynäk.*, xxxii. 200, 1895) may be accompanied by deficiency of liquor amnii; the condition may recur several times in the same patient (Mekerttschiantz, *Centrlbl. f. Gynäk.*, xi. 831, 1887); and there is some connection between oligohydramnion and amniotic bands. In all these directions hydramnios and oligohydramnion show resemblances. Many interesting questions arise out of the study of the pathology of deficiency of the liquor amnii, although most of them belong rather to the pathology of the embryo than to that of the fœtus; but here it may be remarked that the frequency of ankyloses and of club-foot in connection with oligohydramnion would seem to support the view that these states are sometimes due to the effects of pressure of the amniotic membrane permitted by the absence of the fluid. It is not likely that this anomaly of the liquor amnii will enable us to settle the question of the source of the fluid (*e.g.*, from the fœtal kidneys); for although absence or cystic disease of these organs may occur in association with oligohydramnion, they may also be met with in hydramnios.

The pathological changes in the placenta and membranes in oligohydramnion have been little investigated. The placenta has been noted to be thick and irregular in form, and to show yellow or grey patches and even caseous nodules; microscopically, sclerosis of both the maternal and the fœtal structures has been found, *e.g.*, endarteritis obliterans and periarteritis of the vessels of the villi. Manifestly these changes cannot be regarded as special to oligohydramnion.

The symptomatology of oligohydramnion is not well known. It may be noted that fœtal movements are unusually distinct, and that they may be very painful. Perhaps the obstetrician may observe that the fœtal parts are unusually palpable. As a rule, however, the diagnosis of deficiency of liquor amnii is not made till labour is in progress, when the absence of a marked bag of membranes and of the fluid itself will reveal it.

There are other morbid states of the fœtal annexa to which reference might here be made. There is, for instance, myxomatous degeneration of the chorionic villi, with its curious occasional sequel, deciduoma malignum; there are the various pathological states of the decidual membranes and the various types of "mole," fleshy and sanguineous; and there are the various anomalies and malformations of the placenta and its vessels and of the cord and its vessels. These, however, are morbid conditions, having their origin anterior to the fœtal period of antenatal life, in the embryonic or germinal epoch. They will, therefore, be considered with the pathology of the embryo and germ, as will also many points touching amniotic bands and pressure, hydramnios, and oligohydramnion, which have been only alluded to here.

In the meantime, let it be again repeated and constantly borne in mind, that the morbid states of the fœtal annexa form a part, and an important part, of fœtal pathology; that they complicate all the questions of antenatal pathogenesis; and that in them may be found an answer to some at least of the problems of antenatal disease and deformity.

CHAPTER XXIV

Intrauterine Death of the Fœtus; Mechanism, Fœtal Asphyxia and Uræmia, Rigor Mortis, Clinical History, Symptomatology, Physical Examination, Diagnosis, Pathology of Maceration, etc., Abortion, Causes of Fœtal Death, Treatment.

ALLUSIONS have been made here and there throughout this work to the occurrence of fœtal death, and it will have been gathered that most of the morbid states which have been described may be the causes of, or at least may be associated with, the cessation of intra-uterine vitality; but it is necessary in this chapter to centralise and elaborate the notions upon this subject which will have been formed. Its discussion is suitably placed here, for it demands a preliminary acquaintance with the phenomena of fœtal pathology and with the laws which govern these phenomena, in so far, of course, as they are known to us.

To the patient who expects to become the mother of a living infant, as well as to her medical attendant, the occurrence of fœtal death brings a disappointment which has a sadness and a vexation peculiarly its own. Little comfort can be got from reflecting that, from the forensic point of view, the fœtus in utero cannot have died because legally it was never alive. So long as the proof of live-birth requires the establishment of pulmonary respiration after the complete expulsion of the infant from the maternal passages, so long will it be possible to deceive one's self as to the value of fœtal life; but the mother of a dead fœtus does not really deceive herself on this matter, and her medical attendant feels no less acutely the opprobrium on his art that the unborn infant should not come living to the birth. Death before (legal) life may be a paradox; but death before birth is a very sad certainty. When, further, the antenatal death is repeated in successive pregnancies,—when, so to say, there is habitual fœtal death,—the maternal disappointment mounts up to complete discouragement and anguish, and the obstetrician feels acutely his helplessness under the most trying circumstances. A reproductive life history which is a record of dead births is an appalling catastrophe, look at it as we may. I have recently interviewed a woman who has had six dead-born fœtuses between the sixth and seventh month of pregnancy, and one eighth-month infant that only lived a few hours; she had seen several doctors and had taken much medicine, but had never brought an infant to the full time, and had only once given birth to a child living at the time of labour. A very careful examination of the case revealed no apparent cause for this reproductive failure; but one cannot put the matter aside and content one's self with the reflection that there is no evident cause, and that the

patient simply has "the habit of giving birth to dead babies." The mother herself feels that there is something very imperfect in the obstetric art and science which cannot help her to bring a living infant to the light; she knows that time after time the fœtus was alive till a week or a fortnight before its expulsion from the uterus; she took every care of herself, and she swallowed faithfully all the medicine that was given her; and yet time after time she noticed that the fœtal movements ceased; she waited in sickening dread for some days, and again gave birth to a macerated fœtus. The medical profession cannot be content to leave uninvestigated this problem of recurrent or "habitual" fœtal death; humanitarian as well as economic necessities impel us.

Reference is not here made to the subject of intranatal death, although it also has a sadness quite its own. To see a child, large, strong, well nourished, and free from disease or deformity, perish during its transit through the birth canals by reason of great disproportion between the size of the pelvis and the head of the infant, or on account of one or other of the many dangerous complications of labour, is indeed a sad spectacle. When this death is apparently due to nothing save a somewhat unusual degree of fœtal development, and to an advanced state of ossification of the cranial bones (as in a case (152) which I saw with Dr. A. T. Sloan in 1893, and in which four pregnancies ended in the expulsion of infants still-born from the above causes), there is a peculiar element of vexatious disappointment in the occurrence. To see the infant pass "from the fœtus-slumber into the sleep of death, out of the amnios-skin of this world into the shroud, the amnios-skin of the next"[1] is to the obstetrician who sets a high value on infantile life both a humiliation and a reproach. When the mother also dies in labour with her child, there is produced a situation which touches every heart, and a calamity which calls forth universal sympathy. Milton's touching lines in his "Epitaph on the Marchioness of Winchester" might well serve for many a humbler mother thus bereft of maternity and life at one blow:

> "And now with second hope she goes
> And calls Lucina to her throes;
> But whether by mischance or blame
> Atropos for Lucina came;
> And with remorseless cruelty
> Spoil'd at once both fruit and tree;
> The hapless babe before his birth
> Had burial, yet not laid in earth,
> And the languish'd mother's womb
> Was not long a living tomb."

But even in the worst cases of intranatal death there is not the same feeling of helplessness which is experienced in dealing with antenatal death. Every year marks new advances in the management of childbirth and in the prevention of accidents to the fœtus in the maternal passages; the limitation of the destructive methods of delivery (embryulcia, craniotomy) becomes ever more sharply insisted upon;

[1] Richter's *Flower, Fruit, and Thorn Pieces.* Noel's Transl., i. 328, 1871.

and the obstetrician looks hopefully forward to a not very distant time when it will be possible, without increasing the risks to the mother, to give every chance to the child. But about antenatal death the same cannot yet be said; the problem of the prevention of intrauterine mortality is much more difficult and much more complicated; there are some few hopeful signs, but as yet they are very far off. *Principiis obsta*, check the beginnings, must be the therapeutic watchword! But how?

Mechanism of Fœtal Death: Fœtal Asphyxia.

When it is remembered that the life of the fœtus is of a semi-parasitic kind, it will be readily granted that the explanation of the mechanism of its death becomes not a little difficult. There are causes of death which will act upon the unborn infant from beyond the placental barriers, and there are causes which may arise in the fœtus itself either as a result of the action of the maternal causes or possibly independently of them. In the vast majority of the cases of fœtal death, the cessation of vitality is no doubt due essentially to causes which develop in the fœtal organism, however closely these may be associated with extrauterine morbid states; the fœtus dies of auto-intoxication; it is poisoned by the products of its own metabolism. Doubtless there are several kinds of fœtal auto-intoxication, but little is known with regard to any of them save fœtal asphyxia. Fœtal uræmia may occasionally occur, but next to nothing is known regarding it. Palazzi (*Ann. di ostet. e ginec.*, xxiii. 225, 1901) has pointed out that when through placental inadequacy there is a risk of uræmia, there is also a possibility that the kidneys may vicariously assist in the elimination of the effete products; while in the case of fœtal asphyxia there is no fœtal organ which can take on the function of the gaseous interchange when the placenta fails. It may also be supposed that poisons and toxins passing from the mother to the fœtus kill the latter by their direct effect upon its tissues; but it is more probable that they prove fatal by their action upon the placenta, which, becoming inadequate, gives rise to fœtal asphyxia. A marked and especially a sudden rise in the maternal temperature may kill the fœtus in utero; it is supposed that the mechanism here is degeneration of the myocardium of the fœtus on account of the high temperature, but even in this case asphyxia may be invoked as a link in the chain of lethal factors. It may then be assumed that fœtal asphyxia is the great immediate cause of fœtal death. The various conditions which may produce this state of the fœtus will be referred to later; in the meantime the mode in which the asphyxia brings about the intrauterine death must be described.

Fœtal asphyxia may be acute or chronic; the former variety is due to causes which rapidly and completely throw the placental system out of action, and the latter to a more slowly produced or a less complete interruption of the fœto-maternal interchanges. During labour (especially after the rupture of the membranes) new factors come into play, but the result is practically the same as in pregnancy.

Carbonic acid and other waste products accumulate in the fœtus, and oxygen is not supplied to it.

In the acute type of fœtal asphyxia, it may be supposed that the carbonic acid in the blood first excites the vagus, which causes slowing of the rate of the fœtal heart and irregularity. Then, the vagus becomes paralysed, the heart's action is quickened; and finally it stops from paralysis of the sympathetic nerves. Meanwhile the respiratory centres will also have been excited, attempts will have been made to inspire, the liquor amnii will have been sucked into the lungs, and, through the congestion of the pulmonary capillaries thus produced, the blood pressure in the aorta and its branches (including the umbilical arteries) will fall. No doubt the process is more complex than has been stated above; but the two factors which have been described lead at any rate by their combined action to the death of the fœtus. In the more chronic form, it is believed that inspiratory efforts are not usually made, the increasingly venous character of the blood slowly diminishing the excitability of the respiratory centres in the medulla, so that neither the absence of oxygen nor the presence of carbonic acid stimulate them. In both types the heart finally ceases to contract, and the fœtus presumably is dead. A difficult question, however, here arises. It is possible that the cause of the fœtal asphyxia may be suddenly removed just after the heart has ceased beating; under these circumstances, will the cardiac contractions recommence, and if so, after what period of cardiac inactivity will they so recommence? It is here that the semi-parasitism of the fœtus comes into play and complicates the problem. I think it is quite possible that the heart may cease beating for a considerable number of minutes, and recommence again if the cause of the asphyxia be removed. Certain facts which were pointed out in Chapter IX. (p. 134, *et seq.*) must here be kept in mind: they were the degree of the automatic activity of the fœtal heart and its less immediate dependence upon an oxygenated state of the blood circulating through it. From these characters of fœtal cardiac action it might be permissible to conclude that fœtal death would generally be established very slowly. On the other hand, there is the well-known fact that in maternal death Cæsarean section must be performed very quickly if the fœtus is to be saved. In the latter case, however, the maternal part of the placenta is dead, while in the former it is alive; further, in the latter case the attempt is made to excite cardiac action by setting up extrauterine (pulmonary) respiration, probably a more difficult matter than to re-excite cardiac action by removiug the obstacles to placental respiration. On account of these facts, and by reason of the difficulties of antenatal diagnosis, it becomes a very difficult problem to give an opinion as to the death of the fœtus in utero. To this matter, however, I shall return immediately.

The immediate results of fatal fœtal asphyxia are not often to be observed save in connection with intranatal death, and, as we have seen, true fœtal death differs somewhat from that. So far, however, as is known, they consist in the presence in the vessels of a very

dark coloured blood, either with no clots or with a few dense clots in it; in the occurrence of ecchymoses on the large vessels of the thorax and in the subpleural and subpericardial tissues, and sometimes of small intracranial and pulmonary hæmorrhages; in the finding of liquor amnii and meconium in the air passages; and in the transitory appearance of rigor mortis. There may be other signs noted, but it is doubtful how far they are to be regarded as due to the traumatism of labour. The advanced post-mortem changes (*e.g.* maceration) are referred to immediately. The changes which have been mentioned above are evidently due to the chemical changes in the blood and to the prematnre attempts at respiration. What the alterations are in the other modes of fœtal death (*e.g.* uræmia ?) we do not rightly know; it has been stated that degenerative changes in the myocardium characterise the lethal effect of a high temperature, but the evidence is slight.

Antenatal Rigor Mortis.

Rigor mortis in the fœtus has been mentioned above. I have already referred to its occurrence on p. 178 of this work, and also in a special article (80) in *Teratologia;* but I may summarise my chief conclusions here, for they are of some importance. I have seen several instances of antenatal rigor mortis, including the one described in the above article. It was a case which occurred in the practice of Dr. D. Milligan. The child's heart did not beat at birth, nor was there any pulsation in the cord during delivery. The head presented, and the labour lasted from four to five hours. The left arm was sharply and firmly flexed, and there was a similar, but less noticeable, condition of the right knee. Two hours after birth I saw the infant, when there was still some stiffness; but soon this entirely disappeared. The fœtus, a male, weighed 1220 grms., had a length of 40 cms., and the appearance of a fœtus of about six and a half months; the pupillary membrane was still present. A large and comparatively recent black blood-clot was found in the placenta, on the maternal surface. I believe that in this case the rigor mortis was passing off when the fœtus was expelled.

The first recorded case of antenatal rigor mortis seems to have been that of Chowne (*Lancet*, p. 199, ii. for 1840–1), yet Casper in his *Forensic Medicine* (New Sydenham Soc. Transl., i. 29, 1861) writes: "I have never observed cadaveric stiffening in the immature fœtus, . . . even in the case of mature new-born infants and little children it is feeble and transitory." Further instances, however, were soon reported by Schultze (*Deutsche Klinik*, No. 41, 1857), by Curtze (*Ztschr. f. Med. Chir. u. Geburtsh.*, 261, 1866), by G. Tourdes, in twins (article "Cadavre" in *Dict. encyclop. d. sc. méd.*, 1 s., xi. 420, 1870), by W. C. Grigg (*Brit. Med. Journ.*, ii. for 1874, pp. 493, 586, 707), J. A. Thompson (*ibid.*, ii. for 1874, pp. 550, 640, 772), P. A. Young (*ibid.*, ii. for 1874, p. 707), C. H. W. Parkinson (*ibid.*, ii. for 1874, p. 772), by M. Bailly, in twins (*Arch. de tocol.*, iii. 641, 1876), by A. Martin (*Ztschr. f. Geburtsh. u. Gynäk*, i. 55, 1877),

by L. W. Müller (*Dissert.*, Marburg, 1880), by E. Dagincourt (*Thèse*, Paris, 1880), by R. Boxall (*Lancet*, ii. for 1884, p. 60), by B. Jones (*Brit. Med. Journ.*, ii. for 1885, p. 963), by T. Davidson (*ibid.*, i. for 1886, p. 12), by Stumpf (*Arch. f. Gynaek.*, xxviii. 472, 1886), by Sänger (*ibid.*, xxviii. 473, 1886), by Dohrn (*Centrlbl. f. Gynäk.*, x. 113, 1886), by O. Feis (*Arch. f. Gynaek.*, xlvi. 384, 1894), by M. Lange (*Centrlbl. f. Gynäk.*, xviii. 1217, 1894), by N. S. Kannegisera (*Journ. akoush. i jensk. boliez.*, ix. 31, 1895), by Steinbüchel (*Wien. med. Wchnschr.*, xlv. 370, 434, 474, 1895), by B. Jones (*Lancet*, ii. for 1895, p. 1020), and by Knorr (*Centrlbl. f. Gynäk.*, xx. 40, 1896). In several of these cases, the dead and rigid infant was removed from the uterus by Cæsarean section, proving conclusively that rigor mortis may occur in the uterine cavity. In most of the cases the labours were abnormal (placenta prævia, accidental hæmorrhage, eclampsia, pelvic contraction, etc.), and the fœtal death must be ascribed thereto; probably the rigor mortis which follows death before labour has commenced will seldom, if ever, be seen, unless indeed delivery occur very rapidly and very soon thereafter.

The rigidity in some of the reported cases was well marked and widespread; practically, it always affected the limbs and generally also the muscles of the jaws and neck. It passed off in times varying from one hour to thirty hours after birth, and the post-mortem examination usually revealed simply the signs of premature respiration. There is nothing in the intrauterine environment to prevent the occurrence of rigor mortis; and J. Tissot (*Arch. physiol. norm. et path.*, 5 s., vi. 860, 1894) has shown that it takes place in fœtal kittens; possibly it may be slightly marked, and may come on sooner and pass off earlier than in postnatal death, but even of these differences there is not much proof. Of course every case of congenital rigidity is not necessarily an instance of rigor mortis (*e.g.* Gibb's case, *Lancet*, ii. for 1858, p. 497). The rarity with which it has been observed, or at any rate recorded, may be explained by several circumstances: the non-coincidence of fœtal death and expulsion from the uterus, the absorption of the obstetrician in his duties to the mother, the characters of fœtal rigor mortis, and perhaps the use of the Schultze swinging movements in attempted resuscitation. Nevertheless the proof of the occurrence of antenatal cadaveric rigidity is, I think, complete, at least in the cases where death occurs during or immediately before the supervention of labour pains; and it may be met with in immature as well as in mature fœtuses. Possibly, in cases of fœtal death occurring slowly in utero from causes not associated with delivery, the gradually ceasing fœtal circulation and the long-drawn-out manner in which vitality disappears may impress special characters on the rigor mortis which then supervenes.

Clinical History and Symptomatology of Fœtal Death.

In cases of fœtal death, it is not uncommon to be able to elicit the history of the previous occurrence of the same fatality in the mother's reproductive record. When this so-called "habit of giving

birth to dead infants" is met with in any case, it is common to find indications of some distinct maternal disease. For instance, there may be the history of syphilitic manifestations (pp. 246, 254), and according to some authorities the "habitual" fœtal death may itself be the manifestation and the sole manifestation of that disease. But there may, in other instances, be a record of long continued anæmia, of malaria, of alcoholism, of lead poisoning, of heart disease, or of renal disease with albuminuria; again, it may be gathered that the mother had for a long time suffered from endometritis, or uterine displacement, or disease of the placenta. Some of the conditions which have been named may be dependent upon each other, as for example placental alterations upon maternal albuminuria. Finally, in some instances, there may be no very evident cause for the recurring fœtal deaths either in the mother or in the father. Very curious cases are those in which every alternate pregnancy ended in the birth of a dead fœtus, or in which all the infants of one sex were born dead and all those of the other alive.

When the past history of the mother yields no information which has any obvious bearing on the death of the unborn infant, the record of the present pregnancy may do so. Thus the mother may have been the subject of a serious traumatism, or have been the prey of violent emotion, although it must be at once admitted that not infrequently even very serious accidents, and very considerable perturbations, may be followed by the birth of a healthy living infant at the full term. Again, the mother may have suffered from an acute illness in her pregnancy, such as pneumonia, cholera, or smallpox; or she may have become infected with syphilis, or have developed cardiac or renal disease. Yet again, there may have been no accident or disease during gestation to give an indication of the possible condition of the fœtus; when a dead fœtus is born after such a pregnancy, we are led to infer that the death must be due to conditions arising in utero, in the placenta or fœtus, independent of the maternal health. These cases present most puzzling problems; and for most of them no hypothetical explanation even is forthcoming. Of course, I do not here refer to instances of intranatal death due to the many lethal influences which may then come into play.

The symptomatology of fœtal death abounds in phenomena which suggest the possibility, or even the probability, of the occurrence of this disaster, but is lacking entirely in positive indications thereof. When it is borne in mind that the symptoms of intrauterine death are in great measure the negation of the symptoms of pregnancy, their indefinite character will be appreciated. Further, since pregnancy may cause no symptoms which can be regarded as absolutely diagnostic, so fœtal death, in a still more marked degree, may yield no certain indications. The mother may fear that her infant is dead; her fears may be justified, but, on the other hand, they may not. All obstetricians must have met with cases in which they were assured by anxious pregnant women that the child in the womb was dead, and yet at the full term a living and healthy infant was born. At the same time there are some symptoms of fœtal death

which have a certain degree of diagnostic value and importance. They are of greater value if they supervene upon well-marked symptoms of pregnancy. They consist, in the first place, in various ill-defined feelings of the mother, such as headache, loss of appetite, sensations of heat and cold, tinnitus aurium, general malaise, epigastric pain, a feeling of weight in the abdomen, and rectal and vesical uneasiness. In the second place, there may occur a profuse perspiration or a sudden diarrhœa, and there may be reason to believe that this symptom was synchronous with the death of the infant. In the third place, there is the disappearance of various symptoms of pregnancy, such as morning sickness, special types of neuralgia, salivation, and the like. In the fourth place, there is the cessation of fœtal movements, and, if these movements have previously been clearly recognised by the patient, it cannot be denied that this symptom, negative although it is, has a very considerable value. Further, its value is increased if the cessation has followed upon a series of very violent and disorderly movements, more especially if these in their turn have been preceded by some recognisable cause of fœtal death, such as a severe blow on the abdomen, a sudden emotion, etc. It need not, at the same time, be pointed out that for the purpose of diagnosis this symptom may be very fallacious, for there are times when the fœtus is quiescent, and conditions under which the active fœtal movements cannot be distinguished; again, the patient may have made a mistake in thinking that she felt quickening at all, and so also her opinion that quickening had ceased may be erroneous. Sometimes a sensation of passive fœtal movements has been described by women carrying a dead fœtus, movements elicited by sudden changes in position; but the value of this symptom is problematical. Finally, there are the indications of the death of the fœtus derived from the retrogression of the mammary changes; the woman may note that the glands are not so tender and have not the swollen feeling which they had, and that these changes have succeeded a time when the tenseness and sensitiveness were greatly increased.

All these symptoms have a greatly augmented importance and diagnostic value when the patient has in one or more previous pregnancies experienced similar sensations, and has found out by sad demonstration that they meant intrauterine death.

Diagnosis of Fœtal Death.

It is doubtful whether the antenatal diagnosis of fœtal death can ever be made with absolute security; it can never be affirmed with the same certainty as one affirms the presence of fœtal life after hearing the fœtal heart; but a very strong provisional diagnosis can be formed. This provisional opinion is founded upon the past history of the patient, the consideration of her symptoms, and the physical examination which the obstetrician makes. To the past clinical history and to the symptomatology I have already referred; I must now consider in detail the physical examination.

In the *first* place, the inspection and palpation of the mammary glands may yield indications of the death of the fœtus. Intrauterine death would seem to have the same effect upon the mammæ as the birth of the child, but this primary effect soon passes off. At first the glands show increased swelling and tenderness, the cutaneous veins become more evident, and the secretion first of colostrum and later of true milk becomes active. In a few days, however, these phenomena pass off, and the glands gradually pass into a quiescent state. When, ultimately, the dead fœtus is expelled from the uterus, it has been noticed that the usual mammary engorgement which follows birth is wanting. E. Tridondani (*Ann. di ostet. e ginec.*, xxi. 71, 1899) draws special attention to the value of these mammary changes, and indicates that perhaps in the microscopical and chemical characters of the milk may be found additional indications of the death of the fœtus (disappearance of colostrum corpuscles, diminution in the amount of sugar and fat, etc.).

In the *second* place, the careful examination of the abdomen has a very considerable diagnostic value by reason of the change in the physical signs there apparent. The abdomen ceases to have the appearances corresponding to the ascertained or estimated date of pregnancy: it seems, and probably is really, smaller than it was; it loses the marked globular projection in the middle line, and becomes more expanded in the flanks, suggesting ascites; the umbilicus is no longer projecting; there is absence of the firmness and resistance of the uterus containing a living fœtus, in fact, it becomes difficult to map out the uterus by palpation at all; no muscular contractions can be felt sweeping over its surface; and the whole uterus on account of its flaccidity tends to sink into the pelvic brim and to lose its normal shape and relations. The pigmentary and vascular developments in the abdominal walls undergo involution, and it may be added here that the vulvar and vaginal dusky red discoloration (Jacquemier's sign of pregnancy) gradually disappears. When the attempt is made to map out the various parts of the fœtus, it usually fails, at any rate when intrauterine death has taken place a week or more previously. The hard globe of the head cannot be detected, and there is a general loss of the feeling of resistance in the fœtal tissues, so that the dead infant is more or less completely moulded to the containing uterus. A special sensation of crackling (*scroscio*), due to the looseness of the bones of the head, has been described by Negri (*Ann. di ostet. e ginec.*, v. 82, 1883; vii. 223, 1885). The head often ceases to be the presenting part. The most careful palpation fails to elicit active fœtal movements, and no fœtal heart is heard on auscultation; but these negative signs have, of course, only a limited value in forming a diagnosis, for over and over again a living infant has been born, and yet the obstetrician had neither heard its heart nor felt its movements after the most rigorous examination. The uterine souffle may be heard after the death of the fœtus, but it has been stated that its quality is changed. Apparently it has little value as a sign of fœtal death, and the same remark applies to the sounds due to intrauterine decomposition which have been referred to by some authors. In the

rare cases, however, in which antenatal putrefaction is set up (usually after rupture of the membranes), the accumulation of gases leads to the development of a tympanitic note on percussion over the uterus.

In the *third* place, the vaginal and bimanual examinations may bring out a few additional facts (of no great diagnostic value) regarding fœtal death. If the death has been recent, no appreciable differences may be detected; but if it has taken place ten or fourteen days previously, it may be found that the cervix and lower uterine segment have already lost the softness peculiar to pregnancy with a living fœtus, and that the pulsating artery in the anterior fornix is no longer to be easily felt. It will be difficult to distinguish the presenting part. Sometimes it may be found that a fluid is discharged at intervals of time from the uterus; it may be clear like serum or it may be blood-stained, or have a dirty brownish colour. This escape of fluid (*hydrorrhœa gravidarum*) has sometimes been associated with fœtal death. It must, however, be borne in mind that it may occur with a living child also; it has, for instance, been noted in those curious cases in which the membranes rupture in utero and the fœtus goes on developing outside them in an extra-amniotic or extra-membranous fashion, as in K. Reifferscheid's observation (*Centrlbl. f. Gynäk.*, xxv. 1143, 1901). On the supposition that the intrauterine temperature falls after fœtal death, it has been proposed to introduce a thermometer between the uterine walls and the membranes for the purposes of diagnosis; but the procedure cannot be commended.

In the *fourth* place, the death of the fœtus may lead to the disappearance of certain signs of pregnancy of a pathological nature, and their disappearance may thus come to have a diagnostic value. In this way, for instance, varicose veins, dropsical swelling of the lower limbs and vulva, and albuminuria (A. H. F. Barbour, *Edinb. Med. Journ.*, xxx. 901, 1884–5) may lessen very evidently, even if they do not entirely disappear. The same remark applies to several morbid symptoms of pregnancy, such as persistent vomiting, grave dyspnœa, etc.

In the *fifth* place, fœtal death may be followed by certain changes of a chemical kind in the maternal excretions. It has from time to time been somewhat confidently affirmed that in the presence of some unusual substance in the urine is the certain test of intrauterine death. There can be little doubt that with the decease of the fœtus a current begins to pass from the uterus and its contents into the general maternal circulation; this current will contain the results of the involution of the uterine muscular fibres, as well as little known substances from the liquor amnii, fœtus, and placenta. Possibly the immediate result of post-mortem changes in utero is a marked increase in the total amount of urine secreted; of this there is some evidence. With regard, however, to the value of acetonuria as a sign of fœtal death there has been much difference of opinion. The presence of acetone in the urine of the pregnant woman was stated by G. Vicarelli (*Prag. med. Wchnschr.*, xviii. 403, 428, 1893) to be a new sign of the decease of the fœtus before birth, other causes being

excluded. Researches were made by others (L. M. Bossi, *Ann. di ostet. e ginec.*, xvi. 276, 1894; L. Knapp, *Centrlbl. f. Gynäk.*, xxi. 417, 1897; H. Lambinon, *Journ. d'accouch.* (Liége), xix. 70, 1898; E. Bidone, *L'acetonuria gravidica*, Bologna, 1898; Lop, *Gaz. d. hôp.*, lxxii. 519, 1899), and Vicarelli himself returned to the subject (*Riv. di ostet.*, ii. 368, 1897). The fact that acetonuria was found by Bossi (*Arch. di ostet. e ginec.*, iv. 193, 1897) in cases in which fibroid tumours of the uterus were in process of absorption, formed a piece of confirmative evidence, and seemed to suggest that the acetone was due to the breaking down of muscular tissue. A. Couvelaire (*Ann. de gynéc.*, li. 417, 1899) is of opinion that acetonuria in the puerperium is due to the neuro-muscular fatigue of labour, the auto-intoxication of the fatigue of the confinement being added to the auto-intoxication of pregnancy; it does not indicate fœtal death with any certainty. It cannot yet be determined what value acetonuria has as a sign of fœtal death; it is probably not developed immediately after the death of the infant, and it may of course be due to other causes, but it is undoubtedly of some importance; and future observations will more clearly define its sphere of diagnostic usefulness. It would seem to be frequently associated with eclampsia and syphilis.

Another possible indication of intrauterine death is peptonuria. A. Kœttnitz (*Deutsche med. Wchnschr.*, xiv. 613, 1888) met with this condition in four cases of fœtal death, and ascribed to it considerable diagnostic importance. The fact that peptonuria is often met with in the puerperium, and after the application of electricity to fibroid tumours, supports the above view, indicating that the peptone comes from the involution of the muscular organisation of the uterus. After the death of the fœtus, the uterus is practically in the puerperium, although its contents are not yet expelled. Further, the belief is strengthened by the observation, made by Truzzi (*Ann. univ. di med.*, cclxxi. 409; cclxxiii. 415, 1885), that peptonuria is absent in the period following the expulsion of a macerated fœtus, the explanation being that here the puerperium has already run its course before the emptying of the uterus takes place. The experience of other obstetricians has not, however, come to support the opinion of Kœttnitz, for P. Caviglia (*Stud. di ostet. e ginec.*, 379, 1890) and some others have obtained negative results; again, peptonuria has been repeatedly found in cases in which the fœtus was alive. It has sometimes been supposed that one might find traces in the maternal urine of other products of macerative decomposition of the tissues of the dead fœtus, such as hæmoglobin, bile pigments, glucose, creatinin, and urea; but nothing has yet been discovered of real diagnostic value.

It is perfectly clear, from what has been said, that the diagnosis of fœtal death must always be a matter of considerable difficulty. When a multiparous woman passes through a severe illness and affirms that she feels sure that her unborn infant is dead, and when her medical attendant now fails to hear the fœtal heart which he had previously heard with ease, the probabilities of intrauterine death rise to a high level; they are also great when previous experience has proved the existence of "habitual" fœtal death; but

under other circumstances no confident diagnosis should be made, and the obstetrician should be prepared for surprises. When actual putrefaction of the uterine contents takes place, the condition is different, for then the discharge of sanious evil-smelling fluid and malodorous gases from the uterus, along with tympanitic distension of that organ (physometra) and grave signs of maternal blood-poisoning, will reveal the nature of the processes going on in utero (E. Chatelain, *Thèse*, Paris, 1883). Putrefaction, however, is a very rare consequence of fœtal death, and its presence nearly always means that the membranes have ruptured, and that air has gained access to the uterine interior from the vagina.

There are certain conditions which, when present, greatly increase the difficulty of diagnosing antenatal death. These are the existence of twins in utero or of an extrauterine gestation. It is almost impossible to give anything approaching a confident answer to the question whether one fœtus in a plural pregnancy has succumbed, and the hopes of determining whether the extrauterine infant has died are scarcely greater. In these cases, as in all the less difficult ones, an important factor in clearing up the diagnosis is *time;* the repeated examination, especially by mensuration, of the abdomen will in the long run throw light upon the problem, and by and by the occurrence of labour will remove all doubt. Instead of true labour there may be a false or spurious one, resultless as regards the expulsion of any uterine contents, but with a certain diagnostic value nevertheless.

Even during labour some dubiety may still exist as to the life or death of the fœtus passing through the birth canals. When the head presents it may be possible by palpation to detect the softness of the presenting part and the crackling sensation of the easily displaced cranial bones; the liquor amnii may be tinged green with meconium, or may contain flakes of desquamated epidermis; and any prolapsed part (hand, foot, etc.) may show signs of maceration. When these conditions are present, the diagnosis of fœtal death may be made; but it is noteworthy that the presence of meconium in the amniotic fluid is not a certain sign (E. Rossa, *Arch. f. Gynæk.*, xlvi. 303, 1894). Further, a swelling may be found on the presenting part of a dead fœtus, not distinguishable by touch from the caput succedaneum which is formed in ordinary labour. Death during labour will be diagnosed by the occurrence of some evident cause, by cessation of the fœtal heart and of pulsation in the cord or other palpable part, and by the premature escape of meconium. If doubt exist, it will soon be set at rest by the complete expulsion of the infant, alive or dead.

Pathology of Fœtal Death.

I have already indicated the changes which, in all probability, immediately follow upon the cessation of the life of the fœtus (subpleural ecchymoses, rigor mortis, etc.); but it is now necessary to consider the less immediate post-mortem alterations which occur in

the dead unborn infant and in its environment. The subject is complicated by the difficulty of separating the true post-mortem changes from those due to ante-mortem disease, and by the lack of reliable descriptions of the changes at various definitely ascertained dates after death.

Four varieties of pathological change are usually enumerated in connection with antenatal death, viz., dissolution, mummification, maceration, and putrefaction. With regard to dissolution or the gradual disappearance of all traces of the embryo in the liquor amnii, it may be fairly confidently affirmed that it can occur only in the embryonic period of antenatal life as a result of early death of the new organism; it is not, therefore, to be reckoned as one of the post-mortem changes incident upon fœtal death. Mummification is a peculiar drying up of the fœtal tissues which occurs only under special circumstances; to it reference will be made ere long. Putrefaction probably occurs only after the rupture of the membranes has taken place and air has gained access to the uterus. Maceration, therefore, remains as the commonest and most typical of the post-mortem changes which follow fœtal death.

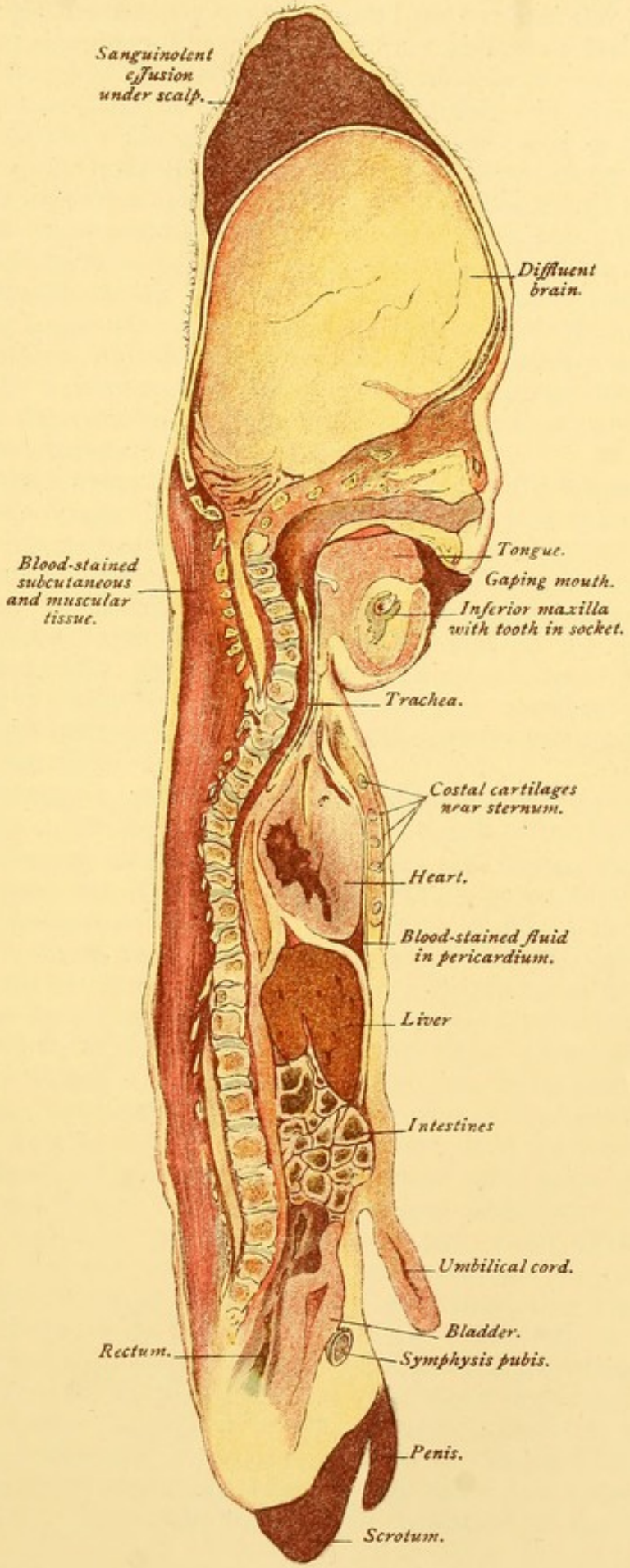
All the stages of *maceration*, as it affects the fœtus and its annexa, are unfortunately not known. The immediate consequences of intrauterine death and those which are found about a fortnight later have been fairly well ascertained; but of the changes which develop between these times our knowledge is very imperfect. For it is common for the fœtus to be expelled very soon after its death or not till ten or fourteen days have elapsed, but rare for it to be born at intermediate dates. If the death of the fœtus is not accompanied by its expulsion, it is common for a sort of spurious labour to occur; this is apparently without result, and the dead fœtus is retained for a fortnight or so. During these fourteen days, various changes have been occurring in the uterus which usually are met with in the first fortnight of the puerperium. Save, indeed, for the fact that it is not empty, the uterus is practically a puerperal organ, and by the end of fourteen days or thereabout the dead fœtus inside it is a foreign body. This is probably one reason for the commonly observed fortnight's retention. At the same time, much longer periods of retention have been recorded. I have myself observed a case (215) of missed abortion, in which the fœtus died at the third month and was retained till the ninth, being ultimately expelled upon what would probably have been the date of confinement had the fœtus lived; and many such observations have been made. It would seem to be much rarer for the dead fœtus to be retained for some weeks or months after the full term of gestation; and most of the cases in which it was stated that the infant was discharged or discovered after a sojourn of seven, ten, twenty, and even forty years in the mother's body, are to be regarded as instances of extrauterine or interstitial pregnancy. B. F. Baer, however, reports an extraordinary case (*Amer. Journ. Obst.*, xv. 229, 1882), in which there was a punctured wound of the uterus, partial escape of the fœtus into the abdominal cavity, and retention of it for five years. From what has

been said, it will be evident that most of our knowledge regarding maceration applies to the maceration found about a fortnight after intrauterine death.

The external appearances and the internal alterations of the macerated fœtus vary with the period which has elapsed since death. They have been specially studied by A. Lempereur (*Thèse*, Paris, 1867), by L. Sentex (*Mém. et bull. Soc. méd.-chir. d. hôp. de Bordeaux*, ii. 486–572, 1867), by O. Hourlier (*Thèse*, Paris, 1880), and by others. The process consists in a gradual softening of the tissues of the body without the development of putrefactive gases or the presence of microbes; it is an aseptic change. It used to be termed "putrefaction" by the older authors, but that name ought to be restricted to the cases in which putrefactive germs have gained access to the interior of the uterus and set up true putrefaction.

In the *first* stage of maceration, which corresponds with the first ten or twelve days following intrauterine death, the external form of the fœtus is hardly modified, and the parts retain their firmness. The epidermis here and there (limbs, neck, etc.) is raised up into blebs containing blood-stained serum; some of these may have burst and their contents passed into the liquor amnii to mix with it and with the meconium in it. In the body cavities there is found a more or less clear serum, and the organs are somewhat soft; the subcutaneous tissue is infiltrated with serum, and the brain shows some softening, especially in the grey matter. In the *second* stage, tenth day to fortieth (Lempereur), the macerative changes have become very marked. They are represented as they appear in a frozen section in Plate XIV. This fœtus, a male, came into my hands for examination in 1893, and I made sections of it after freezing in order to bring out certain peculiarities not easily recognised by other methods. It had been dead for fully a fortnight. At this stage the whole fœtus is somewhat swollen, but on account of its softness tends to flatten out on any hard surface upon which it may be laid. The abdomen, in particular, flattens out, as does the head in an antero-posterior direction. The epidermis is absent over nearly the whole surface of the body, leaving the dull red underlying skin fully exposed. On the scalp, however, it is still attached. The cranial bones move freely on each other, and the scalp tissues are swollen and infiltrated with sero-sanguinolent fluid, which may accumulate, especially at the vertex, and produce a spurious caput (Plate XIV.). Everywhere there is found this sero-sanguinolent fluid—in the subcutaneous tissue, between the muscles, in the abdomen, in the thorax; so constant and so copious is it, that C. Ruge gave the name *hydrops sanguinolentus* to the fœtus in this stage of maceration (*Ztschr. f. Geburtsh. u. Gynäk.*, i. 57, 1877), and the name was quite warranted, although it came erroneously to be regarded as equivalent to the syphilitic dead fœtus. All the internal organs show softening, and the brain is quite diffluent, only maintaining its form by the help of the surrounding membranes. The heart, the liver, the spleen, and the lungs are all more or less altered in shape on account of their softness; they may be pale in colour, or stained to a greater or

PLATE XIV.


Sanguinolent effusion under scalp.
Diffluent brain.
Tongue.
Gaping mouth.
Inferior maxilla with tooth in socket.
Blood-stained subcutaneous and muscular tissue.
Trachea.
Costal cartilages near sternum.
Heart.
Blood-stained fluid in pericardium.
Liver
Intestines
Umbilical cord.
Bladder.
Rectum.
Symphysis pubis.
Penis.
Scrotum.

less degree with blood. Under the microscope, the epithelial elements of the tissues can be recognised as swollen and granular or fatty in appearance; the changes in the stroma of the organs are little known; and the blood corpuscles may be found swollen and paler in colour than normal, or else shrivelled and broken up into granular masses. The colouring matter of the blood is dissolved in the fluids of the body cavities, or lies as small crystals in the tissues. During the second stage of maceration the histological elements of most of the organs and tissues become unrecognisable. In the *third* stage, which lasts, according to Lempereur (*op. cit.*), from the fortieth to the sixtieth day of intrauterine retention, the cellular elements of even the lungs are unrecognisable. The absence of the epidermis is now complete, and is seen even on the hairy scalp; the softening of the body is very marked; the internal organs rest in a collapsed state upon the vertebral column; and the brain is simply an "emulsion of nerve tissues."

The post-mortem changes which ensue when the fœtus is retained in the uterus longer than two months, are not well known. Sometimes the maceration proceeds, and the body breaks up and is expelled in fragments at various times; sometimes true putrefaction is set up, necessitating the artificial clearing out of the uterus; sometimes possibly all that remains in the uterine cavity may be the dry skeleton of the fœtus; and possibly also petrification or saponification may occur. It is difficult, however, to determine whether the results above named occur save in cases of extrauterine gestation in which the fœtus has died.

There is also a great lack of knowledge respecting the changes which occur in the fœtal annexa after the death of the unborn infant. The placenta may show various alterations, *e.g.*, fibrous degeneration, fatty changes; but it is always very difficult to exclude the possibility of ante-mortem disease of the organ. Even in twin cases in which one fœtus is dead, and in which the part of the placenta from which it derived nourishment is affected with fibrous or fatty change, it is still an open question whether the changes are the results or the causes of the fœtal death. I have several times been impressed by the fact (as indeed I suppose all obstetricians have been) that the placenta may have an almost normal appearance, and yet be expelled along with a fœtus which has evidently been dead for some time; on the other hand, I have noted the conversion of a large part of the placenta into fibrous tissue with functional destruction of a great number of villi, and yet the infant has been born alive and well nourished. Evidently the placenta has a certain degree of vital independence as regards the fœtus; evidently also the placenta always contains many more villi than are absolutely necessary for the conservation of fœtal life and health. Nature plans with no niggard hand. When the fœtus has been born dead and markedly macerated, I have found villi in the placenta containing apparently normal blood-cells, and I do not regard it as an impossibility that the placenta may increase somewhat in size after the decease of the unborn infant. As a rule, however, the cessation of the circulation

through the placenta is probably followed by the formation of thrombi in the vessels of the villi, and by the development of fibrin in their neighbourhood, and there may be signs of inflammatory processes round them. Winkler (*Dissert.*, Wurzburg, 1895), at any rate, describes perivascular inflammation and obliteration of vessels of the villi as signs of fœtal death; but Otto von Franqué (*Ztschr. f. Geburtsh. u. Gynäk.*, xxxvii. 277, 1897) is very guarded in drawing conclusions. Changes of various kinds have been met with in the umbilical cord (gelatinous infiltration, vascular inflammation), in the chorion and amnion (loss of transparency, thickening, so-called choriitis and amnionitis), in the liquor amnii (absorption, increase in quantity), and in the decidual membranes; but what has been already said regarding the placental alterations in structure may be here repeated—it is very doubtful whether they precede or follow the fœtal death. It is quite possible that there may be a much greater degree of independence between the vitality of the fœtus and that of its annexa than has been hitherto supposed, and that when the cause of fœtal death resides in the fœtus itself the life of the placenta may to a certain extent be continued. When, on the other hand, the fœtus dies because the placenta is practically dead, the dependence will be more manifest. We think of the semi-parasitism of the fœtus as regards the mother; we may have to think of the semi-parasitism of the placenta both as regards the mother and the fœtus.

As has been already stated, *mummification* is a peculiar result of fœtal death, perhaps similar to the preserving of a fruit in a liqueur or the pickling of meat in brine. It would seem to occur specially in early fœtal and in neofœtal death (third or fourth month); and it is characterised by a drying up or tanning of the fœtal tissues, by the absence of the liquor amnii, or by the presence of some drops of muddy fluid representing it, and by the close contact which exists between the fœtus and its enveloping membranes. This desiccative process produces its most striking result when one of twin fœtuses dies in utero and is pressed upon by the other, which continues to live and grow. Then the so-called *fœtus compressus seu papyraceus* is produced; in it there is flattening as well as desiccation, and the result is not unlike the gingerbread figures sold at fairs ("des bonshommes de pain d'épice"). I have met with several specimens of the fœtus compressus (159, 180, 190), and in all of them the flattened twin had its own placenta; in all of them fœtal death had occurred about the second or third month, but the dead fœtus had not been expelled till the full term along with the living infant. There may, however, be a common placenta, as in H. J. Ilott's specimen (*Trans. Obst. Soc. Lond.*, xxxvii. 16, 1895).

When the dead fœtus lies in an *extrauterine gestation sac*, it may undergo the post-mortem changes of maceration and desiccation which have been described above; it may also putrefy. The other changes which are of doubtful occurrence in intrauterine death most certainly occur in the ectopic pregnancy. Thus the fœtus may be converted into adipocere (saponification) or into a lithopædion (calci-

fication, petrifaction). Sometimes the deposit of lime salts affects only the fœtal membranes, sometimes it would seem as if the vernix caseosa had been changed into a calcareous shell, and sometimes the lime is distributed throughout the fœtus itself (true lithopædion). The mode of formation of the adipocere and lithopædion are not understood. A good account of the microscopical appearances of the lithopædion was given by Inez-Gachès Sarraute (*Arch. de tocol.*, xii. 237, 1885); and J. G. Clark (*Bull. Johns Hopkins Hosp.*, viii. 221, 1897) has furnished a long bibliographical list, bringing F. Küchenmeister's record (*Arch. f. Gynaek.*, xvii. 153, 1881) up to date. J. C. Webster (*Ectopic Pregnancy*, p. 102, 1895) has referred to the occurrence of hæmorrhages in the placenta after the death of the fœtus in ectopic gestation.

Upon the whole subject of the morbid anatomy of fœtal death, W. O. Priestley's Lumleian lectures (*Pathology of Intrauterine Death*, London, 1887) may be consulted with great profit.

While the changes which have been described above are going on in the fœtus and its annexa, the uterus is passing through a sort of puerperium. So far as is possible in its unemptied state, the womb undergoes involution. The muscular and vascular hypertrophy in its walls disappears, and, if we may draw conclusions from Orloff's case (*Prag. med. Wchnschr.*, xx. 232, 1895), the mucous membrane is restored when the retention is long continued. But, as every obstetrician knows, the usual result of fœtal death is abortion or premature labour, and not prolonged retention of the products of conception. Let us, therefore, consider abortion from this standpoint.

Abortion and Premature Labour.

It is not my intention to describe in any fulness the causes, mechanism, diagnosis, and treatment of abortion and premature labour; these matters are dealt with in all text-books of midwifery. I shall here consider only abortion and premature labour in so far as they concern fœtal death.

In the first place, abortion does not always follow fœtal death immediately, neither does premature labour. As has been pointed out above, the dead fœtus may be, and often is, retained for a varying period in utero. This is proved by the more or less advanced signs of post-mortem change so often found in it when it is expelled. Can this be explained? I think it may possibly be due to several causes. First, there is reason to believe that there are special dates in pregnancy at which it is more likely that the uterus will empty itself than at others. That these dates correspond to what would have been menstrual periods if pregnancy had not occurred, is very probable, as indeed L. M. Bossi (*Ann. di ostet. e ginec.*, xxi. 445, 1899) has pointed out. It is quite rational to think that if fœtal death occur just before one of these dates, with perhaps its recurrent pelvic congestion, the expulsion of the uterine contents will follow immediately; whereas if it take place midway between two periods, the

uterus may not empty till the next date. It may be that at these times there is an œstrous toxin which, circulating in the blood, increases uterine excitability. Second, there is the transition time of neofœtal life, which is a period when there is a special liability to the occurrence of abortion. At this time a delicate readjustment of intrauterine affairs is taking place, for the general chorionic-decidual attachments are loosening, and the placental ones are not yet fully formed and secure; fœtal death or any other disturbing cause arising now will be much more likely to cause the emptying of the uterus than at other times.

In the second place, neither abortion nor premature labour by any means always implies preceding fœtal death. Fœtal death is only one of many possible causes of abortion and premature labour. It is true that most of the causes of intrauterine death may be also causes of abortion; but it is not very rare to find a living fœtus in an abortion sac, and prematurely born babies are of course frequently born alive. A certain cause may produce abortion without killing the fœtus, just as another cause may kill the fœtus without leading to its expulsion. What, then, are the causes which both kill the fœtus and produce abortion or premature labour? Theoretically, we may suppose that they are those which attack in a special way the placenta; and, practically, there is some reason to believe that this conclusion is justified. Certainly syphilis, which produces marked placental changes, is a very frequent cause of both fœtal death and abortion or premature labour. As a matter of fact, it would seem that the life of the placenta (or at least its functional integrity) is more necessary for the maintenance of the intrauterine *status quo* than that of the fœtus itself. Probably this is one reason why in a given case the slightest cause will lead to the emptying of the uterus, while in another case serious injury and the most provocative abortifacients will not suffice. In the one the placenta is prone to disease or is already morbid, in the other it is not. No doubt there is also that curious and variable factor, uterine irritability, to which I have referred in a recent lecture on "Abortions" (126*b*). The *aborting coefficient* is to be arrived at by the consideration of the cause in action plus the uterine irritability. If the total stimulus be represented by 100, then in some cases the exciting cause may be 45 and the uterine irritability will require to be 55 in order to lead to abortion; in other cases the uterine irritability will be 95, then an exciting cause represented by 5 will be sufficient to produce the same effect. Of course, neither factor can be fixed exactly, but when we are dealing with patients we soon begin to know those with a high degree of uterine irritability, and to take altogether different means to prevent miscarriage with them. Specially must the aborting coefficient be borne in mind in cases of recurrent abortion.

When we study the mechanism of abortion more fully, it becomes clear that, in the early fœtal period at any rate, the expulsion of the uterine contents is dependent more upon the state of the decidual membranes than upon the life or death of the fœtus. As has been demonstrated by D. Berry Hart (*Trans. Edinb. Obst. Soc.*, xvi. 20,

1891), in "normal and complete" abortion, the decidua is first separated over the lower uterine segment and later over the whole interior above the lower segment, with consequent expulsion of the whole mass; or else the part of the ovum covered by reflexa is driven down into the cervical canal before the complete separation of the part covered by the vera. In "abnormal" forms, the separation may occur in other planes; the fœtus and liquor amnii alone may be expelled, or the whole chorionic sac and its contents may be driven down uncovered by the deciduæ, or the fœtal sac in the decidua reflexa may be separated first from the vera and later from the serotina. Various parts of the products of conception may thus be retained, constituting incomplete abortion. Possibly the life or death of the fœtus may explain some of these varieties of abortion, but manifestly the state of attachment of the decidual and fœtal membranes will be a very important, perhaps a dominating factor.

In the case of premature labour, it will be admitted that the death of the fœtus has a more immediate bearing upon the supervention of labour than in abortion. Yet, even here, as clinical records show, the dead fœtus may be retained for some days in utero. This delay is by no means unfavourable for the mother, whom perhaps it saves from infection by allowing the involutionary processes in the uterine walls to be to some extent completed before the separation of the placenta and membranes takes place. If the cause which has led to the fœtal death do not at once produce also premature labour, then the uterine contents remain in situ till the occurrence of changes in the uterine walls converts the fœtus and its annexa into a "foreign body," so far as the containing organ is concerned.

Causes of Fœtal Death.

From what has been said, the reader will now be prepared to recognise that the long lists of causes of fœtal death given in the text-books are in some senses unnecessary. They are not repeated here, for, as I have tried to point out as each chapter of the work was written, all the various pathological states of the fœtus and its annexa may be causes of death, just as the various morbid states of postnatal existence may also produce a fatal issue. They do not always or with certainty do so, for there are several factors to be taken into account, such as severity and extent of the pathological process, power of resistance of the organism, degree of placental permeability, etc. One certain cause of fœtal death is the premature expulsion of the fœtus from the uterus before the sixth month; strictly speaking, this is not intrauterine death, but fœtal death, due to a too early entrance into extrauterine existence. Possibly as the means for rearing premature infants are perfected, even this certain cause of fœtal death may become less sure, and the date of viability be pushed further back than it is at present.

Treatment.

Fœtal death is confessedly a failure and a disappointment, and the treatment it calls for is prevention. To prevent fœtal death means, of course, to abrogate the causes thereof, and in process of time we shall doubtless be better able to do so than at present. The elimination of certain notorious causal conditions, such as syphilis alcoholism, and lead-poisoning, would reduce in a startling fashion the mortality of intrauterine life; but much must be accomplished before any one of these well-known causes can be got rid of or rendered innocuous. Failing the power of eliminating the causes of fœtal death, it has been proposed, in cases in which the fœtus "habitually" perishes in the last month of intrauterine life, to induce premature labour so as to send the fœtus forth alive. If the cause of death reside in the placenta, this plan may perchance succeed; if in the fœtus itself, the result will be most problematical. In cases in which the fœtus dies in labour on account of too advanced ossification of the head, the idea of the induction of labour is well founded and may prove successful; but of course it is always difficult to exclude the fallacy arising from simple coincidence; for the pregnancy in which induction was performed *might* have terminated in the birth of a living infant.

If there be reason to suppose that the fœtus is dead in utero, the question of obstetric interference will arise. If the membranes are intact, the expectant plan is to be followed, for during the next week changes will occur in the placenta, membranes, and uterine wall which will greatly diminish the risks of sepsis and hæmorrhage in labour. When uterine contractions supervene, the expulsion of the fœtus and annexa will not, in most cases, be delayed, and the recovery may be expected to be rapid. If, however, the membranes rupture, and yet no signs of labour occur, the question of intervention is more difficult to decide. There is now the risk of putrefaction in utero with all its attendant dangers. On the whole, perhaps, it will be best, in the absence of signs of maternal infection, to await the onset of uterine contractions; but in the presence of such signs and symptoms it will become imperative to empty the uterus expeditiously, and to use all the means in our power to diminish the septic absorption. A very important factor in guiding our conduct in all such cases is the difficulty of determining with anything like certainty the actual occurrence of fœtal death. When everything seems to point to the fœtus being dead, the obstetrician may be surprised to find a living infant expelled. In the presence of this uncertainty, the intervention of the medical attendant may serve no good purpose, and may, indeed, produce evil effects and precipitate dangers. The use of antepartum antiseptic douches may be permitted, but they must be administered with caution. What has been said as to expectancy in treatment applies to fœtal death both in the early and in the later months of pregnancy. It must, further, be borne in mind that when the obstetrician has to empty a uterus he will find that his most valuable ally is the uterus itself;

in other words, uterine contractions make the operation very easy, their absence makes it one of the most difficult of tasks.

There is much yet to be learned regarding fœtal death, regarding its mechanism, its symptoms and signs, its diagnosis, its pathology, its causes, and most of all regarding its preventive treatment. But every advance in our knowledge of the various departments of Antenatal Pathology will in the long run tend to diminish the frequency of intrauterine death. In the meantime, it must be said sadly that the fœtus has indeed the gift of antenatal life accompanied by the risk of antenatal death.

"L'œuf fécondé jouit de la vie, sujet par conséquent aux maladies, à la mort." "Ad mortem maturi omnes sumus, etiam antequam nati." To these, from other lands, I may add the words of Sir Thomas Browne (*Letter to a Friend*): "Nothing is more common with infants than to die on the day of their nativity, to behold the worldly hours and but the fractions thereof; and even to perish before their nativity in the hidden world of the womb, and before their good angel is conceived to undertake them."

CHAPTER XXV

Diagnosis of Fœtal Morbid States: Difficulties and Scope; Antenatal Diagnosis, Maternal, Medical, and Reproductive History, Paternal and Family History, Maternal Symptomatology and Physical Examination, Physical Examination of the Fœtus; Intranatal and Postnatal Diagnosis.

HERE and there throughout this work, allusions have been made to the diagnosis of antenatal morbid states affecting the fœtus: thus under variola (p. 193), malaria (p. 202), syphilis (p. 237), general dropsy (p. 296), endocarditis (p. 372), hydramnios (p. 402), and fœtal death (p. 416), some space has been given to the subject. Now, however, it is necessary to draw together into one chapter these scattered allusions, and to attempt to present in a more systematic fashion the means at our disposal for the making of an antenatal diagnosis.

Diagnosis implies difficulty. The making of a successful diagnosis implies the overcoming of a considerable difficulty. It is true that by the elaboration of mechanical aids, and by the long training of the senses, it is possible to reduce the making of a diagnosis under certain circumstances to a very simple and a very rapid process. Then, however, it can scarcely any longer be called diagnosis; it has become recognition, and requires very little, if any, mental effort. In dealing with antenatal morbid states, it is diagnosis in its true and best and most interesting sense that is needed. There is no immediate risk that any one will obtain such facility in the discovery of intrauterine conditions as to convert antenatal diagnosis into a dull and featureless and supremely easy procedure. It ought, therefore, for a long time yet to retain a special attraction for the diagnostician who rejoices in the meeting and overcoming of difficulties, and he is no true scientific physician who does not welcome with the relish of the epicure the truly intricate and obscure problems of his professional work. There is a feast ready for him in Antenatal Pathology.

Medical and surgical diagnosis began with the separation one from another of the external morbid states and of the injuries of the limbs; after many centuries, it passed to the investigation of the pathological conditions of the organs contained in the three body cavities; and while some still alive can look back to the elaboration of the diagnosis of intrathoracic and of intra-abdominal diseases and injuries, many of us who have not yet become old in the profession regard with almost personal pride the development of intracranial diagnosis. All these advances have meant the overcoming of many difficulties, some of them not inconsiderable, some of them at first

sight insuperable, but all of them yielding before the active brain of man. The brain itself has been the last to yield up its secrets. It is now full time that an energetic and sustained effort be made to carry the diagnosis of intra-abdominal pathological states further than it has ever been yet taken. The task is difficult, for we have to investigate the condition of things in a cavity within a cavity; we have to diagnose not merely intra-abdominal morbid states, but intrauterine intra-abdominal morbid states. The difficulty ought to be, indeed it is all the stimulus we need.

It is often concluded that by antenatal diagnosis is meant the recognition of antenatal morbid states during antenatal life or intrauterine existence—this and nothing more. The definition of antenatal diagnosis, however, is a wider one than that; for by it are understood the recognition and the separation one from another of all the pathological conditions which are produced during antenatal life, not only while that period of existence is still in progress, but also after the product of its pathology has been expelled from the uterus, and even during the time it is passing through the vagina on its way to the exterior. The birth of a diseased or malformed infant does not remove the necessity for a diagnosis of its particular disease or malformation, nor does it always clear away the difficulty in making it; even if the child be already dead, it will be for the advantage of future treatment that the medical man make out the cause of death. It must, therefore, be kept constantly in mind that the diagnosis of antenatal pathological states may be made at three times—during antenatal life while the fœtus is still in utero, during the act of parturition or intranatally, and after birth or in postnatal existence. It is, of course, easier to make the diagnosis intranatally than antenatally, and much easier to do so postnatally; but with decrease in difficulty has come decrease in value, and the chance of successful treatment may have passed away. It is necessary, therefore, to give the first place to the discussion of antenatal diagnosis made during antenatal life, as well on account of its difficulty as of its value.

Antenatal Diagnosis.

Emphasis has already been laid upon the difficulties of diagnosing morbid states while the subject of them is still in utero, and it is true that while the facilities are few the difficulties are many; but it must not be forgotten that after all they are not more than impediments, they are not insuperable obstacles to the making of a diagnosis of intrauterine diseases. Further, can the medical man declare upon "soul and conscience" that he makes in every case of pregnancy that comes under his care a full and searching effort to remove these obstacles? It is not that he does nothing; he listens for the fœtal heart, he notes the growth of the uterine tumour, he asks about the fœtal movements, and he examines the maternal urine for albumen, not once, if he be wise, but several times. But he is content with little; he is satisfied with far less from his examination of the

pregnant woman's abdomen than he would be, for instance, from the investigation of her husband's chest. In the case of an obscure lung complaint in the pregnant woman herself, this same medical man would doubtless percuss and auscultate and palpate the thorax till he had cleared up the diagnosis, and would feel not a little guilty and ill at ease if he failed to do so; but I fancy there are few practitioners who would pay the same amount of attention to the examination of the abdomen and uterus if the patient complained of unusually active, or unusually inactive, fœtal movements, or of acute pain in the hypogastric region. In surgery and in medicine the most careful and searching abdominal palpation is not infrequently made, and with good diagnostic effect; but for some reason a similar procedure has not yet become common in obstetric practice. Yet it is precisely in obstetric practice that it is most called for. There can be no doubt that in antenatal diagnosis the means of clinical investigation at our disposal are seldom made full use of, and are too often nearly completely neglected. It may be urged that the medical man has little or no opportunity of examining pregnant women in such a manner as would enable him to form an opinion on the health or disease of their unborn infants; and it may further be stated that patients do not offer themselves for such an exhaustive examination, and even refuse to allow it when it is pressed upon them. Now, for this state of affairs the medical profession is largely responsible; it has not demonstrated the value of such a procedure, and it cannot be expected that the public will follow where the profession does not lead. I doubt not the willingness of the pregnant woman to submit to examination, even to suffer to some extent in so doing, if it can be shown to her that she is thereby ensuring her own welfare and that of her unborn infant.

It must constantly be borne in mind that the antenatal diagnosis of fœtal diseases and other morbid states does not stand on the same platform, so to speak, with the recognition of the maladies of the adult. There is something special in it and peculiar to it. In many respects it resembles rather the diagnosis of disease in the new-born infant than in the child or adult. Neonatal diagnosis is, in fact, a sort of transition between antenatal and postnatal diagnosis. In it, as in antenatal diagnosis, the medical attendant has to learn many of the facts on which he forms his opinion from the statements of the mother or nurse, and in his physical examination of the infant he pays special attention to its movements, attitude, and appearance, and relies much upon palpation and auscultation. He does not expect to get any answers from the infant of the verbal sort, and such articulate replies as he elicits may hinder rather than help. So it is, only in a more marked form, with antenatal diagnosis. Only now the inspection of the infant is impossible, and the physician is thrown back still more upon the symptoms of the mother and the palpation of the fœtus still in her uterus. The first thing he ought to do is to form in his mind the visual image of what the fœtus in utero is at the ascertained or conjectured date of pregnancy. At first he will find it difficult thus to imagine his little unseen patient, but

practice will do much, and he will ere long have in his mind the pictures of the fœtus at the different months of intrauterine life, and be able to call them up, as it were, at will. He will find it a great help to read over a description of the outstanding features of the fœtus at the different stages of development and growth, such as is given him on pages 80 to 92. He will doubtless sympathise not a little with the Western physician who is expected to diagnose and treat his Eastern female patients by the feeling of the pulse alone. Having formed the visual image of his patient, he must next make up his mind to give more weight to past events in the estimation of present conditions; in other words, he must trust to the tendency there is in antenatal disease to repeat itself. He must be prepared to emphasise factors in antenatal which are little dwelt upon in postnatal diagnosis; and altogether he must be ready to make use of every scrap of evidence which he can obtain. He will be disappointed in the results obtained, but he must not be discouraged. Finally, he must remember that the morbid state in utero may be the result of the pathology of the period preceding the fœtal; it may be a monstrosity or malformation which has been carried from the embryonic into the fœtal epoch. I shall not here specially describe the diagnosis of monstrosities, but I must, of course, make passing references to it. Antenatal diagnosis includes the discovery of normal pregnancy and of plural pregnancy, of fœtal death, of diseases and monstrosities of the fœtus, of hydramnios, and of morbid conditions of the placenta. All these matters must be kept in mind in examining a patient who may be pregnant; and in all of them there is at any rate an increasing probability that the diagnosis may be thoroughly well established under favourable circumstances and with care and skill.

The making of the diagnosis of the antenatal morbid state during antenatal life will best be accomplished by taking up the following lines of investigation in order. *First*, the previous medical history of the woman, both general and sexual, must be inquired into, for there are certain circumstances which may be regarded as commonly preceding the development of morbid states in pregnancy; *secondly*, the past history and present state of the father, and the family history on both sides ought to be taken into account, for there are fœtal diseases and embryonic deformities which appear to be hereditarily transmitted; *thirdly*, the maternal symptomatology during the pregnancy which is in progress must be carefully investigated; *fourthly*, a very complete physical examination ought to be made of the maternal organs, and especially of the abdominal viscera; *fifthly*, the fœtus should be fully examined by the hands, by the ear, by the cephalometer, by the Röntgen rays, and by any other means of exact research that may yet be invented; and, *finally*, the maternal urine and blood should be subjected to chemical and microscopical investigation, as it is beginning to be realised that the condition of the fœtus in utero is to some extent reflected in the composition and characters of the maternal excretions. The rest of this chapter will be devoted to the consideration of some of the diagnostic possibilities suggested by these lines of research.

Maternal Medical History.

The investigation of the clinical history of the mother of a still-born or dead-born or diseased or deformed infant must, in the first place, deal with certain purely medical questions. The bearing of these questions upon antenatal morbid processes may not, in the meantime, be very evident; but it is of importance in a subject of such complexity that all available information should be secured, and in other branches of medical diagnosis the physician is every day learning that details, at one time considered of no value in the etiology of maladies, sometimes take on a sudden and preponderating importance—for example, the pre-cancerous phenomena. Reference is now made to the medical conditions of the mother existing prior to and apart from her sexual and obstetrical history, and the question that has to be solved is whether there are maternal medical states which predispose to, or at any rate precede, the morbid occurrences of reproductive life. Are there any facts which shall enable us to predict that in a given case the future will show either morbiparity or monstriparity or mortinatality? Can, in other words, a typical past medical history be looked for in the mother who gives birth to diseased, deformed, or dead infants? *A priori* it may be expected that women who have had a healthy childhood and girlhood, who have suffered not at all or but slightly from the maladies of early life, who show no signs of rickets or of congenital syphilis or of anæmia, and who are not the victims of evident cardiac, pulmonary, hepatic, renal, or nervous disorders, will give birth to healthy infants. On the other hand, it may be expected that women with a past medical history the very reverse of the foregoing will produce off-spring dead, or dying, or diseased, or deformed. Now, it is not difficult to find cases which apparently contradict or disappoint these expectations, for perfectly healthy mothers who have not suffered from severe illnesses in early life give birth occasionally to deformed offspring, and delicate and diseased mothers sometimes astonish every one by bringing forth strong and well-formed infants; but such instances do not altogether prove that the past medical history of the mother is of no importance as a premonition of future reproductive irregularities; they simply remind the investigator that there is a second factor to be taken into account—the state of health of the father. But, even admitting the occurrence of contradictions to the expectation that a woman who has been previously healthy in other ways will be healthy also in the matter of reproduction, the past maternal medical history ought to be inquired into. I have been struck on several occasions by the frequency with which women who have had disastrous obstetrical histories have also suffered previously from neuroses of various kinds, from tubercle, from alcoholism, from syphilis, from kidney trouble, from rheumatism and gout. It does not necessarily follow that these medical conditions of the mother prior to her pregnancy have so altered the ova in her ovaries as to make them incapable of healthy development, nor does it even prove that her whole system has been so altered as to be

unable to react in a healthy fashion on the contents of her uterus. It may be taken as supporting the idea that both the morbiparity and the bad medical history of the mother are results of a common cause; that they are both hereditarily transmitted to her; and this is, I think, the more correct way of looking at the question. Further, it gains support from the fact that the degenerative conditions, such as nervous diseases, insanity, arthritic developments, some neoplasms, tuberculous predisposition, and the tendency to take alcohol and other toxic agents to excess, are apparently governed by the same laws as to transmission, etc., as preside over malformations, morbiparity, mortinatality, pluriparity, abortions, congenital debility, and the other numerous phenomena of antenatal pathology. They show family prevalence very markedly, and they exhibit the form of heredity which has been called dissimilar. This association between the insanities, the nervous diseases, the arthritisms, the tumours, and the morbid phenomena of antenatal life has been strongly insisted upon by Féré in his most suggestive work, *La Famille Névropathique*, to which reference has already been made more than once in these pages.

It will, therefore, be of the greatest importance for the progress of antenatal pathology for observers to investigate the medical history of the morbiparous and monstriparous mothers along the lines which have been suggested. So far as my own observations have proceeded, they tend to show the existence in the mothers of congenitally malformed or diseased infants of more than the ordinary amount of manifestation of nervous disease and even of insanity, of arthritic manifestations, and of tubercle, and syphilis, and alcoholism. It must be repeated, however, that it by no means follows that all these medical states are the causes of the morbid phenomena of antenatal life. Some of them may be so; but others will be the associated manifestations of a common cause or causes which appear most evidently in the form of impaired nutrition of the tissues. Nevertheless their presence has a diagnostic value if it can be fully established that they are met with more often in women who give birth to dead or still-born infants, to diseased or malformed fœtuses, to twins, or to congenitally weak children.

Maternal Reproductive History.

The mother's previous reproductive history is of much more immediate value in the diagnosis of antenatal morbid states than is her purely medical record. Here the phenomena are closely associated; they are to a certain extent manifestations of the activity, physiological or pathological, of the same organs. There is a close connection between menstruation and ovulation and pregnancy; and there is a very close connection between successive pregnancies; for although it may not be correct to say "*ab uno disce omnes*," yet there can be no doubt that the occurrence of one abnormal gestation greatly increases the chances of the supervention of others. The inquiry into the maternal reproductive history may be made along the following lines:—

1. *The menstrual habit and type* ought to be ascertained, and any abnormal conditions, such as excessive or diminished flow, pain, etc., noted, for from such information something may be learned of the state of the genital organs and their fitness for the discharge of the reproductive functions. It will be of special importance to elicit the presence of symptoms pointing to the existence of endometritis, for it is well known that a diseased uterine mucous membrane predisposes to various forms of antenatal deviation from the normal.

2. *The condition of the mother as to marriage* must be inquired into. It will be well to ascertain whether she married at a very early age or late in life, for in neither of these circumstances are her pregnancies likely to be normal. Further, the fact that she has married a relative such as a cousin, and much more an uncle, must be referred to, for although the marriage of first cousins need not of itself lead to abnormal developments during pregnancy unless the heredity and individual health on both sides be bad, yet the fact is of importance; and certainly the marriage of relatives nearer than cousins—for example, uncle and niece, aunt and nephew, would seem to produce pathological results.

3. *The history of the previous pregnancies* of the patient may yield information of the very greatest value in the making of a diagnosis. As case after case of antenatal disease or disorder has come under my notice, I have been more and more impressed by the tendency of abnormalities in pregnancy to repeat. I do not mean that a given fœtal disease or embyronic monstrosity will occur several times in succession in the uterus of the same patient, although that also has been observed, and I have myself noted its occurrence in fœtal dropsy, in anencephaly, in polydactyly, in tylosis palmæ et plantæ, in absence of the radius, etc.; but I refer rather to the very commonly noted fact that pregnancies that are pathological—although not pathological in the same way—are almost certain to be associated. Over and over again there is the history of abortions, fœtal death, fœtal disease, still-birth, congenital debility, twins, hydramnios, malformations, and possibly also monstrosities, in the same mother, who may on this account be called morbiparous. Necessarily, these phenomena do not often all occur in one patient's history, but the appearance of any one of them ought to prepare us for the possible supervention of any other of them in a future pregnancy. Further, other pathological events of rarer occurrence might be added to the list, such as the hydatid mole and extrauterine and extra-amniotic pregnancy. Yet, again, it is wrong to think that syphilis is the only morbid state that determines this long series of morbid developments. Alcoholism at least does so also, and possibly tuberculosis, lead-poisoning, and other infective and toxic and toxicological states. Syphilis and alcoholism offer a striking contrast, in that, while the antenatal phenomena of the former tend to diminish in virulence as the reproductive history of the woman progresses, those of the latter morbid condition show a marked tendency towards intensification. Enough has been said to show the supreme importance of a knowledge of the mother's previous obstetric history in

forming an estimate of the probable character of the gestations of the future, and it is unnecessary to do more than refer to the diagnostic aid that may be received from the record of previous confinements in which the size of the fœtus or its malformed or diseased state caused delay or danger, or both, or in which it was noted that the placenta or membranes were abnormal in any way. So well recognised is this tendency to repeat in antenatal pathology, that the terms "habitual abortion," "habitual premature labour," and "habitual fœtal death" have, as has been said, been used to express it; but a more correct nomenclature would be "repeating abortion," etc., for the idea of habit is scarcely what is meant; and we ought to look not so much for the repetition of identical morbid phenomena as for the repetition of gestations abnormal in some way, but not necessarily in the same way.

Paternal Medical and Reproductive History.

In most records of fœtal disease and monstrosity, little is found stated with regard to the health of the father. This is unfortunate, for it seems to be probable that paternal morbid states acting through the spermatozoa are potent in inducing antenatal pathological conditions. It is a striking comment upon this line of inquiry, that cases have been reported in which women have given birth to healthy infants by one husband and to diseased offspring by a second consort. I have myself seen several cases in which I believe I was justified in tracing to the father the origin of the antenatal malady or deformity of the infant; further, the condition of the father was not invariably syphilitic, although it is true that more is known of the paternal factor in syphilis than in any other morbid state which is capable of transmission to the fœtus. It is, therefore, necessary to take note of the age of the father when he begets his child, of his age in relation to that of his wife, of his habits especially in respect to alcohol, of his state of development, and of certain diseases, such as syphilis, nephritis, diabetes, cancer, tubercle, malaria, lead-poisoning, mental disorder, etc., from which he may be suffering or have suffered, for there is good reason to believe that any of these pathological states may have a direct and injurious effect upon the offspring engendered by him. It may also be that the morbid paternal influence is transmitted directly to the fœtus without the mother suffering from it save secondarily through the fœtus; this is believed in respect to syphilis (*vide* p. 249), and there is some evidence that it holds also for malaria (*vide* p. 203), and probably for other diseases. The influence of paternal alcoholism has not yet been fully worked out; but one of the striking results obtained from Sullivan's contribution, already referred to, was that total abstinence on the part of the father did little, if anything, to improve the prospects of the unborn infant so long as there was still maternal alcoholism.

Family Medical History.

In forming a diagnosis of antenatal morbid states, the observer cannot afford to neglect the family medical and obstetrical history, for such conditions are not infrequently hereditary. The heredity, further, may not always be of the same kind. Direct and similar heredity is sometimes met with, and when it occurs it is so striking that it seldom passes unnoted; thus, in the case recorded by the late Dr. G. Elder and myself, tylosis palmæ et plantæ had been handed down from mother to daughter and then to granddaughter and great-granddaughter with such regularity, that it was expected and looked for at once when a female infant was born into the family (*vide* p. 318). The same thing has been noticed in anomalies of the fingers and toes, and especially in polydactyly, in congenital cataract, in retinitis pigmentosa, in hare-lip, in cleft palate, in fistulæ of the lower lip, in nævi materni, in microphthalmus, in aural fistulæ, and in a very large number of other anomalies and congenital diseases. In other phenomena of antenatal pathology the same tendency is evident. I have, for instance, given striking statistics illustrating the heredity of twin-bearing and of large families (96), and the heredity of triplets has also been established by various records. The following case I cite from the contribution made to the Edinburgh Obstetrical Society to which I have just referred. Mrs. I. was one of a family of seventeen children, and one of her sisters has had twins, while another sister has had triplets. She herself has had twenty-two children in eighteen confinements, four times twins and fourteen single births. The first confinement produced a boy dead-born; the second, twin boys at the sixth month, both dead; the third, a boy, dead-born; the fourth, a girl, who lived six weeks; the fifth, a boy at the eighth month, who died in ten days from umbilical hæmorrhage; the sixth, a boy and girl at the sixth month, dead-born; the seventh, a boy, dead-born; the eighth, a boy, still alive; the ninth, a boy, died in sixteen days from umbilical hæmorrhage; the tenth, a girl, still living, aged ten years; the eleventh, a girl at full term, died shortly from convulsions; the twelfth, a boy, who died at the age of one year from wasting; the thirteenth, a boy, who died at six weeks from wasting; the fourteenth, a girl, who died at eighteen months from whooping cough; the fifteenth, a boy, still living; the sixteenth, twin boys at the sixth month, one of whom alone survived his birth, and that only for twenty-four hours; the seventeenth, twins, a boy and girl, of whom the girl soon died from wasting; and the eighteenth, a boy, who died at the age of six weeks.

Of course, teratological states which are incompatible with extra-uterine life cannot be transmitted by direct and similar heredity; but dissimilar heredity may and does occur, and occasionally a parent with a minor malformation which permits the continuance of prolonged postnatal life, procreates a fœtus with a monstrous condition which renders it quite non-viable. I have elsewhere (117) referred to a woman with malformed thumbs, the daughter of a woman similarly deformed, who gave birth to infants with anencephaly,

hydrocephaly, and absence of radius and thumbs, a case in which there was both similar and dissimilar heredity. Dissimilar heredity also is very common in antenatal pathology, and in estimating its presence it is necessary constantly to bear in mind that the phenomena of antenatal pathology are not confined to one group of conditions such as malformations or fœtal diseases, but include also abortions, twin births, mortinatality, congenital debility, extrauterine pregnancy, and placental and membranous abnormalities. It has sometimes been said paradoxically that sterility is hereditary, and the statement is true if it be meant that a woman or a man in whose ascendants (for example, in aunts or uncles) sterility has been common, will also run a great risk of being sterile.

In the family history of morbiparous and monstriparous mothers, it is not uncommon to find a morbid predisposition to various diseases developed postnatally, but in all probability present potentially before birth; in this group the neuroses find a prominent place, as do also susceptibilities to be acted on abnormally by such toxic agencies as alcohol, morphine, and tobacco.

Maternal Symptomatology.

In making an antenatal diagnosis of morbid intrauterine conditions, the closest scrutiny must be given to all the details of the pregnancy. It ought to be our object to elicit from the mother all that she can remember of her symptoms during both the early and the later months of her gestation; too often we repress such information, partly because we do not wish to make the patient nervous about herself, and partly because we do not desire to hear long tales about maternal impressions. Therein doubtless we err; for although the mother's speculations regarding her sensations may be worthless, and worse than worthless, for the formation of a diagnosis, the same cannot be said of the definite information she gives as to the occurrence of her sensations. Her theoretical opinions may be of no value, but her statement of facts is of great importance; we must, therefore, endeavour to direct her flow of information along the line of facts, and not in the current of theories.

In the first place, we inquire into the symptomatology of pregnancy itself, for it is not altogether a truism that before we can diagnose an abnormal pregnancy we must diagnose that there is a pregnancy. Further, the very ease with which we recognise that there is the normal symptomatology of gestation, is indirect evidence that intrauterine affairs are progressing in a natural way; for it is the abnormal gestation that is difficult to separate from conditions which are not connected with the presence of a fœtus in utero. The very fact that the diagnosis of pregnancy is not easily made, is presumptive evidence that there is an abnormal pregnancy. If, then, it be found that in the history of the case the symptoms upon which we rely in diagnosis, such as suppression of the menses, morning sickness, frequency of micturition, quickening, mammary fulness, nervous phenomena of a reflex type, abdominal enlargement, etc.,

show deviations which make us doubt the existence of pregnancy, we may almost unconsciously have made the first step in the diagnosis of a case of antenatal morbid change. The patient herself will often sum up the symptomatology for us in the remark that she does not feel in this pregnancy as she did in previous ones; that, in fact, she doubts if she is really "in the family way" at all. By this she generally means that one or several of the symptoms upon which she has learned to rely for the detection of pregnancy have deviated so much from the usual, that her opinion has been shaken, while the presence of other of these symptoms in a natural way has prevented her altogether abandoning the notion that she is pregnant.

Some of the symptomatological deviations which are met with may be referred to. There is, for instance, the occurrence of more or less regular and more or less sanguinolent discharges from the vagina—the persistence of menstruation in an erratic form. In the early months this may indicate a threatened abortion or a hydatid mole, and in the later months it may point to a low implantation of the placenta, or to premature separation of the afterbirth. It may also point to the existence of an antenatal morbid condition of the uterus itself, such as a bicornate or septate organ, or to the presence of a tubal or tubo-abdominal pregnancy. Along with these hæmorrhages, however, there is a continuance of the other phenomena of pregnancy, and the patient becomes alarmed about her dubious condition.

It may be stated generally that we do not yet know the exact significance of irregular menstrual discharges during pregnancy, and the same remark applies with still greater force to the occurrence of hydrorrhœa gravidarum. P. C. T. van der Hoeven (*Monatsschr. f. Geburtsh. u. Gynäk.*, x. 329, 1899) has given details of three cases of hydrorrhœa in pregnancy, in all of which the infants were born alive and healthy, but premature, and from the chemical and microscopical examination of the fluid it did not appear that it was either liquor amnii or a transudation through the membranes from the liquor amnii. J. A. Macdougall in 1885 gave details of seven cases of marked hydrorrhœa gravidarum, and I note that in at least five of them the fœtus was small, puny, and poorly developed (*Edinb. Med. Journ.*, xxx. 691, 1885).

Again, the patient may complain of deviations from the normal in the symptomatology of quickening. The fœtal movements may have been felt very early or unusually late in pregnancy, or they may have been very strong or very weak, or they may have been very frequent or have occurred only at long intervals, or, finally, they may have shown different deviations at different epochs in the gestation. Sometimes fœtal death has been indicated by unusual activity of the fœtal movements, followed by complete cessation of them. In cases of maternal malaria, the mother has occasionally described attacks of fœtal quivering and shaking either synchronous with the ague fits in herself, or occurring at other but at regular times (*vide* p. 202); it has been concluded that there was fœtal malaria, but not always of the same type as the maternal. Fœtal movements of a kind very different from the normal have been

described under the name of fœtal singultus. The details of a case of this sort were communicated to me some time ago by my friend Dr. T. B. Darling. It was that of a woman, 29 years of age, a 4-para, who had in each of her four pregnancies, and always about the seventh month, suffered from convulsive movements of the fœtus which were quite unlike the usual "kicking" sensations. They were regarded by her as due to hiccough of the unborn infant, and they occurred most markedly at night. Her belief received considerable support from the fact that all her infants suffered from hiccough for a few days after birth, and that the movements were very similar. It is interesting to note that in the first two pregnancies the vertex presented in the L.O.P. position, that is, with the fœtal abdomen anterior; in the third and fourth gestations, however, the position was the R.O.A. It has recently been affirmed that these peculiar movements are not very rare, although it is likely that they are not often so marked as to attract special attention from the mother; but this point will be referred to again under the head of the physical examination of the abdomen in pregnancy.

The symptomatology of morbid pregnancy has also to do with abnormalities in the degree and rate of abdominal enlargement, in the mammary sensations, and in morning sickness, dysuria, headache, neuralgia, etc. The patient may, for instance, assert that she is larger or smaller than she ought to be for the supposed date of pregnancy, circumstances which may, on the one hand, indicate hydramnios, hydatid mole, twins, a dropsical fœtus, a double monster; and, on the other hand, oligohydramnion, poorly developed fœtus or monstrosity by defect, such as anencephaly. Of course, it may mean nothing more than that she has made an error in her estimate of the age of her pregnancy. Again, she may state that she has a sensation of weight or of coldness in the lower part of the abdomen, that the abdominal enlargement has ceased to grow, that the breasts have stopped swelling, and that certain neuralgias or other reflex phenomena which she has come to associate with the continuance of gestation, have ceased; and from these symptoms she may draw the conclusions that the fœtus in utero has died, and it may very well be that she is quite right (*vide* p. 416).

In the second place, we must inquire into the symptoms which have been present in pregnancy which have nothing to do with pregnancy as pregnancy. For instance, she may have suffered from an infectious fever, and have had its typical symptoms, or she may simply have been exposed to the infection without herself showing its manifestations. It does not, of course, follow that the diagnosis of fœtal infection can be certainly made under such circumstances; but it makes it a probability, and it ought also to make the observer think of fœtal death, of premature labour, and of congenital weakness, or other indication of toxinic poisoning of the unborn infant. Further, there is evidence that an infectious condition in the mother may be connected with an apparently entirely different morbid state in the fœtus, as in Bidone's case of erysipelas in the mother with streptococcic endocarditis in the fœtus (*vide* p. 198), or in Moncorvo's

record of repeated lymphangitis in the mother as the result of traumatism, with infection and congenital elephantiasis in the infant (*vide* p. 302). Although apparently unconnected, the fœtal state may nevertheless be the result of the maternal infection, for allowances must be made for differences in environment and in physiology. Reference may here be made to the occurrence of traumatism in pregnancy; this should always be noted, for it may have a direct bearing upon fœtal injuries, death, and even deformities. Here also it may be well that maternal impressions be recorded, and their nature and the date of gestation at which they took place noted, if for no other purpose than to disprove the efficacy of these impressions in the production of monstrosities. Further, the fact that the mother during her pregnancy has had for any reason to take powerful or poisonous drugs ought to be referred to in the formation of a diagnosis of fœtal disease or death; the toxicology of intrauterine life is a large and as yet almost unworked field (*vide* p. 258). The commencement or continuance of habits of intemperance during the gestation must be noted; and, finally, the supervention of symptoms of disorder in any of the great systems, such as the circulatory, respiratory, digestive, urinary, cutaneous, or nervous, must not be passed over, for such may throw light, often quite unexpectedly, upon morbid intrauterine states.

It may be that in this enumeration of the symptoms of morbid gestation I have referred to conditions which have little apparent diagnostic value, but the antenatal pathologist is not yet in a position to say what is and what is not of importance in this matter. It is only by the careful recording of all such circumstances that he can ever hope to build up a system of fœtal symptomatology. If the truth be told, it is not excess of zeal in recording the phenomena of morbid pregnancies that is to be deplored or feared, but the reverse.

Maternal Physical Examination.

After the history and symptomatology of the pregnancy have been ascertained, it will be necessary to proceed to an exhaustive physical examination of the maternal and fœtal organisms, and in the case of the mother it will be important to examine not only the reproductive organs, but also the other bodily systems.

1. Physical examination of the maternal circulatory, respiratory, and other systems (except the reproductive). The discovery of a serious diseased condition of any of the maternal systems does not, of course, enable the observer to declare that the fœtus is suffering in the same organ, and in the same way. Antenatal diagnosis is not so easy as that. At the same time, it makes it possible, and with some maladies even probable, that the fœtus is affected with the same pathological change as the mother, and it nearly always enables the observer to predict that the infant unborn is suffering in some way or other, and that the pregnancy will be in some way or other abnormal. The structures in the uterus do not reflect, as in a mirror, the state of the maternal organs;

but it is doubtful whether there can be anything far wrong with the mother's economy without the fœtus or embryo suffering in one way or another, and it occasionally happens that it suffers in the same way. For instance, the discovery of grave maternal cardiac disease (namely, a state of mitral incompetence and stenosis of recent origin and without compensation) will be an undoubted warning that abortion, or premature labour, or fœtal death may be looked for; and it may, especially when the maternal valvular lesions can be traced to acute rheumatism, mean that the infant will be born with a malformed heart, and possibly with a murmur caused thereby. Again, the existence of pulmonary tuberculosis does not often carry with it phthisis of the fœtus, or even evident tuberculous changes in any of the organs or in the placenta; but it may and often does carry with it deviations from the normal progress of gestation, such as premature delivery, and the infant may, as has been pointed out by Hanot and others, show malformations—for example, stenosis of the pulmonary artery (*vide* p. 215). Septic pneumonia of the mother may occasionally produce septic pneumonia of the fœtus; it cannot be doubted that it nearly always interferes in some way with the pregnancy which it complicates. Similarly renal mischief in the mother produces changes in the fœtal tissues, which are sometimes localised in the kidneys, but more often are found in the other organs, and very often in the placenta, which is, after all, the kidney of the unborn infant. Marked maternal dropsy often means simply placental lesions and a puny, badly-nourished fœtus; but sometimes the fœtus when born shows general anasarca; out of 36 cases of marked fœtal dropsy there was also maternal dropsy in 16 (*vide* p. 290).

After having examined the maternal circulatory, respiratory, and urinary systems (I omit for the present a reference to the testing of the urine), the observer should turn his attention now to the other systems. The osseous and locomotor structures should be examined, for women with achondroplasia have given birth to achondroplasiac infants; and congenital rheumatism, although rarely recognised, has now and again been noted in the offspring of mothers who have suffered from rheumatic fever in pregnancy. Nervous diseases, in addition to being distinctly hereditary, produce effects in other ways upon the products of conception. Goitre in the mother has sometimes been found in her fœtus, and Demme of Berne found that in 53 cases of congenital goitre 37 had mothers suffering from the same malady (*vide* p. 376).

The physical examination of the mother must include the search for congenital anomalies in herself, such as nævi, minor malformations, and muscular peculiarities, for such are now and again to be expected in her infant. It must include the taking of her temperature and the inspection of the skin, for in nearly all the infectious maladies, such as smallpox, scarlet fever, typhoid, measles, varicella, and erysipelas, the possibility, and indeed the strong probability, is that there is a transmission of the morbid agency through the placenta to the fœtus, with results which may not always exactly resemble those existing in the mother, but which are, nevertheless, due to

them. Jaundice in mother and fœtus has been noted, so has hæmorrhagic purpura, so has epidemic cerebro-spinal meningitis. Even if the fœtus escape the disease in its ordinary manifestations, it may fall a victim to the increased maternal temperature; or the toxins arriving in the placenta may cause disease of that structure, or may pass on to the fœtus and cause pathological changes in it.

There is another aspect to this subject. It is possible, and indeed probable, that morbid states in the fœtus may cause changes in the maternal organs which are capable of being recognised by the observer. Fœtal death, for instance, may be followed by the disappearance of varicose veins, by shrinking of the thyroid enlargement, and by a freer condition of respiration; when the fœtal death is accompanied by putrefactive changes in utero, maternal vomiting, hectic, high temperature, and other signs of blood-poisoning will occur. It is also very probable that a diseased fœtus may react upon the maternal system; but this is a matter upon which we have little information, and the cases which might teach us something about it—such as instances of fœtal smallpox in an immune mother—are very rarely noted. At the same time, there is reason to believe that a high temperature in the fœtus, with excess of waste products passing to the placenta, and so into the mother's system, may sometimes determine eclampsia, or albuminuria at least.

2. Physical examination of the maternal reproductive system. It goes almost without saying that in diagnosing intrauterine conditions it must be from the examination of the uterus and its contents that the facts of the greatest value will be obtained. The examination of the maternal organs of generation now falls to be considered.

The inspection and palpation of the mammary glands may reveal retrogressive changes which point to fœtal death; so may the fading of the purple discoloration of the vulva and vagina. The inspection of the abdomen may show at a glance that it is larger or smaller than the calculated age of the pregnancy warrants it being, and this observation may be corrected and confirmed by careful mensuration. Periodic mensurations may show that the abdomen is not enlarging in a steady fashion, or is not enlarging at all. Palpation may discover a uterus more cystic in feeling than is normal in gestation, a circumstance which will suggest hydramnios, or may, indeed, cast grave doubts upon the existence of pregnancy at all. Here it may again be said that when we are in doubt about the existence of pregnancy, it will be well for us to suspect the existence of an abnormal pregnancy. Percussion of the abdomen may serve to mark out more clearly the uterine outlines and to eliminate pseudocyesis from the diagnostic possibilities; and auscultation may make known irregularities of the uterine *souffle*, pointing to anomalies in the growth of the uterus.

Physical Examination of the Fœtus in Utero.

The physical examination of the unborn infant can hardly be separated from that of the mother's uterus and vagina, either in

theory or practice. As a matter of fact, the two procedures are carried on simultaneously.

Abdominal inspection can scarcely do more than suggest that the fœtus is very large or very small, or not alone in utero; abdominal palpation, on the other hand, may be made a diagnostic means of the greatest importance and value. Nowadays, when so much stress is laid upon the recognition of presentations and positions by abdominal without vaginal manipulation, it must follow that obstetricians will feel better able to appreciate deviations from the normal in the size and form of the fœtus. Further, the widening of practice in the sphere of abdominal surgery must have given most of us a more distinctly erudite touch than we ever possessed before. It is largely, I believe, want of utilisation of our powers in this respect that has interfered with the more frequent making of an antenatal diagnosis. Let us examine the abdomen of the gravid woman with the same care that we would employ if we were anticipating the performance of an ovariotomy or a hysterectomy. Further, let us not forget to use both hands, either both outside the abdomen, or one outside and the other inside the vagina, in order to get the help which the bimanual method always gives. Anæsthesia may yield as valuable results in the examination of the fœtus in utero as in any other department of medical practice; and there are some emergencies in antenatal pathology which fully justify us in putting the mother under chloroform.

By abdominal palpation, either with or without anæsthesia, it may be possible to make out the irregular fœtal outlines and the indistinct crepitus associated by Negri (*Ann. di ostet. e ginec.*, v. 82, 1883; vii. 223, 1885) with fœtal death, to diagnose provisionally that there are twins in utero or a double monstrosity, to ascertain the presence of excess or of scantiness of liquor amnii, and possibly also to hazard the speculation that the fœtus is small, or large, or grossly malformed. Peculiarities in the fœtal movements, such as their great strength, or frequency, or character (for example, singultus), may be detected by the hands, and the difficulty or ease with which *ballottement* can be elicited has a diagnostic value. In cases of hydramnios, where it is usually very difficult to palpate the fœtus, and where it is particularly important to be able to do so, it has been recommended to put the patient in the genu-pectoral position, so as to allow the fœtus to gravitate towards the abdominal part of the uterus, where it can be better felt; but care must be taken that the mother does not faint or have very grave dyspnœa during the process, and I fancy the same result in aiding palpation will be obtained by putting the patient on the side or in the semi-prone position. An unusually cystic feeling in uterus, with the existence of the other symptoms and signs of pregnancy, ought to make the observer suspect hydramnios, and along with it a monstrous condition of the uterine contents or the presence of twins; for if there is one fact in antenatal pathology that is well established, it is the association of teratological conditions, twinning, and hydramnios. The scarcity of the liquor amnii is also a sign of intrauterine morbid changes, especially of

multiple malformations, congenital dislocations, fractures, and ankyloses. Doubtless in the future the palpation of the fœtus in utero will be much more widely practised than it has been in the past.

Auscultation of the abdomen to detect the presence of the fœtal heart is a common, indeed a constant, practice with the careful obstetrician, but there seems to be no doubt that the observant ear ought to be able to make out more from this method of investigation than the diagnosis of pregnancy. Some years ago, a colleague showed me some daily estimations of the fœtal heart-rate taken by himself in the case of his pregnant wife; he had made them with the hope of arriving at a conclusion regarding the sex of his unborn child, and his method had been to make dots with a pencil on paper as he listened over the abdomen with the stethoscope for a period of half a minute or a minute, as determined for him by the patient. The procedure was a little difficult, but it struck me at the time that it had possibilities in it which could scarcely be overestimated; it might, for instance, be valuable in giving warning both of disease and of impending death in the fœtus, and it might be used as a clinical means of determining what drugs, when given to the mother, passed through the placenta and produced a pharmacological effect upon the infant in utero. In a recent case of pregnancy which was under my charge during 1899, I was impressed by the fact that the mother, a primipara, who had not been strong during girlhood (threatened hip-joint disease), during the latter half of gestation rapidly put on flesh and weight; synchronous with this improvement in the maternal condition, there was a marked slackening in the growth of the fœtus and a weakening and slowing of the fœtal heart, with an almost entire absence of fœtal movements; it seemed, to put it into ordinary language, as if the mother were being nourished at the expense of the offspring. At any rate, I diagnosed a small infant with very little liquor amnii and possible placental changes. The event proved me to be right, for the infant—a male—was puny and had a senile appearance, was brought through the first weeks of life only with the greatest care; and the placenta was small, of the marginate variety, and diseased; there was scarcely any liquor amnii.

The character of the fœtal heart sounds may also give diagnostic indications, and the number of cases in which fœtal heart disease or malformation was found out before birth is every year being added to. Within the past few years, Bellot, Padgett, Nazaroff, and Hall have all diagnosed fœtal heart murmurs, and confirmed the diagnosis after the infant was born (*vide* p. 372). Hall in his communication gave details of cases by Barth, Hennig, and Christopher; in the example reported by himself, the lesion seemed to have been a roughening of the lining membrane of the ductus arteriosus, for the murmur which affected the first sound disappeared ten days after birth. It has been affirmed by Giglio (*Ann. di ostet. e ginec.*, xix. 333, 1897) that the presence of an anencephalic fœtus in utero may be suspected from the weak, uncertain, distant, and frequent beat of the heart, characters which may be due to the absence of cerebral and spinal centres having to do with the innervation of the heart. In

such cases, and on account of the above-named peculiarities of the fœtal heart-beat, it is often supposed to be absent unless very carefully listened for; this apparent absence, when associated with active fœtal movements (and with signs of hydramnios), may point, therefore, to anencephaly.

The absence of the fœtal heart sounds, especially in a case where they have been previously well heard, and in which their disappearance has been preceded by a slowing of them, points strongly to fœtal death; but it must always be remembered that absence of the fœtal heart is a negative sign, and therefore never of the same diagnostic importance as, for instance, presence of it is in the estimation of pregnancy and fœtal life (*vide* p. 417).

Other sounds in utero detected by the stethoscope have been referred to by authors. Thus bubbling sounds due to intrauterine decomposition, and alterations in the uterine or placental souffle have been described in cases of fœtal death; but their diagnostic value is most problematical. It seems, however, that the early fœtal movements may be heard even before they are felt.

Mensuration of the fœtus in utero is a well-known means of forming an idea of the age of the pregnancy, especially in connection with the induction of premature labour; but it is a method which seems to have been little, if at all, employed in the diagnosis of anomalies in the size and form of the unborn. It may be carried out with the aid of a pair of callipers, or, better, with the special modification of them known as the cephalometer of Budin and Perret (*L'Obstétrique*, iv. 542, 1899); by means of this instrument, which I have employed by preference, certain of the fœtal cranial diameters have been determined with a degree of error rarely amounting to more than 5 mm. There is no reason why this instrument should not be used for the detection of abnormalities in head and body measurements.

The graphic representation of the fœtal movements is another way in which mechanical methods may be made to help the obstretrician in his attempt to find out the state of the unborn infant. Fœtal movements are chiefly of four kinds: revolutionary; extensions and flexions of the limbs; extension and flexion of the spine, especially of the cervical part of it; and rhythmical movements of the trunk, and particularly of the thorax, which have been ascribed to fœtal singultus, to swallowing, and to intrauterine respiration (*vide* p. 169). These movements, as also the fœtal heart-beat, may be represented as tracings by the ordinary, although slightly modified, apparatus known as the cardiograph. Pestalozza, in a case of twins, succeeded in getting a tracing of the fœtal heart, but the conditions were peculiarly favourable, and not likely soon to occur again (*vide* p. 137). Ferroni, however, has shown that it is quite feasible to get good tracings of the two kinds of rhythmical movements which have been ascribed to fœtal singultus and to respiration, the former being abrupt, with an apex, and of a rate of from fifteen to thirty-four per minute, the latter being undulatory, without interruptions, and at a rate of from forty to seventy per minute (*vide* p. 144). Ferroni also got fœtal tracings in a case of maternal typhoid and in another

of malaria. There is some justification for the hope and expectation that ere long this method of investigation of the infant in utero may be expanded and made of use. When it is borne in mind how much we can learn from the movements and attitude of the new-born and young infant, there is surely reason for trying to learn something about these same movements and attitude in the fœtus. It is a fact, but not perhaps a recognised fact, that the symptoms and signs of disease in the fœtus will more closely resemble those of the infant than those of the adult or child.

Skiagraphy will no doubt also play a part, perhaps not an unimportant part, in the antenatal diagnosis of the future, but in the meantime the results obtained by Varnier (*Ann. de gynéc.*, li. 278, 1899) have been exceedingly unsatisfactory as regards the fœtus. For this failure various reasons are forthcoming. Among these may be named the deep shadow thrown by the mother's pelvis and spinal column, the imperfectly ossified fœtal skeleton, the thickness of the maternal structures, the impossibility of getting the sensitive plate in the same relation to the abdominal and pelvic part of the pregnant uterus, and perhaps the respiratory maternal and the irregular fœtal movements. To meet some of these difficulties, Varnier has proposed to take a skiagram with the patient in the lateral and another with her in the ventral posture, but he has not overcome the technical obstacles in the way.

There is yet another means of diagnosis of fœtal conditions which has scarcely at all been employed, and which might yet be made use of. I mean the detection of changes in the chemical composition of the maternal excretions (*vide* p. 418), and in the microscopical appearances of the blood. Progress in this direction is in the meantime hindered by the fact that so little is definitely known about the physiological chemistry of pregnancy, and still less about its pathological chemistry. What a wide field of research, and not difficult research, there lies open in connection with such questions as the occurrence of albuminuria, of peptonuria, of acetonuria, of glycosuria, of hæmoglobinuria, and of urobilinuria in pregnancy. Some of these changes in the urine have been supposed to indicate the occurrence of fœtal death, but none of them can as yet be regarded as an infallible test, and in one case at least—namely, in albuminuria—the disappearance of the morbid product, and not its appearance, may point to fœtal death. Further, we know little of the effect of illness (short of death) of the fœtus upon the maternal excretions and blood. There are many problems. Why, for instance, should the ingestion of from 60 to 120 grms. of glucose by the pregnant woman produce alimentary glycosuria, while the non-pregnant woman requires to take from 140 to 180 grms. to bring about the same effect? Why should the toxicity of the maternal urine diminish during pregnancy? Why should Bunge's law (the ashes of the fœtus closely resemble the ashes of the milk of the mother animal) not apply to the human fœtus and mother's milk? Whatever the answers to these and to other problems may be, there can be little doubt that

from the chemical side will yet come diagnostic aids of no small importance.

Intranatal Diagnosis.

Even when labour has commenced, and is in progress, it is of importance to diagnose morbid states in the fœtus on its way through the maternal passages. It may be all-important to recognise, for instance, causes of delay in labour due to enlargement of the fœtal body or head, so that they may be dealt with ere the delay has become a danger; it may be well for the peace of mind of the obstetrician that the diagnosis of the presentation be made, and it will be an advantage for him to be able to forewarn at least the relatives of the mother of the arrival of a monstrosity or a dead fœtus, for it will at any rate save him from some of the reproach associated with the unexpected appearance of such an unwelcome little stranger.

The symptomatology of the labour must, therefore, be taken into account, and deviations from the normal noted, such as excess of liquor amnii, or dryness of the labour, the absence of fœtal movements, and the like. Again, the most careful abdominal and vaginal examinations must be made. It will now be more easy to palpate the fœtus through the abdominal walls, for the liquor amnii will, in part at least, have drained away, and the vaginal palpation will be facilitated by the opening up of the os and the exposure of the presenting part. It may be taken as a common occurrence for the malformed part of a monstrous fœtus to present at the os uteri—for example, the intestinal coils in exomphalos and the basis cranii in anencephaly. If the *tactus eruditus* fail to make out the presentation with ease, the erudite mind ought to think of a monstrosity. It is a good plan for the obstetrician, when he gets a chance, to palpate the deformed part of a malformed fœtus, so that he may recognise it again if he feels it coming down the birth canal. The escape of meconium-stained liquor generally, but not always, forewarns of fœtal death; the feeling of the hydrocephalic head is characteristic, islands of bone in a sea of membrane; and the introduction of the hand well into the passages ought to detect the coming down of a distended fœtal abdomen (as in ascites), or the presence in utero of united twins. An interesting case of hydrocephalus, with intestinal atresia diagnosed during labour, was put on record by Salus (*Prag. med. Wchnschr.*, xxi. 529, 1896); it was that of a breech presentation, in which delay occurred after the birth of the body from the large size of the head; whilst the trunk was thus protruding from the maternal parts, meconium of an earthy colour and devoid of bile was passed from the anus, and it was concluded that there existed an imperforate condition of the bowel in some part of its extent; the conclusion was confirmed after birth by post-mortem examination. Fœtal ichthyosis may also be recognised during labour. The presence of a hairy mole on the shoulder in, say, a transverse presentation, might prove misleading to a man who thought that hair only grew on the fœtal scalp. There are many other matters which might be

referred to under intranatal diagnosis, such as the detection of fœtal anasarca, or of fœtal rickets, from the inspection and palpation of a limb or limbs lying in the vagina, or the feeling of the bones of the cranium of a dead fœtus; but enough has been said to show the possibilities.

Postnatal Diagnosis.

After the morbid or dead fœtus is born, the necessity for the formation of a diagnosis does not disappear; for, if the infant be dead, it will be essential to discover the cause, so as to take measures to prevent its recurrence in a future pregnancy; and if it be diseased or malformed, it will be needful to make a diagnosis in order to institute the proper treatment. Now, however, the diagnosis will not differ in its details from that carried out by the pediatric or general physician, and it will have lost much of its difficulty. The disease or the deformity may be external, and need little more than recognition; on the other hand, it may be internal, for example, congenital heart disease or pyloric stenosis or diaphragmatic hernia, and necessitate the most careful application of all our diagnostic methods. Finally, the placenta and membranes and cord ought always to be scrutinised, and, when possible, submitted to microscopical and bacteriological examination.

I may summarise this long description of diagnostic methods and means in a case-taking scheme, which differs only in some details from one published in 1892 (53).

I. Antenatal.
- 1. Clinical History.
  - *A.* Maternal.
    - (1) General Medical.
    - (2) Reproductive.
  - *B.* Paternal.
  - *C.* Family.
- 2. Symptomatology.
- 3. Physical Examination.
  - *A.* Maternal.
    - (1) Circulatory, Respiratory, and other Systems.
    - (2) Reproductive System.
  - *B.* Fœtal.
    - (1) Abdominal Palpation and Auscultation.
    - (2) Mensuration by Cephalometer, Callipers, etc.
    - (3) Skiagraphy.
  - *C.* Chemical and Microscopical Examination of Excretions and Secretions.

II. Intranatal.

III. Postnatal.

CHAPTER XXVI

Therapeutics of Fœtal Diseases: Erroneous Opinions; Value of Fœtal Life, Estimation, Appreciation; Therapeutic Fœticide; Possibilities of Antenatal Therapeutics; Postnatal Treatment of Antenatal Morbid States; Intranatal Hygiene and Treatment.

THE goal of the medical man's ambition, and the limits of his usefulness to his patient, are not reached when the diagnosis of the malady from which the latter is suffering has been made. The most exact diagnosis is unsatisfactory if unaccompanied by effective treatment. The end and aim of all medical practice is prevention; and, failing that, cure; and, failing that, amelioration. A manual of Antenatal Pathology which contained no reference to antenatal hygiene and treatment might be of great scientific value, but it would lack practical interest. It is the treatment of antenatal morbid states, rather it is the hygiene of antenatal life, that is in the mind of the inquirer into the phenomena of antenatal disease and death as he prosecutes his research. He knows by this time enough of the subject to expect little; but he has hope, even although it be feebly nourished. Let us see whether his confidence is in any degree justified.

The medical profession stands upon the threshold of antenatal therapeutics. It has been standing there so long that even the unbiassed onlooker must have begun to wonder when it intended to enter in, whether, indeed, it did not mean to turn away again from the open portal. Not but that there has been some entering in, of a retiring kind, unobtrusive, stealthy, passing unobserved by the spectator who is growing weary of watching. High time is it that an estimate be formed of the probabilities and possibilities of antenatal therapeutics. Even if the possibilities turn out to be small, vanishing almost, it will yet be better to know than to remain ignorant. *Omne ignotum pro magnifico* will not serve as a cloak; for the unbiassed onlooker (already referred to) is hardly prepared to admit the existence of an *omne, notum* or *ignotum*. It is, of course, everywhere admitted that much may be done after labour, even in labour, to cure or at least to ameliorate morbid states arising during antenatal life; but this is not usually regarded as antenatal therapeutics in the strict sense of the term. It may be claimed, however, that it is an integral part of the subject, and I look upon the claim as one that must be yielded. In this way the field is greatly widened; and the subject at once becomes one of great practical importance. Even in that part which deals with the treatment of the fœtus still in utero (and which is regarded by many as constituting the whole of antenatal therapeutics), it will be found that advances have been

made and victories won. The subject is not so hopeless, although neglected, as is generally supposed.

Erroneous Opinions on Antenatal Therapeutics.

During the last few years I have been honoured by inquiries from members of the profession as to individual problems in antenatal therapeutics, and by suggestions as to the extension of our therapeutic resources in dealing with morbid states during fœtal life. A consideration of these suggestions and inquiries has led me to believe that many medical men hold erroneous views as to the necessity of treating the unborn child, and that some are inclined to institute unfair comparisons between this and other departments of therapeutics.

In the *first* place, let me again state that the possibility of influencing morbid states that affect the infant while in utero does not cease with its birth. Many malformations produced antenatally can, of course, be corrected postnatally, and some congenital diseases can be alleviated, if not cured, by therapeutic measures instituted after birth. The treatment of antenatal morbid conditions is not, therefore, exclusively antenatal; it may be, in part, postnatal, and its effects must of necessity be largely postnatal in their manifestation.

In the *second* place, it may be pointed out that most physicians, if they think about it at all, compare the therapeutics of the diseases of the fœtus with the treatment of disorders of the adult, doubtless much to the prejudice of the former. They contrast the many medicines which can be administered to the more or less willing adult, with very definite result, with the very few drugs which can be given, with almost unknown results, to the fœtus in utero (always presupposing that its passive resistance to being drugged at all can be overcome,—that, in other words, the placental barriers can be passed). But in so arguing they are not acting quite fairly. Why should comparison be made between the therapeutics of the fœtus and that of the adult? We do not contrast the therapeutics of the new-born infant with that of the adult, but with that of the infant and child. Let us, therefore, contrast antenatal therapeutics with neonatal therapeutics. I think I am right in supposing that few medical men commonly administer more than two or three drugs to the new-born infant; that few feel altogether at home in its management, medicinal or otherwise; and that few can boast of brilliant results and assured triumphs in the domain of neonatal therapeutics. In comparing neonatal with antenatal therapeutics, we compare similar things; the one is divided from the other, it is true, by that epoch-making occurrence, birth, yet they are in many respects similar. A little reflection will make it clear that, after all, antenatal therapeutics in its scope and utility is little, if at all, behind neonatal therapeutics. Let us see.

Few drugs are needed by, or commonly administered to, the new-born child, and even those are of doubtful utility: castor-oil to do

what the colostrum does equally well or better, and dill water to undo the evil effects of unnecessarily filling the infant's stomach with sugar and water. The first draught of the mother's milk thoroughly clears the bowel of meconium. The infant does not come into the world in a state of starvation; his tissues are not crying out for pabulum; it is doubtful if, after birth, he ever again receives so full, complete, and well-adapted a meal as is provided for him while still in utero; he requires nothing more for eight hours after birth, by which time the mother's breast begins to supply his wants. Some physicians add hydrargyrum cum cretâ to the drugs given to the new-born, presumably on the principle that mercury for infants is certain to do good, and cannot, at any rate, do harm; but is it not somewhat of a reflection upon every one concerned, that it should be deemed necessary to start every child upon his postnatal career with the specific for syphilis, always supposing that he is free from that disease? The most rational plan of giving medicines to the new-born infant is through the mother's milk or by inunction through the skin, which at this time of life absorbs freely; but not many new-born infants require drugs at all. Now, the same general principles apply to antenatal therapeutics. The unborn, like the new-born, infant requires drugs seldom, and he can best receive them through the mother, *i.e.*, through the placenta, which, after all, is in its fœtal part an extension of the fœtal skin, or ectoderm. In this way arsenic and mercury, and doubtless many other remedies, may be administered. As has been shown, there is much ignorance as to the conditions which favour or obstruct the passage of these drugs to and from the fœtus; but all is not by any means known regarding the transmission of medicines through the milk.

In the *third* place, it is an error (although not so common an error as it once was) to think only of medicinal treatment. There are other means of influencing beneficially the maladies of all periods of life. In this respect, also, neonatal and antenatal therapeutics may be compared. When an infant is born into the world in a weak, puny, or delicate state, or when it develops weakness or illness soon after birth, the best line of treatment will often consist in attempting to return it to its antenatal surroundings, in re-establishing the *status quo ante partum.* In its most complete development this attempt finds expression and visible embodiment in the *couveuse*, or incubator, which has become so important an addition to the therapeutic armamentarium of the maternity hospital. The treatment of the new-born is then environmental rather than medicinal; so, I maintain, should be the treatment of the unborn. The fœtus, when healthy, requires no external help, and, when ill, no more than is given to the ailing new-born infant by the pediatric or obstetric physician. Indeed, it requires considerably less, for Nature has already carried out a large part of the treatment by providing the best possible *couveuse;* for a fluid medium of constant temperature is better than an atmospheric one, even when artificially warmed and carefully sterilised. When an adult is ill, we order him to keep his bed in a room of even temperature; when a fœtus is ill, we are glad

to know that he is, so to say, keeping his room. We are embarrassed only if he leave it, for to be prematurely born is a serious matter for a diseased fœtus; and if this should happen, all we can do is to provide another "room," which very imperfectly resembles the uterus, namely, the incubator. But it may be asked, Can we in any way aid in keeping the fœtus in utero? I think we can. We can keep down the maternal temperature and prevent a sudden rise, which would loosen the intrauterine connections; we can assist the mother's excretory organs (skin, kidneys, intestine) to act vigorously, and throw off the effete products which pass in large quantity into the maternal from the fœtal economy, for maternal toxæmia will tend to set up uterine action and bring on labour; and, finally, we can do something towards maintaining the structural and functional integrity of the placenta, for chlorate of potash would seem to act as a placental tonic. How it acts, whether on the placenta directly, or indirectly by keeping the maternal blood in good condition, does not so much matter; in my experience and in that of others it prolongs intrauterine life, it maintains the placental functions, and so saves the fœtus from the dangers of premature exposure to an extrauterine environment.

In the *fourth* place, it has been often supposed that the causes of antenatal morbid states were special, peculiar, and indeed unknown in their nature, and that therefore the treatment must be also quite peculiar or perhaps nil. *Therapia nulla* has been too quickly written as an epitaph over antenatal therapeutics. There is good reason to believe that the same causes are at work in the antenatal as in the postnatal period of life. The reader will have learned from the preceding pages that the agencies which, when acting upon infantile and adult organisms, produce pathogenic and toxic effects, are those which lead to pathogenic and toxic effects when acting upon the fœtus. Further, in the part of this work which is to deal with the morbid states of the embryo and germ, it will be shown that probably these same causes are again in action in producing malformations and monstrosities. The results of their action are very various—sterility, single and double monstrosities, abortions, still-births, mortinatality, twinning, fœtal disease, many tumours, congenital debility, and tendencies dissolving heredity and leading to the later development of tubercle, rheumatism, gout, and many neuropathic disorders—these, and not fœtal diseases and deformities only, are the protean phenomena of Antenatal Pathology. So there is good reason to believe that the morbid causes also are not one but many, and that all the toxic and pathogenic agents whose action in postnatal life is known, may act before birth upon the developing organism. In this way the poisons, such as alcohol, lead, morphine, nicotine, and the rest, and the microbes and their toxins, such as those of tubercle and the exanthemata, and to some extent traumatism, enter into the arena of antenatal etiology, and have to be taken into account in the investigation of every instance of Antenatal Pathology. So far as has been discovered, one and the same morbid cause may produce in one instance a fœtal disease, in another an embryonic monstrosity, and in

another a tendency to the breaking of normal heredity in the development of a proneness to certain maladies of body and mind in later life. Yet again, this same cause may produce sterility, embryonic or fœtal death, possibly twinning, and certainly abortion and premature labour. In syphilis and tubercle and alcoholism are to be found three morbid causes which may produce the protean effects which have been enumerated. Further, similar effects may be produced by different causes, the results depending apparently not so much upon the nature of the morbid agent, as upon the time of its action and the condition of the organism acted upon. It is quite likely that if it were possible to reduce these morbid actions to their ultimate factor, it would be found to be the common one of interference with nutrition, and probably chemical in its nature.

If these views, then, be correct, it follows that the medicines and plans of treatment which are applicable in postnatal life may, with certain restrictions, prove useful in antenatal life also. If the phenomena of Antenatal Pathology are not due to some occult and mysterious special cause, then their prevention, or even their cure, may be less hopelessly looked for in the therapeutic measures which are known.

Having considered these erroneous ideas regarding the treatment of antenatal morbid states, we are now, I think, better able to approach that great problem, and are less likely to be either disappointed or startled with the results. There is, however, yet one other preliminary matter to be discussed before we can take up in detail the possibilities of antenatal therapeutics; I refer to the value of fœtal life.

The Value of Fœtal Life.

Closely bound up with the problem of the value of fœtal life is the question of the amount of fœtal death. What is the antenatal death-roll? No estimate has ever been formed of the loss of life which takes place immediately after birth as the direct result of birth, during birth from the traumatism of labour, in the fœtal period, in the embryonic epoch, and during germinal life. Mortality tables tell something of the frequency of death during the first months of life, obstetricians know something of the many times that they have to deal with premature labours, still-births, and abortions; but I doubt whether the most pessimistic has an adequate conception of the loss of life in the earlier periods of antenatal existence. Even if we neglect all deaths occurring before the second month of intrauterine life, the result is nevertheless appalling. The frequency of abortions has been regarded by Tarnier and Budin (*Traité de l'art des accouchements*, ii. 474, 1886) as something like one to every three or four pregnancies; since abortions are equivalent to fœtal deaths (in their ultimate results), this means that the fœtus, at the beginning of the fœtal period of intrauterine life, has a 25 per cent. or a 20 per cent. risk of never reaching the time of viability.

In maternity hospital practice, premature births occur to the extent of about 16 per cent. (C. Hahn, *Des prématurés*, p. 46, Paris,

1901), if we regard all the infants weighing less than 2500 grms. as prematurely born; but if 3000 grms. be taken as indicating prematurity, then the percentage rises to 41·5. For practical purposes, the frequency of premature labours in maternity hospitals may be put at 20 per cent.; but, of course, this does not enable us to estimate the percentage in general obstetric practice. Further, premature birth does not necessarily mean fœtal death; some prematurely-born infants are dead when born, and some die very soon afterwards, but a certain number survive. The number of the survivors will vary with the age in fœtal life arrived at when birth took place, with the means employed to keep the infant alive, with the season of the year, etc. The variation will be within wide limits; it is not difficult to find statistics of mortality among premature infants showing any percentage between 90 and 10. It is true that recent reports show a most gratifying fall to little more than a 6·5 per cent. mortality (C. Maygrier, *L'Obstétrique*, vi. 497, 1901); but if a wide view be taken, it is probable that 50 per cent. or 40 per cent. must still be regarded as not uncommon. Perhaps, then, it may be said that if a fœtus reach a viable age, and is then born before the full term, he will have a 30 or 40 per cent. risk of early postnatal death. Of course, it must be added that some fœtuses go to the full term, and are then born dead; they are not nearly so numerous, but statistics are difficult to obtain, for some of the deaths are no doubt due to obstetric difficulties, and not to truly antenatal causes. It will be seen, from what has been stated, that it is very difficult to obtain any idea of the fœtal death-rate, for it is almost impossible to exclude the intranatal deaths due to purely intranatal causes, and it is far from easy to estimate the mortality due to premature labours and abortions. One conclusion may perhaps be safely drawn: through improved obstetric methods, and the elaboration of the means for keeping premature infants in life, and possibly also by the amelioration of the condition of the pregnant woman-worker, the fœtal death-rate is perceptibly less than it was, say, fifty years ago. It is very doubtful, however, whether it can be said that this fall in the fœtal death-rate has done anything towards altering the economic value of fœtal life, for, as will now be shown, another and a far more important factor has been at work; I refer to the fall in the birth-rate.

From a strict and rigid utilitarian standpoint, it may not matter much that there is a high fœtal death-rate, so long as there is also a high birth-rate, so long as the population is going up by leaps and bounds. But if not, what then? The social economist of the country whose population is stationary or receding will soon be forced to take an interest in the fœtal death-rate; in his mind the value of fœtal life will undergo appreciation. He will, of course, consider first the cause or causes of the diminished birth-rate; if he find that they are removable, he will hope to see them removed by legislation or some other means; but if he find that they are not removable, he will be forced back to the plan of trying to increase the number of living full-time infants born. His idea of the value of fœtal life will have changed. Now, there can be no doubt that in most civilised countries

there is a drop in the birth-rate, neither can there be any doubt that it is due to causes which are practically unremovable. These causes are chiefly the voluntary prevention of conception and the procuring of early abortion in order to prevent large families, and behind these causes lies the "wish for ease and material enjoyment." It is doubtful whether a greater dissemination of educational opportunities among the masses will lessen this tendency; at any rate, there is reason to fear that it will be long before it does so. The fall in the birth-rate in France has been well known for years; but in the United Kingdom we find a still more startling, because more rapid, fall from a birth-rate of 35 per 1000 in 1875 to one of 29 per 1000 in 1900! This means in each year, and with the present population of 41½ millions, a deficiency of a quarter of a million infants. In the face of this deficiency, a slight improvement in the fœtal death-rate is soon counterbalanced. The effect, however, is to increase the value of fœtal life, for if the abortions and premature labours could be diminished, and if the diseases of fœtal life could be prevented or cured, something at least might be accomplished to check the downward trend of the population. There is, of course, no increase in the intrinsic value of the life before birth; it is simply an accidental appreciation.

This appreciation in the value of fœtal life has had an evident effect in another direction; I refer to the question of the relative value of maternal and fœtal life. This question usually arises in connection with the performance of some obstetric operation, such as craniotomy or the induction of abortion or premature labour, in which the life of the fœtus is sacrificed or put into jeopardy on behalf of the mother. Under the title of "Mother *versus* Child," Dr. S. Macvie of Chirnside (*Trans. Edinb. Obst. Soc.*, xxiv. 123, 1899) dealt with this matter in the form in which he met it, namely, inoperable rectal cancer in a woman pregnant at the sixth month; he had to decide whether to induce abortion at the sixth month or premature labour at the seventh, or do Cæsarean section at the full time; and, in attempting to decide the line of procedure, he found himself face to face with the problem of the relative value of the life of a mother with inoperable cancer of the rectum, and that of an unborn infant at the sixth month of intrauterine life. Which was the more valuable life? He was still deliberating upon this matter when circumstances arose (increase in the mother's sufferings, blocking of the rectum, risks of performing Cæsarean section in the country) which led him to induce premature labour; the child was born alive and lived five weeks, and the mother recovered from the effects of the labour, and was able for some time to attend to her household duties. The problem in this case was a very involved one. It usually arises in a simpler form in the choice of the alternative operations in cases of contracted pelvis; but Macvie's attempt to arrive at a solution of the problem is so ingenious and interesting, that it must be considered more in detail.

If we consider the question of life-expectancy, it would seem that at twenty years of age that of the mother is barely equal to that of

her new-born infant, and at every subsequent pregnancy it is less. Therefore, if at every birth after twenty years of age the life-expectancy is taken as the measure of value, the new-born child is the more valuable life. The general practice, however, is to regard the mother's life as the more valuable, although her life-expectancy may be less than that of her child. "It is not difficult," writes Macvie, "to find ethical justification for the practice. Life-expectancy tables are misleading indices of life values, unless the duration of the expectancy covers the same series of years. If two lives have an expectancy of twenty years each, reaching from twenty to forty, they may safely be said to be of equal value. Each individual would have the same time in which to discharge the obligations of life. The lives of mother and child do not give such synchronous parallelism, and a life-expectancy of equal duration might give widely unequal life values. For example, if a child's life-expectancy covered the first ten years, and the mother's reached from twenty to thirty years, there would be no hesitation in giving to the mother's the higher value. The difficulty lies in determining the figure with which to multiply it. . . . Ethically regarded, the value of life consists in the discharge of subjective and altruistic obligations, instinctive or volitional, as the case may be, and with such opportunity or capacity as the individual possesses. To this may be added the due performance of procreative functions from which the life acquires a racial in addition to an ethical value. In other words, life value is composed of three elements, personal, social, and racial. At certain periods of life the discharge of these obligations is an impossibility, and at such periods life has either not acquired or has lost its highest value. For example, the fœtus in utero is a parasite performing no function whatever." [This is not quite correct, for there can be no doubt that its life reacts upon the maternal life in an obscure, even in a mysterious fashion, either as a stimulus to a high degree of physiological activity or as a cause of disease; but the point need not be insisted upon, and Dr. Macvie's line of argument need not be broken.] "Its existence involves a physiological loss to the maternal organism. Unlike an arm or a spleen, it performs no duty in return for its sustenance. Its actual value could only be expressed by a minus quantity. Its potential value is equal to its extrauterine life-expectancy. If that is, by reason of dangers ahead, reduced to a life-expectancy minimum, its potential value may never be realised. The new-born child is still parasitic, though detached; and, though it inhales its own oxygen, is still a physiological loss to the maternal organism. The *actual* value is still a minus quantity, but it has begun to realise its potentiality by satisfying the parental instinct, and contributing to the subjective element of life. The mother, on the other hand, has realised the potentialities of life. Value after value has been added to her existence as consciousness, self-consciousness, and volition developed. The later-added procreative function has given it a racial value. In the discharge of her manifold functions, she, living less to herself than any other being, attains a higher self-sacrificial value. She is directly and indirectly contributory to the

life of her children, and her own life, to be accurately estimated, must be multiplied by some fractional sum of theirs. Thus, while child-life in its partially developed stages must be represented by a varying fraction, the maternal life must be represented by an integer raised to an nth power equivalent to her manifold functions. Therefore, unless the life-expectancy of the child covers the years in which its potentiality is converted into actuality, the relative values of the maternal and fœtal life will be that of actual as against potential."

From all this, and from much more of a like inconclusive, perhaps even inconsequent, kind, it may be gathered that we cannot estimate the actual or the relative value of fœtal life. The mother's life has a value because she is what she is; the fœtal life has a value on account of what it may become. We are not able for want of data to calculate life-expectancy at either the third or the seventh month of intrauterine existence, much less at earlier dates. During the last fifty years there has probably been a slight increase in the chances of a fœtus surviving till the full term; but against this has to be put the fact that apparently parents have decided that there are to be fewer fœtuses to enjoy this enhanced chance of life. Proletaneous parents are to be rare. When the birth-rate begins to go down, the value, economic as well as sentimental, of the unborn infant begins to go up. This, at least, is undoubted.

A very practical question meanwhile awaits an answer. Be the value of fœtal life what it may be, has any one the power to ordain that a fœtus shall die? In whose hands, if in any one's, is the jus vitæ neci que? Pinard (*Ann. de gynéc*, li. 1, 1899; lii. 81, 1899; liii. 1, 1900), discusses this matter very seriously, and in view of the various fœticidal operations still in use it requires serious discussion. Pinard puts to himself the following question: "A woman in labour cannot be delivered spontaneously on account of contraction of the pelvis; the fœtus is at full term and alive, the interference that you regard as necessary, indispensable, and indicated, is forbidden to you by the patient herself or by her relatives; another means of treatment is proposed to you, and it implies the death of the infant: under these circumstances, what are you to do?" Pinard examines in turn the paternal right to decree the death of the offspring, the maternal right to demand the same thing, the power that the medical attendant has during a confinement to decide whether the infant shall live or die, and the right of any one else (*e.g.* the managers of a maternity hospital) to interfere in the matter. The conclusion would seem legitimately to be that the right of life or death over the infant belongs to no one, neither to the father nor to the mother, nor to the medical attendant, nor even to the directors of the hospital. The infant's right to his life is an imprescriptible and sacred right which no power can take from him. The right of choosing the operation to be employed belongs to the medical attendant, and his duty is to both his patients, to child as well as to mother. If it seem to be advantageous for the mother, embryotomy or embryulcia may be performed upon the *dead* fœtus; but if the unborn infant be still alive, the logical and the moral conclusion is that its birth be

effected without deliberately killing it. "Sacrifier l'enfant pour sauver la mère est une légende qui doit disparaitre" (C. Zalackas, *Progrès méd.*, 3 s., xiii. 421, 1901). But if the mother forbid the special operation needed, what then? The obstetrician is hardly ready with an answer yet. Fortunately many things are contributing to make the abolition of craniotomy upon the living fœtus possible: the great fall in the mortality from Cæsarean section at the full time, the introduction of symphysiotomy, the improvement of the forceps, the development of the means for keeping in life the prematurely born infant; these and other advances in the obstetric art are having a manifest influence upon professional opinion in this matter. As to therapeutic fœticide, or the induction of labour before the fœtus has arrived at a viable age, it is possible for some doubt to arise, when it seems certain that the mother if undelivered will die, and if delivered will live. The thinking obstetrician awaits with impatience the discovery of some alternative means of dealing with such conditions. Let him, as he thinks, repeat to himself the legal maxim, "Qui in utero est, pro jam nato habetur," and extend its application to matters other than the succession to estates. Surely it will yet be found possible to deal with hyperemesis in pregnancy in some other way than by terminating pregnancy before the seventh month, and so sacrificing the product of conception.

Possibilities of Antenatal Therapeutics.

In many respects the field of research which has been designated Antenatal Pathology resembles a battlefield, rather perhaps a whole campaign. It is indeed a field thickly strewn with the dead, the dying, the wounded, the maimed; for it is not only antenatal death that has to be taken into account, we have to think of the antenatally wounded, crippled, and diseased. Now, in such a campaign, it will be evident that the individual may require medical treatment after the battle, during the campaign, or before the war. For the wounded from the battle the Army Medical Department provides the ambulance corps, the field hospital, and the base hospital; but it does more, it endeavours to keep the troops healthy and in a healthy environment during the campaign, and by means of a good water supply and suitable food sends them into the fight fit to bear the strain to which they will assuredly be subjected. Yet more, before the campaign is begun, the medical inspection of recruits is the subject of great care, and only such are selected as give promise of strong and healthy development; and, when selected, these are still further trained until they become almost perfect fighting machines. Like all comparisons, this one may be pushed too far; but it may be said generally that the postnatal treatment of morbid states arising during birth, or before birth, corresponds to the field and base hospitals, being mainly reparative and palliative; that intranatal therapeutics and the treatment of the fœtus and embryo may be likened to the care of the soldier during the battle and in the whole campaign, being mainly preventive; and that germinal

therapeutics resembles in its possibilities the work of the recruiting sergeant and the drill instructor, being mainly selective and preparatory. The watchwords, then, in both cases, must be repair, prevent, prepare, and select with care. Here we have chiefly to do with the treatment of fœtal maladies during the fœtal period, but some reference must also be made to treatment during the later and earlier periods.

Postnatal Treatment of Antenatal Morbid States.

It may be thought to be almost a work of supererogation to enter into details regarding what may be done, after the birth of the infant, to remedy the ills with which it comes burdened into its extrauterine existence, but it is doubtful whether the medical profession realises how much may be done, and is done, in this direction. Few indeed are the malformations which are compatible with the life of the individual that have not now come under the sway of the surgeon, and there are several instances in which his skill has made anomalies that were formerly regarded as certainly lethal no longer so. Now, the malformations and monstrosities are not, strictly speaking, fœtal in origin, but the opportunity of treating them comes at the same time, namely, at birth; they are, therefore, referred to here, although their fuller consideration will be found in the part of the work which deals with Teratology. Less immediate and striking beneficial results have followed the ministrations of the physician and obstetrician; but here also noteworthy advances have to be reported.

As has been said, it is in the domain of surgery that the postnatal treatment of antenatal morbid states has secured its most noteworthy triumphs. Club-foot, cleft palate, hare-lip, phimosis, imperforate hymen and anus, congenital dislocation of hip, shoulder, and knee, torticollis, spina bifida, congenital fistulæ, cysts and tumours of various regions, umbilical and other herniæ, extroversion of the bladder, atresia of urethra, vulva, or vagina, epispadias, hypospadias, non-descent of the testicle, vulvar anus, supernumerary digits, syndactyly, congenital absence of tibia, fibula, and radius, and many other conditions quite as markedly antenatal in origin, are every day taxing the ingenuity of the surgeon. In the repair of some of these deformities surgery has been quite successful; in others, such as ectopia vesicæ, congenital dislocations, and absence of fibula or radius, only a moderate degree of success has been registered. Even in the latter, however, there has been progress; attempts to close the bladder in extroversion of that organ have been abandoned for the implantation of the ureters into the rectum, and that in its turn seems likely to give way before the implantation of them into the dorsum penis; the so-called bloodless methods of reducing congenital dislocation of the hip appear to be gaining ground, as compared with the various cutting operations, and so also with other deformities and their treatment. Further, it cannot be doubted that new triumphs await the orthopædic surgeon in the dealing with such conditions as meningocele, encephalocele, parasitic or attached fœtuses and united twins

(Chapot-Prévost, *Chirurgie des Térátopages*, Paris, 1901). Scarcely any serious attempts have yet been made to correct the internal malformations; and the reparative surgery of congenital diaphragmatic hernia, of kidney in the pelvis, of intestinal and œsophageal atresia, and the like, has to be elaborated.

The results obtained by the physician in his treatment of antenatal morbid states, although less brilliant than those of the surgeon, have been sufficiently good to encourage further efforts. It is unnecessary to do more than refer to the beneficial effects of medicinal treatment of the manifestations of congenital syphilis; and the value of thyroid feeding in cretinism and infantilism is well known. It must, however, be confessed that little success has as yet attended the medical treatment of the congenital skin diseases; and ichthyosis, tylosis, sclerema, hypertrichosis, hypotrichosis, nævus neuroticus, and congenital elephantiasis must still be looked upon as nearly intractable. The ordinary form of jaundice of the new-born yields readily to treatment of the simplest kind, but the grave form does not yield at all. Umbilical hæmorrhage usually requires surgical interference, and that of a very active kind, to control it; congenital heart disease handicaps the individual for life, and congenital dropsical states are rarely amenable to the drugs of the physician. There are, however, hopeful signs in connection with congenital hypertrophy of the pylorus, fœtal endocarditis, fœtal goitre, etc.

On the other hand, wonderful results have been obtained in the branch of medical practice that deals with congenital defects and diseases of the nervous system. Witness the effect of medically regulated educational training upon the congenitally blind, or deaf and dumb, or idiotic. The combination of medical supervision with educative methods has almost made the blind to see, the deaf to hear, the dumb to speak, and the idiot to understand. This is no random statement, for every one knows what the congenitally blind, deaf, or dumb can accomplish, notwithstanding his infirmity. With regard to idiocy, the following sentence contains a report of the results of twenty years' work in its alleviation (Shuttleworth in Hack Tuke's *Dict. Psycholog. Med.*, ii. 675, 1892). "Of patients discharged after full treatment, 10 per cent. are self-supporting, whilst another 10 per cent. would be so if they had obtained suitable situations, and about 20 per cent. were reported as useful to their friends at home."

In one direction, however, the treatment of idiocy has not been altogether encouraging. I refer to craniectomy for the microcephalic form of it. The operation is not uncommonly followed by evident and immediate improvement, which continues up to a certain point, and then all that has been gained is too often steadily lost. The reason probably is that in primitive microcephaly the arrest in brain development has occurred before the fourth month of intrauterine life, and that, therefore, the division of the cranial vault does not reach the root of the mischief; it is not the cranium but the brain that is at fault. In cases developed later, the operation is theoretically more hopeful. In this relation it may not be out of place to refer to the treatment of cranial depressions in the new-born

by trephining. Sometimes the natural resiliency of the bones alone, or aided by manipulation (Munro Kerr, *Trans. Edinb. Obst. Soc.*, xxvi. 42, 1901), restores the normal form of the head, and obviates symptoms; but this good result does not always follow. In a case, of which Dr. D. D. Jennings (*Trans. Edinb. Obst. Soc.*, xix. 105, 1894) kindly sent me the notes, the use of forceps had produced a distinct depression of the left frontal bone; pneumatic suction was first tried, and that failing, the trephine was employed and the bone elevated; the child made an uneventful recovery. It seems to me that this mode of treating congenital depressions and fractures of the cranium might be extended with advantage.

Part of the postnatal treatment of antenatal morbid states falls into the hands of the obstetrician. He it is who has to deal with apnœa neonatorum; and it will be well if he give heed to the causes of this morbid state, for it is very certain that all instances of still-birth are not due to one cause, and are not, therefore, all amenable to the same treatment. The obstetrician ought to scrutinise each case, endeavour to ascertain the special cause, and treat accordingly. It also falls within the province of obstetrics to examine the new-born for fractures, dislocations, and imperforations, and to remedy them as far as may be. I need not refer to the incubator and the wet-nurse in the rearing of premature infants; but it may be necessary to supply to the milk certain minerals (*e.g.* iron) which the fœtus gets through the placenta in the last two months of intrauterine life.

Intranatal Hygiene and Treatment.

Intranatal treatment, under which I include the management of the infant during labour, both in the uterus and in the vagina, is entirely in the hands of the obstetrician. It is mainly preventive in character. In discussing the intranatal factor in neonatal pathology (*vide* pp. 44–56), I pointed out some of the risks run by the infant on his way through the birth canals. There is, for instance, the danger of septic or gonorrhœal or syphilitic infection affecting the eyes or mouth or lungs; this danger may be almost entirely averted by the prophylactic vaginal douche during labour, and by the cleansing of not only the eyes, but also the nose and mouth of the child immediately after birth. Prophylactic douching in labour for the sake of the infant is a procedure the full value of which has not, I think, been fully appreciated as yet. The introduction of air into the uterus in some cases of labour (breech presentations, prolapse of cord) to obviate asphyxia has been recommended, but it is of doubtful value (Rapin, *Ann. de gynéc.*, lii. 326, 1899). Again, the obstetrician has it in his power to prevent tetanus neonatorum by the application of surgical cleanliness to the dressing of the umbilical cord, and by the same means it may be confidently anticipated that erysipelas neonatorum and omphalitis with defective closure of the umbilical ring will be banished from practice. Porak (*Ann. de gynéc.*, lii. 122, 1899) has proposed crushing of the umbilical cord (omphalotripsy) with a special kind of forceps (omphalotribe) instead of the ordinary ligature

and section; and it must be admitted that the present mode of allowing the gelatinous stump of the cord to separate by mummification does not seem to fulfil the requirements of aseptic surgery. The rational treatment of the physiological flow of milk from the breasts of the new-born will prevent many of the cases of mammary abscess due to the mistaken notion in midwives' minds of the necessity of "breaking the breast strings." The almost complete banishment of ergot until after the infant is born, has already, doubtless, saved many infantile lives; and the rapid delivery of the second twin is, I believe, a step in the right direction.

Further, every improvement in obstetrical instruments and manipulations is beneficial to the fœtus. The better the forceps, and the more correctly it is applied in the right cases, the greater will be the infant's chance of being born alive and free from intracranial hæmorrhages and facial paralysis; and the more thorough the obstetrician's knowledge of the safe methods of delivery in contracted brims, in face cases, and in head-last labours, the better it will be for the child. It may be suggested, further, that in cases of fluid accumulations in the fœtus, such as hydrocephalus, ascites, and distended bladder, diagnosed in labour, it may be well to aspirate instead of widely incising the affected region of the infant; the tapping of the spinal canal in breech cases with hydrocephalus ought to be kept in mind.

It will not be out of place if I here strongly insist upon the necessity for the registration of still-births that exists in our country. Registration, if it were obligatory, would necessitate necropsy, and necropsy would do much to familiarise the medical practitioner with the appearances of still-born infants, and would be of enormous value in elucidating the causes of intrauterine and intranatal death. Tidy (*Legal Medicine*, ii. 253, 1883), says:

> So notorious is it that a large number of these deaths could be averted, that some legislation is urgently needed, requiring that still-borns, whose bodies weigh, say, not less than 2 lbs. (the average weight about the sixth and seventh months, and at which age children are viable), should not be buried without registration and a medical examination.

Although it may not be well to insist upon it by law, it would also be most beneficial to our treatment of antenatal states if fœtuses of less than six months were also submitted to post-mortem investigation by the medical man in whose practice they occurred.

CHAPTER XXVII

Hygiene and Therapeutics of Fœtal Life: the Hospitalisation of the Pregnant; "Plea for a Pre-Maternity Hospital"; "Sanatoria de grossesse"; Hygiene of Pregnancy; Diet, Occupation, Exercise, Dress, etc.; Medication of the Fœtus, in Syphilis, Placental Disease, Nervous Maladies, Hæmophilia; Transmission of Immunity; Germinal Therapeutics; Conclusion.

Antenatal Hygiene and Treatment.

HITHERTO I have referred simply to the treatment which may be adopted after or during birth to correct or ameliorate the morbid changes which are produced before birth. I have not gone into details, for the measures I have alluded to are all well known or can be learned from text-books of Medicine, Surgery, and Midwifery. I have now, however, to describe antenatal hygiene and treatment in the true and strict sense of the word, I mean the antenatal prevention, cure, or amelioration of morbid states arising in antenatal life. This is a subject which is not found discussed in the ordinary text-books. I have already pointed out some of the erroneous opinions that are held about it, and can therefore proceed at once to set forth what, to my mind at least, can be securely affirmed concerning it.

It is possible to bring hygienic and medicinal influences to bear upon the fœtus while still in utero, but it is absolutely necessary that these shall act first upon the mother; antenatal treatment is primarily maternal; it cannot be otherwise. The fœtus is immediately surrounded by the liquor amnii—its hydrosphere; around that again are the maternal tissues and placenta which together constitute the fœtal biosphere. For any influence to act upon the fœtus, it must influence it through its environment, through its hydrosphere and its biosphere. One can produce an effect upon the unborn infant by altering the condition of its environment or by transmitting medicinal substances to it through its environment. Of these two methods the former is probably the more important; theoretically, it is possible to separate them, but it is doubtful whether in practice this can be done. The first step, therefore, in the direction of successful treatment of the unborn infant must be successful treatment of the pregnant mother. Here, on the very threshold of the subject, we meet with a check; for, when we come to consider it, we realise that about the physiology of pregnancy, and more especially about its pathology, our knowledge is very imperfect. Further, if we set about to try to remedy this defect in our knowledge, we discover that there is no hospital where we can study the normal and pathological

phenomena of pregnancy as we can those of labour or of the puerperium or of the non-pregnant state. It was this reason among others that lead me to publish in the *British Medical Journal* of April 6, 1901, a "Plea for a Pro-Maternity Hospital." As the plea puts forth my views on this matter in a concise fashion, I reproduce it here, simply altering the word "pro-maternity" into "pre-maternity," as being the more correct form.

A Plea for a Pre-Maternity Hospital or Home.

In youth or early manhood one plans enterprises and hopefully embarks upon projects which in old age are put aside as visionary or Utopian; no one blames Youth for so planning and projecting, not even Age. *La jeunesse vit d'espérance, la vieillesse de souvenir.* "Youth lives on hope, and old age on remembrance"; and a reversal of the *rôles* would be unfitting, grotesque even. So in the infancy of the twentieth century it is permissible to suggest schemes which in the old age of the nineteenth might have been characterised as vain or stigmatised as chimerical. The young century is full of hope, and is not ashamed; *la jeunesse vit d'espérance.* The cure of cancer; the prevention of the preventible (but not yet prevented) diseases; the laying of the spectre of morbid heredity; the "suppression of the weeds to give the flowers a chance": these are some of the hopes in the beating heart of the twentieth century, and the faint echoes of "fantastic," "imaginary," "impossible" from the nineteenth do not cause it to beat less high. As the years roll on, it may be necessary to confess to partial failure; it will assuredly be necessary to revise the plans of procedure—it will probably be found, for instance, to be better to try to turn the weeds into flowers rather than to suppress them; but who shall dare, in full remembrance of what has been accomplished in the past century, to set limits to the progress to be achieved in the present?

In the sphere of medicine, one of the most noteworthy and praiseworthy advances of the nineteenth century was the birth and coming of age of scientific gynecology; it is difficult to realise that in 1801 ovariotomy was unknown, and special hospitals for the treatment of gynecological diseases undreamed of, and yet these are solid facts. The advances in the sister subject of obstetrics were also numerous if not so startling; there were improvements in the construction of instruments and in the mode of their use, there was the discovery of the real nature of puerperal fever and of means for preventing it, and there was the growth of correct views as to the management and internal arrangements of the maternity hospital consequent upon the recognition of the value of antisepsis and asepsis. But there was one department of obstetrics in which the same degree of progress could hardly be reported,—that, namely, of the pathology of pregnancy. At the end of the past century obstetricians were still in doubt as to the real nature of eclampsia gravidarum, of hyperemesis gravidarum, of the malignant jaundice of pregnancy, of hydramnios, of hydatid mole, and of most of the idiopathic diseases of the fœtus and of many of the causes of fœtal death; at the best, they were but slowly seeking after the truth, being much hampered by the absence of reliable information concerning the physiology of pregnancy, and more especially the physiological chemistry of pregnancy. The condition of the urine of the pregnant woman, its toxicity, the changes in her blood, the modifications in her nervous system, the state of her thyroid gland, the cause of the physiological vomiting of

pregnancy, the origin of the liquor amnii, the nature of the placental interchanges, the physiology of the fœtus, the inter-relation of the life of the mother and the fœtus,—these and many other matters were imperfectly known or merely guessed at in the nineteenth century. Was it strange or inexplicable that eclampsia and hyperemesis continued to claim their many victims—mothers and fœtuses—and that most obstetricians were in almost complete ignorance as to the state of matters in the gravid uterus, and found it safest to make their diagnosis of the health or disease or deformity of the uterine contents after their expulsion? Of course, the fœtal heart was listened to, and a few conclusions drawn therefrom, and there was a certain degree of accuracy attained in the palpation of fœtal parts; but antenatal diagnosis was far from exact, and it was, indeed, little attempted.

The question may now be fairly asked, if we, in the twentieth century, are going to be contented with the knowledge (or ignorance) of the nineteenth in these matters of the physiology and pathology of pregnancy, with the maintenance of the *status quo ante?* I suppose obstetricians everywhere will agree that no such easy contentment is possible or to be thought of, with the maternal mortality from eclampsia what it is, and with the number of abortions and antenatal deaths and malformations what it is. This being so, the next question is, whether, with the methods and material at our disposal, we are making all the progress that is possible, and whether any further means can be suggested for the perfection of antenatal diagnosis and its certain concomitant, the improvement of antenatal therapeutics? I think it must be admitted that we are not making all possible haste towards the solution of the many problems of prenatal diagnosis and treatment, and I think that there is a means of investigation which has not yet been tried, at least not yet attempted, on a large scale and in a systematised fashion. Herein lies the plea for the pre-maternity hospital.

The pre-maternity hospital need not be a separate establishment; it may quite well be an annexe of the maternity; in time it may come to be of equal size with the maternity, but it must be distinct from the maternity; it will be for the reception of women who are pregnant, but who are not yet in labour. In the first place, doubtless, it will be for the reception of patients who have in past pregnancies suffered from one or other of the many complications of gestation, or in whose present condition some anomaly of the pregnant state has been diagnosed; but in time it may be taken advantage of by more or less normal ambulants, working women for example, who ought to rest during the last weeks of pregnancy, but who are unable from financial reasons to do so, and by the patients who clamour for admittance to our maternities, but who are told to come back again when the "pains have begun." It is worth while for us to realise that practically no provision is made in existing hospitals for pregnant women. In general hospitals, cases of morbid pregnancy (for example, hyperemesis gravidarum) are sometimes received and treated, but mostly under protest, lest there occur a birth in the wards. In maternities, pregnant women are not welcome much before the full term of gestation, for obvious or easily ascertained reasons. Such patients would be received into the pre-maternity; it would be their special hospital. When labour pains came on, they would be transferred to the adjoining maternity, and it would therefore be advisable that the two buildings communicated, by a covered way, for example. A system of linked hospitals!

The idea of a pre-maternity hospital has been forced into my mind by several circumstances during the last few years, but more particularly by

communications which I have received from medical men in various parts of this country and the United States. In these communications the particulars of cases of antenatal disease and deformity were stated, and an opinion asked for with regard to possible plans of treatment. In some I was able to give advice, in others I had to confess that I had little or nothing to propose; but in all I could not help wishing that I knew of a hospital where the case could be placed and scientifically investigated. The first case which powerfully impressed me was one of recurrent abortion, so-called habitual miscarriage, in which there was no evident and sufficient cause for the tendency which the uterus had, on the slightest provocation, or on really no provocation at all, to expel its contents. Had the patient been in circumstances that would have permitted it, I should have recommended her to go into a nursing home for the dangerous period in pregnancy, and not only have treatment with chlorate of potash, but have also her various excretions and functions thoroughly investigated, so as, if possible, to ascertain the cause of the special "uterine irritability." Another patient who might have benefited by such a hospital as I imagine the pre-maternity might be, was the subject of hyperemesis gravidarum, which terminated fatally after twin fœtuses had been expelled from the uterus.

I cannot help thinking that the investigation of such cases in the pre-maternity might lead to the adoption of a more scientific method of management than the artificial induction of abortion, which, of course, entails therapeutic fœticide. In fact, one of the principles of the pre-maternity would be the conservation of fœtal life, although, of course, not at the expense of maternal safety; the result aimed at would be the continuance of the pregnancy with safety to the mother; that would be the ideal. Then there have been several cases of albuminuria in pregnancy, all of which would, I am certain, have been fit and proper patients for the pre-maternity; several of them developed eclampsia, and in one of them albumin appeared in the urine for the first time the night before the convulsions manifested themselves. In a pre-maternity we might be able to study, with scientific exactness, not only the pre-eclamptic but also the pre-albuminuric modifications of the urine, and we might also discover the relationship which exists between the absence of normal thyroid hypertrophy and the presence of albumin in the urine. In one of the cases of eclampsia that I have met with during the last twelve months, the urine kept for nine months without showing any signs of putrefaction, and without giving any positive results on the ordinary culture media; this case would have been a suitable one for such scientific investigation as could have been given to it in a pre-maternity.

The cases to which I have referred were instances of the pathology of pregnancy in which the maternal factor was of primary importance, and in which the treatment aimed at the safety of the mother; but there were others in which it was antenatal therapeutics that came under consideration. There was the case of an alcoholic mother who had given birth to an infant with congenital heart disease (persistence of the patency of the foramen ovale), and who was again pregnant; the obvious treatment was total abstinence from alcohol, a treatment which might have been carried out with some chance of success in a special hospital. There was the hæmophilic mother who had given birth to two hæmophilic male infants, and had suffered from dangerous *post-partum* hæmorrhage on each occasion, and who was given calcium chloride during the last three months of the third pregnancy, in the hope of preventing the *post-partum* bleeding, and perchance of benefiting the fœtus. There was the case of the woman who had given

birth to a series of very large children, dead-born on account of their great size; in the pre-maternity the effect of variations in the maternal diet (as suggested by Prochownick and others) upon the bulk of the fœtus might be carefully tried. The same remark applies to cases of narrow pelvis, in which a small infant might pass safely, while a larger one would have to be sacrificed or be extracted prematurely, or born by the Cæsarean section at term. There was the case of the patient who had in previous pregnancies given birth to imbecile or mentally defective children, and to whom phosphorus was given with the apparent result that the next infant was normal in these respects. Finally, there was the case of the woman, truly a monstripara, who had brought three monstrous fœtuses into the world, and had had several abortions; she was willing to do almost anything that might be recommended, in the hope of having a more satisfactory reproductive record; she would undoubtedly have entered the pre-maternity, even if but little hope of betterment were held out to her.

The number of cases which might be benefited by the systematic and scientific investigation of the bodily functions in pregnancy, might easily be increased; but I have contented myself with a reference to the actual instances which have been brought under my notice recently. I have emphasised the scientific value of such a hospital as the pre-maternity might be; but the more distinctly economic aspects are not to be lost sight of, especially if it be found to be true that working women who are able to rest for the last month or two of pregnancy give birth to larger and more healthy infants. I have not gone into the question of the management of this as yet imaginary hospital, nor into the matter of the medical staff; but from the scientific standpoint there would have to be every appliance for the perfection of antenatal diagnosis (skiagraphy, cephalometry), and one member of the staff would require to be a skilled physiological chemist. That there will be difficulties in the way may be expected; that the idea will be regarded as visionary or chimerical is certain, and will not surprise me, as it has been only by slow degrees that I have come to regard it as anything else. In the meantime, this communication may be looked upon as a "*ballon d'essai*," the whole matter of the pre-maternity being still *in nubibus*.

Since I published the plea for a pre-maternity hospital, I have become still more impressed with the need there is for the hospitalisation of the pregnant woman. The idea of a special hospital attached to each maternity may be chimerical, but there might at least be a ward or some beds set apart for the special treatment of diseases of pregnancy. That this would be beneficial for the maternity hospital itself, I do not doubt. Many of the fatal cases which occur in our maternities at present are due to complications of pregnancy (*e.g.*, eclampsia, albuminuria) which have arisen before the admission of the patients. There can be no doubt, further, that a patient who has passed through a morbid pregnancy will be more liable to a bad labour than one in whom the changes of the wonderful gestation period have been accomplished in a physiological fashion. Even when the pregnancy has been fairly normal, some preparation for the fast approaching labour and puerperium would not be amiss. Pregnancy is a great strain upon the resources, anatomical and physiological, of the body; and labour is the crowning test of a woman's strength; yet in too many cases the parturient patient

comes to the birth with little or no preparation at all. A pre-maternity hospital or a ward in the maternity for the diseases of pregnancy would make it possible for a woman who was ill during gestation to get the best treatment, and so to fall in labour under better conditions than could otherwise have been obtained for her. More would soon be learned regarding both the pathology and the physiology of pregnancy; and a gratifying fall in the mortality lists of the hospital could scarcely fail to follow. The maternity hospital might then hope to attain more nearly to its ideal state, that of a hospital with two patients, mother and infant, to each bed. Sepsis is admittedly one of the great causes of hospital deaths, and it is clear that there would be less risk of it if patients were admitted before the labour was in the second stage, and while, therefore, there was still the opportunity of thoroughly cleansing the genitals.

Since November 1, 1901, through the liberality of an anonymous donor, a bed has been endowed in the Edinburgh Royal Maternity and Simpson Memorial Hospital for the study of the diseases of pregnant women; there have already (December) been in it (under the care of Professor A. R. Simpson and myself) several interesting cases of disease in pregnancy, including one of hydramnios and twins, another of hyperemesis gravidarum with retroflection of the uterus, and another of peculiar convulsions, regarded as of the nature of petit mal, with hysteroid sequelæ. We have been able to analyse the urine in these cases accurately, to take sphygmographic tracings, to count the fœtal heart-beats, to test reflexes, to use the cephalometer, etc., in a way that was before difficult or impossible. I believe the "Hamilton bed," as it has been called, will very soon practically demonstrate its value, if it has not already done so.

At the time when I was writing my plea for a pre-maternity hospital,[1] other obstetricians were approaching the idea of the hospitalisation of pregnant women from other standpoints. Professor J. A. C. Kynoch of Dundee (*Brit. Med. Journ.*, i. for 1901, p. 929) has pointed out that homes for the reception of pregnant women exist in large towns, and it is true that there are such; but they are often of the nature of reformatories or asylums rather than of hospitals in which the medical care of the patients is put first. L. Bouchacourt (*La Grossesse; puériculture intra-utérine*, Paris, 1901) has traced the history of the various establishments in France and Austria for the reception of pregnant women, and has argued strenuously for the creation of numerous "sanatoriums de grossesse." The "Secret Maternity" of Prague seems to have been the first of these "sanatoriums," for it was founded in 1789, but it was very different from what is understood by the "sanatorium de grossesse" of the present day. Into it pregnant women were received on the payment of a fee, and neither their religion nor their social position nor their nationality were inquired into. In Paris, also, there were beds for needy pregnant women in connection with some of the obstetric clinics; but they were too often occupied by strong and

[1] I had previously mooted the subject in a tentative fashion early in 1900 (*Scott. Med. and Surg. Journ.*, vi. 476, 1900).

healthy young women who could render service as cooks and washer-women. In 1885 the "asile de nuit de la rue Saint-Jacques" was increased by the addition of a ward containing sixteen beds for pregnant women, and similar institutions are to be found both in Paris and in other large towns; but they are often of the nature of reformatories or "maisons de correction," and their sanitary condition has seldom given satisfaction. In Paris the first "sanatorium de grossesse," in the proper sense of the word, was not founded till 1892; it was called the "Refuge de l'avenue du Maine," and it received thirty-six pregnant women who required to rest. Since then several other sanatoriums of the same kind have been established ("asile public pour femmes enceintes," "asile maternel," "asile Sainte-Madeleine," etc.). These institutions have done good service, especially in the case of working women, who were thus enabled to rest during the last month of pregnancy; and Pinard (*Ann. de gynéc.*, l. 81, 1898) has shown that the infants of these patients weighed more than those of pregnant women who had to work for their living up to the onset of labour pains. All these facts are very interesting, but in the idea of the pre-maternity hospital I aim at something more than is accomplished by any of these existing institutions. I look forward to a specially set apart hospital for the treatment of diseases of pregnancy, with a medical staff capable of carrying on all kinds of research, and with all the known means of diagnosing and treating both the pregnant woman and her unborn child. I am fully convinced that the only way to establish, on a sure foundation, the preventive treatment of the diseases of pregnancy and of the unborn infant, is by the institution of pre-maternity hospitals or pre-maternity wards in maternity hospitals. Under the title "*la defense de l'enfant*," Ollive and Schmitt (*Gaz. hebd. d. sc. med.*, xxii. 478, 1901) enumerate many ways in which the health of the new-born is to be preserved; among these the pre-maternity hospital must surely find a place. "La defense de l'enfant est à l'ordre du jour," writes Maygrier (*L'Obstétrique*, vi. 481, 1901); but it is necessary to begin with "la defense du fœtus."

Hygiene of Pregnancy.

As has already been pointed out, treatment of the fœtus must be primarily maternal; so, to maintain the hygiene of antenatal life one must maintain the hygiene of pregnancy. This is the true environmental treatment of the unborn infant; this is one aspect of puericulture. Most of the text-books of Obstetrics give a chapter or part of a chapter to the management of pregnancy; but in many of them the advice consists largely in the recommendation that all the laws of health which apply to the non-pregnant condition should be specially enforced in the pregnant state. This is, of course, quite true; but it is too often interpreted by the profession and the public as permission to the pregnant woman to continue disregarding many of the laws of health just as she did when non-pregnant. As I have said already, pregnancy is a severe strain upon the whole system,

and weaknesses which were unrevealed or unnoticed, as a result of hygienic errors prior to gestation, may give rise to grave dangers in pregnancy. For instance, the kidneys may be somewhat diseased, and yet cause the woman no inconvenience; but under the strain of their increased activity in pregnancy, with perhaps the special tax of a full meal of proteids, they may fail, and eclampsia be induced. Constipation, which may apparently cause no ill effects in the non-pregnant state, may set up a toxæmia in pregnancy. The result of all this is that, while we occasionally meet with a normal pregnancy, we too often have sadly to admit that pregnancy frequently is not strictly physiological. It ought to be so, but it is not. That the fœtus suffers no more than it does, is probably due to the wonderful regulating mechanism which tends to counteract errors and to prevent ill effects.

As a matter of fact, the profession does not understand the physiological changes of pregnancy, possibly does not believe in their existence or in their importance. There are, however, popular notions on the subject, and these overshadow the scientific ideas and cover them as with a mantle of fog, through which some few well-ascertained facts loom forth dimly to be discerned. Thus, the popular mind has opinions on diet in pregnancy, on the power of maternal impressions, on exercise, on sea-bathing, etc., and these are often far from correct, but pass as truth because the profession does not very actively contradict them or replace them. Of late, however, there have been some signs of lifting of the fog curtain, and here and there some things are coming into sight, and others are losing that unnatural magnitude which fog-shrouded objects often show. There is a freshening breeze of scientific investigation, and the mists are rolling slowly away. The light that may come from the pre-maternities of the future may wonderfully dissipate these fogs.

Diet in Pregnancy.

Let us take a few examples of these popular beliefs. There is, for instance, the question of diet in pregnancy. The popular advice to the pregnant woman is to eat "enough for two," and, as generally and confidently interpreted, this means to eat double the usual amount; and it may be safely said that, if this injunction be carried out, too much is eaten. Even supposing for a moment that the dietetic difficulties of pregnancy could thus be got over in this arithmetical fashion, to be logical, the popular advice ought to be to eat enough for one and a varying fraction of one, namely, at the mid-term of pregnancy, enough for one and one-hundred-and-twelfth of one. Since, however, most healthy persons habitually eat more than enough for one, it may reasonably be concluded that the pregnant woman who eats heartily consumes quite sufficient food to supply the wants of herself and her fraction. That there is a real and not a visionary danger in the application of such popular advice, is borne out by cases like that reported by Barton Cooke Hirst (*Text-Book of Obstetrics*, p. 189, 1900), in which a woman took two quarts of milk a day between

meals, and was confined (with difficulty) of a child weighing 11¾ lbs.; and by the results of experiments upon the lower animals. D. Noel Paton has found that, in the case of well-fed pregnant guinea-pigs, each grm. of mother's weight produced from 0·4 to 0·35 grm. of young, while in the case of an under-fed animal, each grm. of the mother only produced 0·22 grm. of young.

With regard to the quality of her food, the popular belief as to the pregnant woman is that she must get what she "longs for," otherwise her unborn infant will suffer. Now, it is quite possible that underlying the "longings" of pregnant women for certain articles of food (sometimes neither nutritious nor nice), there is a true physiological need which thus finds expression (a sort of inarticulate crying out of the tissue for acids or alkalies), yet in the great majority of cases no such dietetic necessity lies patent or latent. Further, there is no valid scientific evidence that the refusal of "longed-for" snacks, consisting of peppercorns and raw oatmeal, or other dietetic eccentricities, will result disastrously to the unborn infant (A. Giles, *Trans. Obst. Soc. Lond.*, xxxv. 242, 1893).

Within recent years, signs have not been wanting that popular beliefs as to the quantity and quality of the food of the pregnant woman were to be soon replaced by scientific views. Apparently, many obstetricians are afraid of giving an opinion on such matters; but L. Prochownick of Hamburg (*Centrlbl. f. Gynäk.*, xiii. 577, 1889; *Therap. Monatsh.*, xv., Hft. 8, 9, 1901) and others (H. Florschütz, A. Hoffmann, J. Reijenga, J. Haspels, v. Swiecicki, Josephson, J. F. W. Donath, Hegele, Leusser, G. Beck, F. Horn, E. Fraenkel, E. Preiss, and Meurer) have gone much further, and have modified the diet of pregnant women in such a way as to produce definite effects both upon the mother and the fœtus. Prochownick and his followers believe that by altering the diet in pregnancy it is possible to influence the character of the confinement, of the puerperium, and of lactation, as well as the state of development of the fœtus. Thus, by dieting anæmic, chlorotic, or fat and weak women, it has been found possible to give them more normal obstetric experiences, and to give them back the power (which they had lost) of nursing their infants. But it is specially with the effect of diet upon the fœtus that we are here concerned. In cases of pelvic contraction between 3¼ and 4 inches, Prochownick shows, by a series of forty-eight cases representing sixty-two confinements, that maternal diet can so influence the size, weight, and osseous development of the fœtus, as to make it possible for it to be born normally at the full term, whereas, in previous pregnancies, instrumental means or the induction of premature labour were necessary. The cases included seventeen of Prochownick's own, and thirty-one under the care of Haspels, v. Swiecicki, Reijenga, and the others mentioned above. The recommendation was that the mother take during the last two or three months of her pregnancy the following diet:—For breakfast, a small cup of coffee (100 c.c.), about 25 grms. of biscuit or bread with some butter. For dinner, any kind of meat, an egg, fish with a little sauce, green vegetables prepared in fat, salad, cheese. Supper, the

same as for dinner, with 40 to 50 grms. of bread and butter at pleasure. Water, soups, potatoes, puddings, sugar, and beer are quite forbidden; from 300 to 400 c.c. of red wine or moselle is to be drunk. Slight alterations were permitted to suit individual tastes, such as the substitution of small quantities of milk and water for the alcohol, along with fresh fruit. Further, a small cup of tea or coffee may be taken in the afternoon, with 15 to 20 grms. of bread or one egg. The total daily quantity of fluid was not to exceed 500 c.c.

So far this dietetic treatment has been used for the definite purpose of diminishing the bulk of the fœtus and delaying the ossification of the cranial bones, so as to allow its passage through a narrow pelvis; but its range of applicability is not limited to these cases. It might conceivably be useful in women who, with normal pelves, had given birth repeatedly to infants so large and well developed as to die in birth simply on account of their bulk and advanced ossification. It might also be valuable in instances of prolonged pregnancies with post-mature fœtuses, as well as in cases of fœtal disease and congenital debility.

Having enumerated these possible therapeutic extensions of the dietetic treatment, I must, however, point out certain difficulties which lie in the way. There is, first of all, the question whether it is possible to slacken nutrition in the fœtus without delaying development. In other words, are the infants born at the full term mature in every respect save size and weight, or do their internal organs, etc., show the characters of the sixth or seventh month of antenatal life? Are they full time babies save in size, or premature infants except in age? Then there is, second, the difficult problem of fœtal nutrition upon which I have already written at some length (*vide* pp. 152–159). There is evidence to show that in the later months of pregnancy, at any rate, the fœto-maternal metabolism is of a most intricate kind, and that the placenta is far from being the simple transmitter of particles (nutritious or excrementitious) as has in the past been believed. There is sufficient proof forthcoming of the selective powers of the placental epithelium to enable us to state that the transplacental interchanges are not governed solely by the laws of osmosis as they are understood by the physicist. The fœtus, also, has a metabolism which is, to some extent, independent of that of the mother; its tissues are assimilating and functioning at a different rate, and perhaps even in different ways, from the homologous tissues in the mother. To put it in somewhat more popular language, the unborn infant may have a better or a worse digestion than his mother. Taking all these matters into account, as well as others to which reference has been already made (*vide* pp. 152–159), the question of fœtal nutrition becomes very obscure, and its relation to the diet of the pregnant woman cannot be simple. We cannot by overfeeding a woman make sure that she will give birth to a large, fat child; at the same time, there must be a relation between fœtal and maternal nutrition, and the state of the maternal health must have an influence, determined by laws, albeit undiscovered laws, upon the size and development of the fœtus. In the meantime, there is no need to

suspend all attempts to influence the development of the unborn infant by modifying the maternal diet; Prochownick's treatment must be tried and its results tested; we cannot afford to wait till we understand all the details of the action of remedies or other therapeutic measures; if they give good results, we use them empirically, hoping later to clear up, in a scientific way, the rationale of their employment. Further, we must surely rejoice that there is some slight but perceptible lifting of the fog curtain hanging over the subject of diet in pregnancy; nevertheless, we must hasten slowly, for with such a fog and that continual lee-shore of the unknown physiological reaction of the fœtus so close at hand, it will be well if our theories carry very little sail.

Occupation, Exercise, etc., in Pregnancy.

Another means of maintaining the mother's health in pregnancy, and so of maintaining also the fœtal well-being, is to regulate the occupations in which the pregnant woman may engage. This matter has been already referred to in Chapter XV. in connection with fœtal poisoning with lead, mercury, phosphorus, etc., and it is now fairly well recognised that there are trades which are so dangerous that expecting mothers ought not to be allowed to engage in them (*Brit. Med. Journ.*, i. for 1900, p. 718). Further, it is doubtful whether women who are within a month of their confinement should be allowed to do hard manual labour of any kind; it ought to be obligatory upon them to rest in the last four weeks of gestation (in Switzerland this is insisted on by law), and there should be provision made for them ("une indemnité de grossesse"). A pregnant woman ought to take sufficient exercise to keep her body in health; but excessive exertion, whether in the form of bicycling (24), or of walking, or of golfing, or of dancing, or of household work, should be forbidden. The clothing should be hygienic, and abdominal compression should be prevented; for there is some evidence, although it is not very strong, that corset-pressure may act injuriously upon the fœtus in utero. The pregnant woman ought to be encouraged to think lightly of the possible effects of so-called "maternal impressions," and to be strengthened by the assurance that there is no real scientific evidence of their potency to deform her infant. This subject, however, will be dealt with in detail when I come to describe malformations and monstrosities (Pathology of the Embryo). The question of permitting tooth-extraction, long railway journeys, small surgical operations, and sexual connection during pregnancy, usually arises in relation to the production of abortion or premature labour. In attempting to give an answer, each case must largely be decided on its own merits; for, as I have already shown, some women will abort on the slightest possible provocation, having a high degree of "uterine irritability"; others may be subjected to severe accidents without the interruption of pregnancy. But, apart from the production of abortion or premature labour, it is sometimes asked whether much travelling or regular sexual intercourse during pregnancy will

have any injurious effects upon the fœtus. It is difficult to give an answer to this; and in the present state of our knowledge it is safest to confess our ignorance, and to take precautions erring on the side of safety.

The use of certain medicines is to be prohibited to pregnant women; among these are ergot, quinine, and all the direct abortifacients, as well as powerful purgatives, especially of the saline kind. Further, alcohol in excess must be forbidden, and all habits, such as the craving for morphia or cocain, sternly combated. Finally, all pathological states of the mother arising during pregnancy should be treated in accordance with the best principles of therapeutics; in order that this may be done, they must first, of course, be recognised, and for this purpose the regular testing of the urine for albumin is one very necessary precaution. The more smoothly and normally the pregnancy runs its course, the more chance the fœtus will have of coming into the world healthy and well nourished, always supposing, of course, that it came into the fœtal period of antenatal life out of a normal embryonic and germinal existence. Unfortunately, that cannot always be assured.

Enough, however, has been said of the value of caring for the fœtus by caring for the mother. I must now pass from the environmental treatment of the fœtus to the direct and immediate.

Medication of the Fœtus.

Many misconceptions have gathered round the subject of the medicinal treatment of the infant still in utero; and while some have greatly exaggerated the possibilities, others have greatly minimised them. From some of the statements that have been made by enthusiastic antenatal therapeutists, it might be imagined that drugs could be passed directly into the unborn infant as one pours a liquid from one bottle into another. On the other hand, it would seem as if those who are sceptical regarding antenatal treatment had come to believe that the fœtal economy was absolutely separate from and independent of the maternal. Now, as is so often the case, the truth lies somewhere between these two extremes.

Just as some diseases can be transmitted through the mother to the fœtus, so some drugs can be administered to the fœtus by administering them to the mother. Just as some diseases sometimes fail to affect the fœtus although they affect the mother, so some drugs sometimes fail to reach the fœtus although they circulate freely in the mother. Into both subjects the placental factor (*vide* p. 179) enters with most perplexing results. All this, and much more, the reader has doubtless already gathered from the perusal of Chapters X. and XV.; but I may here summarise our knowledge of the passage of medicines from mother to fœtus in the following few words:—There is evidence (clinical and experimental) that not only do the chemical substances which make up the fœtal body pass from the woman to her unborn infant, but that also certain substances, foreign to the constitution of the fœtus, sometimes, and under certain circumstances, pass through

the placental barriers. Among these last may be mentioned arsenic, lithium, mercury, alcohol, chloroform, ether, morphin, antipyrin, carbolic acid, quinine, and the salicylates. We do not know in what form and in what special combination any of these substances (whether those, such as phosphorus, calcium, soda, or potash, which exist normally in the fœtus, or those such as mercury and morphin, which are foreign to it) pass through the placenta, for the chemistry of the fœto-maternal interchanges is an unworked (almost unworkable) field of research. Of fœtal pharmacodynamics, or the physiological action of drugs on the healthy fœtus, we also know exceedingly little. We must be content in the meantime with the knowledge that some medicines pass to the fœtus.

At this point it may be well to emphasise the fact that it is not necessary for the drug to reach the intracorporeal tissues of the fœtus in order to influence it. It may, by improving the mother's health, beneficially affect the fœtus. That, of course, is quite clear. But, further, if it reach the placenta, it is already in touch with the fœtus, it is indeed in one of the fœtal organs; for the placenta is part fœtal as well as part maternal. Possibly it is in this manner that mercury and chlorate of potash act upon fœtal disease. The presence of the drug in the placenta may produce its beneficial effect simply by prolonging pregnancy to its natural term; the placental integrity is maintained, and abortion or premature labour avoided. Or it may increase the bactericidal or resisting or selective powers of the placental tissues, and so influence for good the fœtus which is so dependent upon the placenta for life and health. At any rate, it is very necessary to keep this fact in mind in judging of clinical evidence or experimental results.

It may be well now to consider some specific cases of fœtal therapeutics by medicinal substances. The treatment of fœtal variola, malaria, general dropsy, and one or two other morbid states, has been referred to already, and will not be given here.

Treatment of Fœtal Syphilis.

The treatment of the fœtus for syphilis may be necessary in several possible circumstances. In the first place, the pregnant woman may herself show evident signs of syphilis; in the second place, the father of her fœtus may be syphilitic, but she herself may show no sign of it; and, in the third place, the condition of the father may be doubtful or unknown, and the only signs of syphilis in the mother may have been the previous occurrence of a series of abortions, or premature labours, or dead-births. In all these cases the rule is to treat the fœtus through the mother with antisyphilitic medicines, for in all of them the fœtus or the placenta, or both the fœtus and the placenta, are very probably syphilitic. The earlier in pregnancy the treatment is begun the better, and it ought to be continued to the end, and then its place taken by direct treatment of the new-born infant. All writers are not agreed upon the second and third indications for antisyphilitic treatment referred to above,

and the risks of administering much mercury to a healthy mother and fœtus have been brought forward; but, according to A. Fournier (*L'Hérédité Syphilitique*, p. 368, 1891), these are not great. The results to be expected are the prevention of abortion and premature labour, of dead-birth, of placental disease and hydramnios, of syphilis in the infant at birth or soon thereafter, and of congenital debility. E. Fournier (*Stigmates Dystrophiques de l'Hérédo-Syphilis*, p. 365, 1898) claims also that a possible result may be the prevention of the dystrophies as well as of the other manifestations of antenatal syphilis; but this, although quite possible, almost implies the commencement of treatment at the very beginning of the fœtal period (second month of intrauterine life).

The medicine to be used is, of course, mercury, either alone or in combination with iodide of potassium, but preferably alone so far as its effect on the fœtus is concerned. The preparation may be that of hydrargyrum cum cretâ in one-grain doses; and one of these powders may be given twice or thrice daily. The mercury may also be administered as the iodide, and combined with iodide of potassium; but the advantages of the iodides are somewhat problematical. We cannot tell what proportion of the dose given reaches the placenta and the fœtus, but it is generally believed that only small quantities are necessary for the fœtus. As, however, mercury is proverbially well borne by the infant, no great anxiety need be felt regarding the exact amount to be transmitted to the placenta. Recently, the local treatment of fœtal syphilis with mercury has been tested by Riehl (*Wien. klin. Wchnschr.*, xiv. 627, 1901), and with apparently good results. Thirty-three cases of pregnancy in women with recently acquired syphilis were treated with vaginal pessaries containing 1 grm. of the German unguentum cinereum with 1 or 2 grms. of oleum theobromatis. The pessaries were introduced as far as the vaginal roof, and kept in position with a tampon soaked in glycerine of tannin. It should be remarked that mercury was also given by inunctions or injections. In the thirty-three cases there were only one abortion (3 per cent.) and three premature labours (9 per cent.) in the eighth and ninth month, while abortions occurred in 22 per cent. of the cases treated in the ordinary way given in Fournier's statistics. The number of still-births was two, or only 6 per cent., and the total number of children (alive or dead) who showed signs of syphilis was seven, or 21 per cent. It will be interesting to learn if Riehl's local treatment prove equally effective where the fœtal syphilis is apparently due to the father alone.

It need hardly be added that the mercurial treatment of the infant after birth is absolutely necessary, and that the treatment of the mother should be continued in view of the occurrence of another pregnancy, and in order that mercury may reach the child also through the milk. These measures, however, do not fall under the heading of fœtal therapeutics strictly so called.

Treatment of Recurrent Placental Disease.

The treatment of recurrent placental disease, with its frequent concomitants, premature labour, still-birth, or dead-birth, is not so well established as is that of fœtal syphilis. Of course, I refer here to the cases of placental disease in which syphilis can be excluded.

As Prof. A. R. Simpson has pointed out (*Trans. Amer. Gynec. Soc.*, xiii. 413, 1888), Sir James Y. Simpson, in a clinical lecture published in 1845 (*Lond. and Edin. Month. Journ. Med. Sc.*, v. 119), stated that he had kept patients constantly on small doses of alkaline salts, such as chlorate of potassa, in cases where they had lost the children of previous pregnancies from disease of the placenta, and "apparently with perfect success." His explanation was that the salt rendered the blood more arterial and facilitated the interchange of gases in the feeble placenta. Sir James Simpson states that he treated in this way "a great number of cases," but towards the end of his life he admitted that the drug sometimes failed. T. F. Grimsdale (*Liverpool Med.-Chir. Journ.*, i. 248, 1857) also obtained good results, as did Bruce (*Edinb. Med. Journ.*, xi. 669, 1865–6), A. Inglis, Cairns, J. Moir, and Keiller (*ibid.*, p. 671), Cuthbert (*ibid.*, xv. 85, 1870), J. Thorburn (*Liverpool and Manchester Med. and Surg. Rep.*, iii. 1, 1875), and A. R. Simpson (*loc. cit.*). I have used it in several cases; in one the success (as judged by the *post hoc* argument) was complete, a living healthy child being born not only not prematurely, but a month beyond the full term; in another (a case of recurrent fœtal dropsy) the pregnancy lasted longer, but the infant was still dropsical; and in two others (recurrent fœtal death), the effect seemed to be nil. I have given it both alone and combined with iron. The dose is twenty grains thrice daily. It would appear to be specially valuable in the cases in which there are traces of placental hæmorrhages. The results to be expected are continuation of the pregnancy to the full term, and the birth of a living infant; and the drug may perhaps be described as a placental tonic. R. Lomer (*Ztschr. f. Geburtsh. u. Gynäk.*, xlvi., 306, 1901) gives iodide of potassium and iron for the same purpose.

Treatment of Fœtal Nervous Maladies.

There is some small amount of evidence to show that phosphorus given to the mother in pregnancy may have a beneficial effect upon the fœtus. Nourse and W. Fleming Phillips (*Brit. Med. Journ.*, i. for 1899, p. 1062) have written on this subject. The latter records the case of Mrs. L., who had had six children, one of whom was idiotic, three were rickety, and the youngest died of hydrocephalus within a year of birth. In the next pregnancy, Phillips gave a mixture containing 2 grs. of calcium hypophosphite and 4 grs. of sodium hypophosphite for a dose during six months; the child was healthy. Two years later the same treatment was followed in another gestation, and again the infant was healthy. The general hygiene of pregnancy was also attended to; but Phillips gives most of the credit

to the medicine. Of course, in this as in all antenatal treatment, one is compelled to judge by consequences, or rather by phenomena which may or may not be consequences. This, however, is a limitation inseparable from the subject; it applies markedly to the treatment of hæmophilia, of which I must now speak.

Antenatal Treatment of Hæmophilia.

As has been said, it is difficult to judge of the effects of antenatal treatment because of the absence of means of accurate antenatal diagnosis. The cases in which, therefore, such treatment can be tested are few and far between. The well-known tendency of morbid fœtal states to repeat themselves more than once in the reproductive history of the same mother, gives, however, a possible opportunity of trying to influence beneficially the health of the unborn infant; further, the hereditary character of some of the maladies which thus tend to repeat themselves, increases the probability of the antenatal diagnosis, although it must be confessed that it diminishes, or appears to diminish, the chances of successful therapeutics. Hæmophilia is a malady which fulfils the conditions which have been stated above: it is very clearly and persistently hereditary, and it also shows family prevalence. As a test case, then, it has advantages: given a woman who comes of a hæmophilic stock, who has a hæmophilic father or hæmophilic brothers, there is a probability that her male offspring will be hæmophilic; and the probability is greatly increased if she have already given birth to one or more hæmophilic male children. There is a presumptive diagnosis, then, of antenatal hæmophilia when such a woman is pregnant of a male infant. But as a test case it has also disadvantages; hæmophilia is a very intractable disease, and it may be urged that, if it cannot be cured after birth, there can be little hope of curing it before birth. The latter statement, however, is merely an opinion; it may also be urged that it may be easier to affect beneficially a morbid state before birth, *i.e.*, in the fœtus, than after birth; but of this more anon. Let me now narrate the history of the following case, which was published by W. N. B. Brook (Lincoln) in the *British Medical Journal* (i. for 1901, p. 957), and by myself (126*a*). On June 25, 1900, I received from Dr. Brook a letter in which he stated the facts of a case of hæmophilia complicating pregnancy and labour which he had in his practice; and he closed his letter with the inquiry, whether in my opinion the administration of chloride of calcium to the mother in pregnancy would prevent the child from being the subject of hæmophilia. The case was as follows:—

Mrs. C., 34 years of age, pregnant for the third time, is a tall, well-built woman, rather spare, with black hair and a sallow complexion; she has always lost much blood at her menstrual periods, and had post-partum hæmorrhage after both confinements. She last menstruated on December 25, 1899, and expected her confinement in October 1900. Her family history was interesting: her mother was healthy, but her uncle (mother's brother) died at the age

of eleven from bleeding; she herself has had four brothers and four sisters, and one of the brothers died at the age of twelve from bleeding; the other brothers are alive and healthy; the four sisters are healthy, and their male children are also healthy. Her first pregnancy ended in 1891 in the birth of a male child; there was a considerable amount of hæmorrhage, which left the mother weak; the child at birth was white and anæmic; the infant survived birth, and is still alive, but is a marked "bleeder," and bruises easily, and has suffered from hæmorrhages into the joints and from the gums during the shedding of the first teeth. In fact, he nearly succumbed several times from great bleeding during the casting of the milk teeth. The second pregnancy likewise ended in the birth of a male infant (in 1894); there was again post-partum hæmorrhage; the infant showed hæmorrhage from the umbilical cord at birth, bruised easily, and died at the age of twelve months during dentition, the cause of death being returned as cerebral hæmorrhage. The mother is now pregnant for the third time, and has reached the sixth month.

Such were the facts upon which I was asked to form an opinion as to the prospects of successful antenatal treatment. I replied to Dr. Brook without much enthusiasm, pointing out the difficulty of being sure that the fœtus in utero was hæmophilic, the uncertainty of the sex of that infant even, and the hereditary nature of hæmophilia. Hæmophilia, I remarked, was not in the same category as the diseases such as syphilis and smallpox and typhoid fever, which the mother transmits to her fœtus in utero; being so distinctly and persistently hereditary, it was hardly to be expected that antenatal medication, begun at the sixth month of pregnancy, would greatly affect it. At the same time, I gave it as my opinion that chloride of calcium might safely be given to the mother, and that it would pass through the placenta and reach the fœtal tissues. I advised that the treatment with the chloride be commenced, although theoretically the hopes of success were small; and I also suggested that iron, arsenic, and strychnin be also administered in order to improve the general health, and possibly to increase the tone of the uterine musculature, and so lessen the risk of post-partum hæmorrhage.

Dr. Brook immediately accepted my suggestions, and put the patient upon a mixture containing 10 grs. of chloride of calcium thrice daily; this was continued till her confinement on October 3, 1900. He also gave her a pill of arseniate of iron with strychnin thrice daily till September 17, when it was replaced by the syrup of the phosphate of iron. I had also referred to the possible benefit that might follow the administration of thyroid extract, especially if the mother did not show the normal thyroid hypertrophy of pregnancy; but, as a matter of fact, thyroid extract was not given, as it was difficult to say whether the thyroid gland was normal in size or not, and it was thought best not to complicate the treatment. During three months, therefore, this woman received the above-mentioned drugs.

On October 3, 1900, the confinement took place, and again the child was a male. On this occasion, however, the infant, instead of being white and anæmic in appearance, was red and mottled, and was,

indeed, in all respects a normal child. There was no hæmorrhage from the umbilical cord as there had been in the previous case. Further, for the first time in the mother's obstetric history, there was no post-partum hæmorrhage. The patient was able to nurse her infant, but Dr. Brook advised that this should not be attempted. The labour was easy, the vertex presented, and the whole process did not occupy more than six hours. It should be added that the cord was not tied for five minutes after the infant was born. Since October, Dr. Brook has kept me acquainted with the progress of the case, which has been quite satisfactory all the time. The infant never had any bleeding, and did not bruise like his brothers; during dentition there was no hæmorrhage. It may be noted as of some interest that his eldest brother still shows the bleeding tendency very markedly; during February he had severe hæmaturia, which was uninfluenced by turpentine, but rapidly stopped under chloride of calcium and thyroid extract.

What are we to say about this case? Here is a woman with a distinct hereditary history of hæmophilia, handed down to her apparently through her mother, and showing itself in the form of post-partum hæmorrhage and profuse menstruation, and in the procreation of hæmophilic male infants; under chloride of calcium, and iron, arsenic, and strychnin, she passes through her third pregnancy, is confined without post-partum hæmorrhage of a male infant without hæmophilia! The treatment, let it be noted, is only begun at the sixth month of pregnancy. Is it nothing more than a coincidence, a remarkable one, no doubt, but still a coincidence, and nothing more? At first thought we are inclined, knowing what we know and have been taught to believe regarding the intractable nature of hereditary maladies, to accept the conclusion that it was a coincidence. If we accept the other view, that the healthy, non-hæmophilic state of this woman's third son was due to chloride of calcium administered during the third trimester of pregnancy, we are face to face with the conclusion that it is possible, by medicinal substances given to the mother in the last three months of gestation, to cure the unborn infant of a malady which no medicines in after life are capable of curing. Here I am tempted to leave the question. Certainly it is far easier to take it that, just as this woman had four brothers only one of whom was a bleeder, so of her three sons two were bleeders and the third was not a bleeder; even with the most hereditary complaints some members of a family escape. It was merely a coincidence that antenatal treatment was instituted in the case in which the hereditary influence was going to fail. But there are some circumstances which encourage me to express the opinion that, after all, there is a chance that the treatment in this case may have something more than a coincidental relation to the healthy state of the third infant.

In the first place, it may be taken from what is known of the physiology of the fœtus, and more particularly of placental transmission, that the chloride of calcium given to the mother reached the fœtal tissues; there is no reason to doubt that the iron, arsenic, and strychnin did so also. In the second place, there is evidence that

chloride of calcium is beneficial in hæmophilia after birth, and there is also evidence that hæmophilia if persistently treated in postnatal life shows a certain amelioration. In the third place, there is in the extraordinary power of recovery possessed by the fœtus, a factor which must not be left out of account in dealing with all questions of antenatal treatment. When we remember the marvellous power of growth and tissue-building which the fœtus displays, a power so great that in one month of intrauterine life the body-weight is quadrupled, we are led to ask ourselves whether this wonder of construction may not be accompanied by an equally great wonder of reparative energy? If there be a greatly exaggerated *vis medicatrix naturæ* in the fœtus, is it not possible that even the hereditary maladies may, if properly influenced, show a tendency to cure during antenatal life? May it not be that medicines acting upon the organs and tissues while these are still in the stage of construction, may be more efficacious than when they act upon structures which are, as it were, *set* either for health or disease?

This problem, like many others in antenatal pathology and hygiene, must be left unsolved; *non liquet* must again be the verdict. Of course, we cannot be too careful about *post hoc* arguments; but unfortunately they are all that we have to trust to in antenatal therapeutics, and that they are untrustworthy is only too evident. In this connection I may refer to the carbonic acid bath treatment for the prevention of monstrosities. The foreign correspondent of the *Medical Times and Gazette* (vol. i. for 1861, p. 209), writing from Driburg, states that the carbonic acid baths of that place produced a marvellous effect upon females disposed to give birth to monsters. Dr. Brück had under his care a lady whose general health was excellent, but whose first pregnancy had ended in the birth of a microcephalus; she took the baths in her second pregnancy, and had a normal infant; in her third, she neglected them and had again a microcephalus; in her fourth pregnancy the baths were resumed, and another normal infant was born; in her fifth pregnancy, it is said that, "incredible though it may seem," she again neglected the baths and had another microcephalus; but, finally, in her sixth gestation she returned to Driburg and had another normal child. Here we have the *post hoc* argument in its most specious and convincing form, and yet, I fancy, few of my readers will feel convinced.

Transmission of Immunity to the Fœtus.

Just as diseases and drugs may be transmitted to the fœtus in utero, so, it may be concluded, may immunities. At any rate, some evidence of this passage of immunising materials has been found in the vaccination of pregnant women (*vide* p. 194). The subject need not be returned to here. It is a most complicated one, but it is a matter in which progress of a real kind may yet be reported. It is conceivable that either there may be a transmission to the fœtus of the antitoxin prepared in the mother's body, or that there may be a transmission to the fœtal tissues of the property of manufacturing

the antitoxin. On this and allied questions, the works of Ehrlich (*Ztschr. f. Hyg. u. Infections-Krankh.*, xii. 183, 1892), of Charrin and Gley (*Arch. de physiol. norm. et path.*, 5 s., viii. 225, 1896), and of many others, may be consulted.

In yet other directions there may be expansions of the therapeutics of the fœtus in utero. We do not, for instance, know whether in cases of morbiparous mothers the administration of the thymus or of the thyroid extract would produce any beneficial effects upon the offspring; but there is evidence that the thymus is a very important organ in the fœtus, just as the thyroid is very active in the infant. Perhaps the thymus may check excess of growth and formation, for it has been found to be small in the large fœtus, as in B. Wolff's case (*Centrlbl. f. Gynäk.*, xxv. 381, 1901). We do not as yet know any drugs, unless it be chlorate of potash, which have a special effect (good or bad) upon the placenta, but there may be such. There is, however, one line of treatment which has sometimes been advocated (I refer to the induction of premature labour at the eighth month when the mother is suffering from some infectious malady), which must be regarded as of very doubtful utility; it is very uncertain if by so doing one diminishes the chances of the fœtus being infected by the mother, while it is quite certain that one increases the risks of the infant succumbing to that or some other infection. I believe that a fœtus suffering from a disease will recover more satisfactorily in the uterus than out of it, and I do not regard the chances of the mother as lessened by the presence of such a fœtus in her womb; but even if her chances of recovery are slightly less good on that account, the risks of a premature labour will more than countervail.

Germinal Therapeutics.

Therapeutics in the earliest period of antenatal life (the germinal), when the future organism is represented by two specialised cells (sperm and ovum), must of necessity be both paternal and maternal, and it must be mainly preparatory and selective. With its consideration I have not in this volume to do, for it belongs to the pathology and hygiene of the embryo and germ, and calls for special discussion along with monstrosities and malformations and morbid heredities; but I may very briefly indicate some of its salient points.

It will be concerned, in the *first* place, with the health of the parents after marriage, but before impregnation has occurred, or between successive pregnancies. With a view to the procreation of healthy infants, it will be pointed out that diseases in the parents ought to be combated, such as syphilis, alcoholism, and tubercle in the father, and endometritis, renal mischief, syphilis, and alcoholism in the mother. In the case of habitual abortion or of recurrent monstriparity, as in the family history narrated by myself some time ago (117), it may be wise and right to recommend curettage of the

uterus prior to a new pregnancy; and persistence in antisyphilitic remedies in the intervals between successive gestations is, of course, *de rigueur*.

In the *second* place, it will have to do with marriage and with the restriction of the marriages of the unfit, and there can be no doubt that there is wide room for action along such lines. At the same time, I think that all attempts to regulate marriage by law in the way that has been so often suggested, of having a sort of bureau of inspection of candidates for matrimony, must be regarded as premature at least, if not founded actually on a wrong principle. At present, it must be confessed that public opinion judges of the suitability or unsuitability of a proposed marriage very much by the amount of money the young couple will have to live upon. It would be better if a basis of health were to take the place of a basis of wealth in the public mind. The young contracting parties often say they are marrying for love, and that is right enough so long as the love is of the right kind; but with them, also, it is to be feared that physical and mental and moral health does not take the high place it ought to do in determining the union.

It has been said by a writer in an American journal (B. O. Flower, in the *Arena*), that "if 100 young men and women in this land, realising the solemn import of this question, enter the marriage relation attracted by pure love, untainted by base or sordid considerations, and recognising the great moral responsibility they assume to the society of to-morrow, no less than the sacred obligation they owe to the unborn, we should have from these true, pure, and ideal unions children who would, I believe, inaugurate an ethical reformation that would awaken the moral energies of civilisation, and lead to a higher and truer order of life." Francis Galton, in his Huxley Memorial Lecture (October 29, 1901), has advocated something akin to this for the possible "improvement of the human breed," and has proposed a system of dowries to make possible the early marriage of girls of a favoured stock as regards health; but, of course, there are big problems in the way.

All this may be brought about ultimately; but in the meantime, and before it can be hoped that it may be accomplished, it is necessary that a healthy public opinion on what constitutes a good marriage be built up, and in the building up of this opinion the profession is expected to act as a guide and leader. What, for instance, has the profession to teach the public on the question of marriages of consanguinity? This matter has been rendered most uncertain by the confusion which has been introduced through the mixing up of two very different states—namely, the marriage of near kin or incest, and marriage of consanguinity or of cousins. In the former case there can be no doubt of the effects, and every breeder of domestic animals will support this assertion; but the marriage of cousins is a different matter. It has been stated that such marriages result in sterility, abortions, congenital deaf-dumbness, idiocy, retinitis pigmentosa, albinism, and such malformations as polydactyly and ectrodactyly. Now, it does not seem that consanguinity *ipso facto*—that is, without

the existence of traces of pre-existing degeneracy in the contracting parties—increases the risk of these diseases and anomalies. Féré goes further, and says that in good families it is to be sought for, not avoided; but the medical man will be well advised if he be very careful in the advice that he offers.

The chief point in all this matter is that the profession and public should remain no longer thoughtless about it. Donald T. Masson has pointed out what "breeding our manhood from the shots" has led to and is leading to (*Caledonian Med. Journ.*, October 1898); and many others have adduced evidence of the heredity of degeneracy. Various legislative measures have been brought forward in the United States of America dealing with the problem of marriage restriction and regulation (*vide* C. W. Parker, *Journ. Amer. Med. Assoc.*, xxxiv. 521, 1900; D. R. Brower, *ibid.*, p. 523; A. H. Burr, *ibid.*, p. 524; and A. Lee Moqué, *ibid.*, p. 526); but I maintain that the first thing to be accomplished is the education of public opinion on all such matters by the medical profession.

In the *third* place, germinal therapeutics will have to face the problems of morbid heredity; and that they are problems of the gravest kind, every one will readily and sadly admit. Morbid heredity in these days stalks spectre-like through the land. It is heard in the pulpit, it is much discussed in current periodical literature, it is found in the popular novel, and it looks at you from the stage. There are some—they constitute the minority, I think—who treat this matter lightly. For them the question has no terrors; every man has his chance.

> "Years roll'd on years successive glide,
> Since first the world began,
> And on the tide of time still floats,
> Secure, the bark of man."

But there are others, and their number is great, to whom morbid heredity is a spectre that will not be laid. They see it in everything. An unreasoning terror seizes them.

If, however, they will only think, they who are so fearful of morbid heredity will soon begin to realise that the most hereditary thing in the world is the normal, not the abnormal; that health is transmitted as well as disease; that even where the past history of the family is bad, the clean livers have handed something to their children that is better than what was handed on to them.

It begins to be evident that inherited diseases and anomalies are rather signs of the breaking of heredity than instances of the persistence of it. The tendencies of the germ plasm are towards the formation of normal structures capable of performing their functions normally; but they are liable, through the action of morbid causes, to dissolution. Much of the harm that is done to the germ in one generation may be undone in the next; there is a constant tendency of the germ plasm to return to right physiological paths, if it be permitted.

But now, again, the terrors of the only half-laid spectre come back. Of what account is it to the individual that the breaking of the

normal heredity of health is only temporary, and not of necessity permanent? Think of the appalling loss of life and health that is going on everywhere before the return to the normal (*le retour à la médiocrité*) can be accomplished!

> "Are God and Nature then at strife,
> That Nature lends such evil dreams?
> So careful of the type she seems,
> So careless of the single life."

It can be answered that, in the very nature of the thing, antenatal pathology and antenatal health cannot be restricted to one generation. We must take a wider view than that which includes the individual alone. It may be better for the family, for the race, that the individual suffer and die. This, however, the individual never can tell. Still must he trust, now with a blind belief, but yet with a real hope. Never can he say the possibilities of the *vis medicatrix naturæ*, of the *vis medicatrix hereditatis*, are ended. Suicide is not the answer to the sad riddle of inherited pathology, but individual cleanness of life and a trust in the tendency to return to health, which is also (and much more) an attribute of the germ plasm.

But it is asked: Why should such things be, what is the meaning of antenatal death, disease, deformity?

> "The same old baffling questions! O my friend,
> I cannot answer them. In vain I send
> My soul into the dark, where never burn
> The lamps of science, nor the natural light
> Of Reason's sun and stars! I cannot learn
> Their great and solemn meanings, nor discern
> The awful secrets of the eyes which turn
> Evermore on us through the day and night
> With silent challenge and a dumb demand,
> Proffering the riddles of the dread unknown,
> Like the calm Sphinxes, with their eyes of stone,
> Questioning the centuries from their veils of sand!
> I have no answer for myself or thee
> Save that I learned beside my mother's knee;
> 'All is of God that is, and is to be;
> And God is good.' Let this suffice us still,
> Resting in childlike trust upon His will
> Who moves to His great ends unthwarted by the ill."

APPENDIX

REFERENCE LIST OF THE AUTHOR'S CONTRIBUTIONS TO MEDICAL LITERATURE FROM 1883 TO 1901, WHICH ARE REFERRED TO UNDER THEIR NUMBERS IN THE TEXT.

A. Published Works.

1. *An Introduction to the Diseases of Infancy: The Anatomy, Physiology, and Hygiene of the New-born Infant.* Oliver & Boyd, Edinburgh, 1891. Pp. viii, 242. Plates, 9 (4 coloured), and Illustrations, 15.
2. *The Diseases and Deformities of the Fœtus: An Attempt towards a System of Antenatal Pathology.* Oliver & Boyd, Edinburgh, 1892. Vol. i. pp. xiv, 252. Plates, 13. Subjects considered in this volume are: The Study of Fœtal Pathology, its Scope, Delayed Progress, Difficulties, etc. (chaps. i., ii.); Historical Sketch of the Diseases of the Fœtus (chaps. iii.–vii.); Classification of Diseases of the Fœtus (chap. viii.); General Characters of Fœtal Disease (chap. ix.); General Dropsy of the Fœtus (chaps. x.–xiii.); General Cystic Elephantiasis (chaps. xiv.–xvii.); General Fœtal Obesity (chap. xviii.); Index of Authors and Index of Subjects.
3. *The Structures in the Mesosalpinx: Their Normal and Pathological Anatomy.* (Jointly with the late Dr. J. D. Williams.) Oliver & Boyd, Edinburgh, 1893. Pp. 52. Illustrations, 12. Subjects considered in this work are: Anatomy and Histology of the Fallopian Tubes, including Hypertrophy, Hydro-, Pyo-, and Hæmato-salpinx, Malformations and Displacements, Tubercle, Cancer, and Cysts; Anatomy and Histology of the Organ of Rosenmüller or Parovarium; Homologues of the Mesonephric Relics in the Mesosalpinx; Pathology of the Organ of Rosenmüller, including Cysts and Cancer; and Anatomy and Pathology of the Vessels and Cellular Tissue of the Mesosalpinx.
4. *The Diseases and Deformities of the Fœtus.* Oliver & Boyd, Edinburgh, 1895. Vol. ii. pp. xii, 264. Illustrations, 8. Subjects considered in this volume are: Sclerema Neonatorum (chaps. i.–iv.); Atrophy of the Subcutaneous Tissue, Subcutaneous Abscess in the Fœtus, Dermatolysis (chap. v.); Fœtal Ichthyosis (chaps. vi.–viii.); Congenital Ichthyosis Hystrix (chap. ix.); Tylosis Palmæ et Plantæ, etc. (chap. x.); Fœtal Keratolysis (chap. xi.); Keratolysis Neonatorum, etc. (chap. xii.); Congenital Cutaneous Affections in General (chap. xiii.); Addenda, Index.
5. *Teratogenesis: An Inquiry into the Causes of Monstrosities: History of the Theories of the Past.* Oliver & Boyd, Edinburgh, 1897. Pp. iv, 62.

B. Articles in Encyclopædias of Medicine.

6. "Malformations of the Female Generative Organs," in Allbutt and Playfair's *System of Gynæcology by many writers.* Macmillan & Co., London, 1896. Pp. 63–112. Illustrations, 31–39.
7. "Les Maladies du Fœtus," in Grancher, Comby, and Marfan's *Traité des maladies de l'enfance.* Masson et Cie, Paris, 1898. Vol. v. pp. 191–215.
8. "Congenital Disorders and Diseases of the New-born," in Keating's *Cyclopædia of the Diseases of Children.* Supplementary volume, pp. 1–17. Lippencott, Philadelphia, 1899. Subjects included are: Congenital Anasarca, Elephantiasis, Ascites, Fœtal Peritonitis, Infectious Fevers, Endocarditis, Tuberculosis, Prolapsus Uteri, Osteogenesis Imperfecta, and Congenital Teeth.
9. "Congenital Skin Diseases," in Keating's *Cyclopædia of the Diseases of Children.* Supplementary volume, pp. 1113–1123. Lippencott, Philadelphia, 1899.
10. "Cheek, Fissure of," in Green's *Encyclopædia Medica*, vol. ii. p. 198, Edinburgh, 1899.
11. "Curettage, Uterine," in Green's *Encyclopædia Medica*, vol. ii. p. 411, Edinburgh, 1899.
12. "Anatomy of the Female Organs of Generation." Green's *Encyclopædia Medica*, vol. iv. p. 127, 1900.
13. "Arrested Developments of the Female Organs of Generation." Green's *Encyclopædia Medica*, vol. iv. p. 150, 1900.
14. "Hermaphroditism." Green's *Encyclopædia Medica*, vol. iv. p. 490, 1900.
15. "Maternal Impressions." Green's *Encyclopædia Medica*, vol. vii. p. 344, 1901.

15*a*. "Malformations of Genital Organs." Reed's *Text-Book of Gynecology*, 1901.

15*b*. "Diseases of the New-born Infant." Green's *Encyclopædia Medica*, vol. viii. p. 345, 1901.

C. Medical Journal.

16. *Teratologia: A Quarterly Journal of Antenatal Pathology.* Williams & Norgate, London and Edinburgh, 1894–1895. Vol. i. pp. viii, 238. Illustrations, 12. Vol. ii. pp. iv, 344. Illustrations, 21.

D. Contributions to the Medical Journals.

1. *Gynecological.*

17. "Cases of Clinical and Pathological Interest in the Buchanan Ward under Professor Simpson." *Edinb. Med. Journ.*, xxx. 438, 1884; *Trans. Edinb. Obst. Soc.*, ix. 173, 1884. Illustrations, 4. The cases recorded in this communication were (1) one of ligation of the blood supply of the ovaries for dysmenorrhœa, etc.; (2) one of removal of a hæmatosalpinx; (3) one of epithelioma of the cervix in a woman 26 years of age; and (4) one of recurrent fibroid of the cervix.
18. "Labia Minora and Hymen." *Edinb. Med. Journ.*, xxxiv. 425, 1888; *Trans. Edinb. Obst. Soc.*, xiii. 179, 1888. Illustrations, 5.

19. "Histology and Pathology of the Fallopian Tubes." (Jointly with Dr. J. D. Williams.) *Brit. Med. Journ.*, i. for 1891, pp. 107, 168. Illustrations, 7.
20. "Influenza in relation to Gynecological, Obstetric, and Pediatric Cases." *Edinb. Med. Journ.*, xxxix. 615, 1894; *Trans. Edinb. Obst. Soc.*, xix. 33, 1894.
21. "Uterine Curettage: History, Indications, and Technique." *Edinb. Med. Journ.*, xli. 787, 908, 1896; *Trans. Edinb. Obst. Soc.*, xxi. 69, 1896.
22. "So-called Epispadias in Woman, with an Illustrative Case." *Edinb. Hosp. Rep.*, iv. 249, 1896.
23. "Congenital Prolapsus Uteri, with two Illustrative Cases." (Jointly with Dr. J. Thomson.) *Am. Journ. Obst.*, xxxv. 161, 1897. Illustrations, 3.
24. "Bicycling and Gynecology." *Scott. Med. and Surg. Journ.*, ii. 529, 1898; *Med. Press and Circ.*, ii. for 1898, p. 54.
25. "The Sequelæ, Usual and Unusual, of Ovariotomy." *Internat. Clin.*, 8 s., iv. 266, 1899.
26. "The Present Position of the Pessary in Gynecological Practice." *Scott. Med. and Surg. Journ.*, iv. 289, 1899; *Trans. Edinb. Obst. Soc.*, xxiv. 53, 1899.
27. "Digest of Recent Literature on Atresia of the Vagina." *Scott. Med. and Surg. Journ.*, iv. 536, 1899.
28. "The Antenatal Factor in Gynecology." *American Med. Quart.*, i. 215, 1900; *Trans. Amer. Assoc. Obst. and Gynec.*, xii. 337, 1900.

2. *Obstetrical (including Antenatal Pathology).*

29. "Sphygmographic Tracings in Puerperal Eclampsia." *Edinb. Med. Journ.*, xxx. 1007, 1885; *Trans. Edinb. Obst. Soc.*, x. 56, 1885. Illustrations, 35.
30. "Report of the Royal Maternity and Simpson Memorial Hospital for the Quarter ending 31st January 1885." (Jointly with Dr. T. B. Darling.) *Edinb. Med. Journ.*, xxxi. 259, 1885; *Trans. Edinb. Obst. Soc.*, x. 174, 1885.
31. "Sphygmographic Tracings during Labour." *Trans. Edinb. Obst. Soc.*, xi. 104, 1886.
32. "Sphygmographic Tracings in Pregnancy, Labour, and the Puerperium." *Brit. Med. Journ.*, ii. for 1886, p. 1094.
33. "Frozen Sections of a New-born Child with General Dropsy." *Trans. Edinb. Obst. Soc.*, xii. 161, 1887.
34. "Mitral Stenosis in Labour and the Puerperium, with Sphygmographic Tracings." *Edinb. Med. Journ.*, xxxiii. 796, 1888; *Trans. Edinb. Obst. Soc.*, xiii. 16, 1888. Illustrations, 21.
35. "Sclerema and Œdema Neonatorum." *Brit. Med. Journ.*, i. for 1890, p. 403. Illustrations.
36. "Intrauterine Rickets." *Edinb. Med. Journ.*, xxxv. 1111, 1890; *Trans. Edinb. Obst. Soc.*, xv. 45, 1890. Illustrations, 3.
37. "The Head of the Infant at Birth, Part I." *Edinb. Med. Journ.*, xxxvi. 97, 1891; *Trans. Edinb. Obst. Soc.*, xv. 103, 1890. Illustrations, 7.
38. "The Relations of the Pelvic Viscera in the Infant." *Edinb. Med. Journ.*, xxxvi. 313, 1891; *Trans. Edinb. Obst. Soc.*, xv. 168, 1890. Illustrations, 5.

39. "The Head of the Infant at Birth, Part II." *Edinb. Med. Journ.*, xxxvi. 429, 1891; *Trans. Edinb. Obst. Soc.*, xv. 235, 1890. Illustrations, 2.
40. "Maternal Impressions." *Edinb. Med. Journ.*, xxxvi. 624, 1891; *Trans. Edinb. Obst. Soc.*, xvi. 7, 1891.
41. "Hæmorrhage during Labour due to Vascular Anomaly of the Membranes." *Edinb. Med. Journ.*, xxxvi. 1006, 1891; *Trans. Edinb. Obst. Soc.*, xvi. 95, 1891. Illustration.
42. "Relations of the Abdominal Viscera in the Infant." *Edinb. Med. Journ.*, xxxvii. 45, 1891; *Trans. Edinb. Med.-Chir. Soc.*, x. 140, 1891. Plates, 4.
43. "A Portable Infant-Weigher." *Edinb. Med. Journ.*, xxxvii. 321, 1891; *Trans. Edinb. Obst. Soc.*, xvi. 165, 1891. Illustrations, 2.
44. "Disease in Early Infancy." *Brit. Med. Journ.*, i. for 1892, p. 321.
45. "The Investigation of Fœtal Disease." *Edinb. Med. Journ.*, xxxvii. 812, 1892; *Trans. Edinb. Obst. Soc.*, xvii. 53, 1892.
46. "Rupture of the Spleen in a New-born Infant." *Arch. Pediat.*, ix. 275, 1892.
47. "The Spinal Column in the Infant." *Edinb. Med. Journ.*, xxxvii. 913, 1892; *Trans. Edinb. Med.-Chir. Soc.*, xi. 71, 1892. Plate, 1.
48. "Series of Thirteen Cases of Alleged Maternal Impression." *Edinb. Med. Journ.*, xxxvii. 1025, 1892; *Trans. Edinb. Obst. Soc.*, xvii. 99, 1892.
49. "Clinical Notes of Four Cases, and Description of Two Specimens of General Dropsy of the Fœtus." *Edinb. Med. Journ.*, xxxviii. 57, 142, 1892; *Trans. Edinb. Obst. Soc.*, xvii. 133, 1892. Plates, 3.
50. "Sectional Anatomy of an Anencephalic Fœtus." *Journ. Anat. and Physiol.*, xxvi. 516, 1892; *Trans. Edinb. Obst. Soc.*, xvii. 228, 1892. Illustrations, 3.
51. "General Dropsy of the Fœtus." *Edinb. Med. Journ.*, xxxviii. 147, 224, 1892; *Trans. Edinb. Obst. Soc.*, xvii. 148, 1892.
52. "General Dropsy in the Twin-Fœtus." *Trans. Edinb. Obst. Soc.*, xvii. 177, 1892.
53. "Case-taking Scheme for Fœtal Diseases and Deformities." *Edinb. Med. Journ.*, xxxviii. 434, 1892; *Trans. Edinb. Obst. Soc.*, xvii. 262, 1892.
54. "An Infant with a Bifid Hand." *Edinb. Med. Journ.*, xxxviii. 623, 1893; *Trans. Edinb. Obst. Soc.*, xviii. 1, 1893. Illustration, 1.
55. "Description of a Fœtus Paracephalus Dipus Acardiacus." *Edinb. Med. Journ.*, xxxviii. 836, 1893; *Trans. Edinb. Obst. Soc.*, xviii. 38, 1893. Plates, 2.
56. "Congenital Measles, with Notes of a Case." *Arch. Pediat.*, x. 301, 1893.
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58. "Congenital Ascites with Retention of Urine." *Edinb. Hosp. Rep.*, i. 612, 1893.
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63. "Paracephalus Monopus, Apus, and Pseudoacormus." *Trans. Edinb. Obst. Soc.*, xviii. 257, 1893. Plate, 1.
64. "Two Cases of General Dropsy of the New-born Infant." *Arch. Pediat.*, xi. 137, 1894.
65. "The Fœtus Amorphus." *Teratologia*, i. 1, 1894. Plates, 3.
66. "The First Monograph on Fœtal Disease." *Teratologia*, i. 37, 1894. Plate, 1.
67. "Congenital Ichthyosis." *Arch. Pediat.*, xi. 257, 408, 1894.
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70. "Teratological Records of Chaldea." *Teratologia*, i. 127, 1894. Plate, 1.
71. "Paracephalus Dipus Cardiacus." *Teratologia*, i. 158, 1894. Plate, 1.
72. "Description of an Anidean Fœtus." *Trans. Edinb. Obst. Soc.*, xix. 41, 1894.
73. "The Fœtus Amorphus Anideus." *Trans. Edinb. Obst. Soc.*, xix. 61, 1894.
74. "The Fœtus Amorphus Mylacephalus." *Trans. Edinb. Obst. Soc.*, xix. 73, 1894.
75. "Case of Preauricular or Branchial Appendage." *Teratologia*, ii. 14, 1895. Plate, 1.
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77. "Pathogenesis of Preauricular Appendages." *Teratologia*, ii. 65, 1895.
78. "Iniencephaly." *Teratologia*, ii. 87, 1895. Plates, 3.
79. "Diphallic Terata." (Jointly with Dr. Scot Skirving.) *Teratologia*, ii. 92, 184, 255, 1895. Plates, 2.
80. "Rigor Mortis in the Fœtus." *Teratologia*, ii. 96, 1895; *Trans. Edinb. Obst. Soc.*, xx. 20, 1895.
81. "Note on the Literature of the Fœtus Amorphus Anideus." *Teratologia*, ii. 182, 1895.
82. "Dr. Pallares' Dicephalic Fœtus." *Teratologia*, ii. 210, 1895. Plate, 1.
83. "Antenatal Pathology in the Hippocratic Writings." *Trans. Edinb. Obst. Soc.*, xx. 51, 1895; *Teratologia*, ii. 275, 1895.
84. "The Biddenden Maids." *Trans. Edinb. Obst. Soc.*, xx. 128, 1895; *Teratologia*, ii. 268, 1895. Plates, 2.
85. "Teratological Types — Iniencephaly." *Teratologia*, ii. 287, 1895 Plates, 2.
86. "Teratogenesis: Supernatural Causes of Monstrosities." *Edinb. Med. Journ.*, xli. 593, 1896; *Trans. Edinb. Obst. Soc.*, xxi. 12, 1896.
87. "Case of Tylosis Palmæ et Plantæ." (Jointly with the late Dr. George Elder.) *Pediatrics*, i. 337, 1896. Illustration, 1.
88. "Congenital Teeth." *Edinb. Med. Journ.*, xli. 1025, 1896; *Trans. Edinb. Obst. Soc.*, xxi. 181, 1896. Plate, 1.
89. "Recent Advances in Antenatal Pathology." *Pediatrics*, i. 455, 1896.
90. "Anomalies in the Form and Position of all the Male Genitals," etc. *Brit. Med. Journ.*, i. for 1896, p. 1392.
91. "Teratogenesis: Physical Causes of Monstrosities." *Edinb. Med. Journ.*, xlii. 1, 1896; *Trans. Edinb. Obst. Soc.*, xxi. 220, 1896.
92. "Report on Mr. J. Rutherford Morison's Case of Congenital Tumour on the Face of a Child." *Edinb. Med. Journ.*, xlii. 132, 1896; *Trans. Edinb. Obst. Soc.*, xxi. 256, 1896. Plates, 2.

93. "Note on Dr. M. Gunsburg's Teratological Cases." *Edinb. Med. Journ.*, xlii. 139, 1896; *Trans. Edinb. Obst. Soc.*, xxi. 252, 1896.
94. "Teratogenesis: Mental Influence." *Edinb. Med. Journ.*, xlii. 240, 307, 1896; *Trans. Edinb. Obst. Soc.*, xxi. 258, 1896.
95. "Management of Labour complicated by Death or Disease of the Fœtus." *Internat. Clinics*, 6 s., iv. 262, 1897. Plate, 1.
96. "The Causation of Twins, as Illustrated by some Clinical Histories." *Trans. Edinb. Obst. Soc.*, xxii. 29, 1897.
97. "Displacement of the Kidney in Obstetric Practice." *Internat. Clinics*, 7 s., iii. 312, 1897.
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104. "Antenatal Therapeutics." *Brit. Med. Journ.*, i. for 1899, p. 889; *Arch. Pediat.*, xvi. 513, 1899.
105. "Spontaneous Dislocation Outwards of the Right Knee Joint in an Infant Eleven Months Old." *Arch. Pediat.*, xvi. 267, 1899.
106. "Pathology of the Fœtus." *Scott. Med. and Surg. Journ.*, v. 112, 1899.
107. "Sequel to the Case of Spontaneous Recurrent Dislocation of the Knee Joint." *Arch. Pediat.*, xvi. 701, 1899.
108. "Some Antenatal Aspects of Tuberculosis." *Polyclinic*, i. 39, 1899.
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110. "The Antenatal and Intranatal Factors in Neonatal Pathology." *Journ. Amer. Med. Assoc.*, xxxiii. 1245, 1899.
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112. "The Term 'Moon-calf'; a Teratological Note." *Brit. Med. Journ.*, i. for 1900, p. 780.
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114. "Chronology of Antenatal Life." *Scott. Med. and Surg. Journ.*, vi. 416, 1899. Plates, 2.
115. "Pathology of the Germinal Period of Antenatal Life." *Edinb. Hosp. Rep.*, vi. 366, 1900.
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118. "Antenatal Diagnosis." *Brit. Med. Journ.*, i. for 1900, pp. 1458, 1525.

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3. *General Medicine, etc.*

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E. Shorter Contributions to the Medical Journals.

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132. "Case of Antemortem Clot in the Heart of an Infant." *Ibid.*, p. 57, 1890.
133. "Note on Syphilitic Liver in the New-born Infant." *Ibid.*, p. 91, 1890.
134. "Case of Uterus Bicornis Septus." *Ibid.*, p. 160, 1890.
135. "Case of Fœtus with Encephalocele." *Edinb. Med. Journ.*, xxxvi. 759, 1891.
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INDEX OF AUTHORS

Abel, W., 367.
Achalme, P. J., 60.
Achard, C., 200.
Adachi, Buntaro, 105.
Addinsell, A. W., 407.
Ahlfeld, F., 144, 268, 271, 305, 329, 395.
Albrecht, R., 198.
Aldrovandus, U., 323.
Alfieri, E., 280.
Allbutt, C., 363.
Andrews, H. R., 386, 387.
Anker, M., 263.
Ansiaux, G., 265.
Apert, 200, 348, 354, 407.
Archambault, P., 303.
Aristotle, 4.
Arlidge, J. T., 262.
Armenteros, F. de, 254.
Ashby, H., 379.
Ashmead, 325.
Aubinais, P., 203.
Auché, 189, 208, 212, 213.
Audebert, 230.
Audion, L. P., 61.
Audion, P., 61, 65.
Augagneur, M. V., 328.
Auspitz, H., 315.
Aviragnet, 209.

Bachimont, 168.
Baer, B. F., 421.
Baerensprung, F. von, 225.
Bailly, M. 413.
Baker, B., 262.
Balland, J., 260.
Bar, P., 64, 144, 195, 209, 232, 234, 235, 236, 327, 404.
Barbezieux, G., 403.
Barbour, A. H. F., 36, 37, 418.
Barker, Fordyce, 270.
Barkow, H. C. L., 314.
Barling, G., 340.
Barlow, T., 353.
Barth, 372, 446.
Bastianelli, 204.
Batten, F. E., 366, 367.
Baumes, 249.
Baumgarten, 212, 213, 214.
Bazin, 203.
Beard, J., 142, 158.
Beatty, W., 328.
Beck, G., 473.
Béclère, 195.
Behm, C., 293.
Behrend, G., 228, 307, 315.
Beigel, H., 323.
Bellot, 372, 446.
Benicke, F., 271.
Bennewitz, 283.
Béraud, 375.
Bermann, 244.
Bernhardt, M., 47.
Besnard, A., 375.
Betz, F., 375.
Bidone, E., 138, 139, 140, 177, 183, 198, 419, 441.
Billig, A., 375.
Birch-Hirschfeld, 209.
Biskamp, A., 348.
Bissell, J. D., 230.
Blackwood, C. M., 381, 382.
Blau, O., 353.
Blondel, 30.
Blumer, C., 328.
Blundell, J., 319.
Blyth, W., 263, 264.
Boeckh, G., 334.
Bode, E., 353.
Bohn, 203.
Bond, 53.
Bonnaire, 217, 407.
Bonnet, R., 327.
Booker, 86.
Bordoni-Uffreduzzi, G., 221.
Borntraeger, J. B., 348.
Borri, L., 265, 266.
Bossi, L. M., 419, 425.
Bouchacourt, 170.
Bouchacourt, L., 470.
Bouchard, Ch., 186.
Bouchut, 203.
Boulengier, 250.
Bourgeois, L. X., 282.
Bourneville, 164, 276, 305.
Bovero, 155.
Bowen, J. T., 328.
Boxall, R., 414.
Braun, C., 353.
Braun, R. von, 329.
Breslau, 267.

Briau, 163.
Brindeau, 372.
Brinon, H., 383.
Brook, W. N. B., 480.
Brosin, 376.
Brower, D. R., 486.
Brown, E. S., 219.
Browne, Sir T., 429.
Bruce, 357, 479.
Brück, 483.
Brun, De, 397.
Brunner, C., 326.
Brunzlow, 203.
Bruyn Kops, C. J. de, 354.
Budin, P., 447, 455.
Bugge, J., 209.
Bulkley, L. D., 226.
Bunge, 148.
Burckhardt, L., 383.
Bureau, 271, 203.
Buret, 247.
Burr, A. H., 486.
Butte, L., 159, 160, 279.

Cacace, E., 337, 338.
Caccini, V., 204.
Cairns, 479.
Cameron, J. C., 284.
Campbell, W., 329.
Carbone, T., 310, 313, 314.
Carbonelli, G., 221.
Carità, V., 222, 223.
Carrara, M., 273.
Carrière, G., 216.
Carstanjen, M., 141.
Carton, A., 353.
Caruso, F., 297, 399.
Caspary, J., 74, 315, 316, 317.
Casper, J. L., 178, 267, 413.
Cathala, 376.
Cathelineau, H., 264.
Cattani, 198.
Caulfield, 323.
Cavazzani, 141.
Caviglia, P., 419.
Cestan, R., 348.
Chamberlain, W. M., 270.
Chamberland, C., 222.
Chambrelent, 200, 208, 212, 213, 283, 354.
Chantemesse, A., 199.
Chantreuil, 190.
Chapot-Prévost, 462.
Charcellay, 199.
Charcot, 192, 351.
Charpentier, A., 279.
Charrier, 200, 320.
Charrin, 149, 163, 182, 184, 195, 207, 212, 283, 334, 484.
Charrin, A., 201.
Chatelain, E., 420.
Chaussier, 394, 395.
Chiarleoni, 29.
Chievitz, J. H., 99, 106, 109, 110, 111, 112, 114, 116.
Chowne, 323, 413.
Christopher, 372, 446.
Cima, F., 203, 235.
Clark, J. G., 425.
Cless, 192.
Coley, W. B., 303.
Colles, 225, 249, 250.
Collina, M., 167.
Combemale, 274, 276.
Comby, J., 55, 72.
Corbin, J. E., 201.
Cordes, L., 308.
Cordon, 320.
Corin, G., 265.
Courmont, 358.
Coutts, J. A., 250.
Couvelaire, 382, 383.
Couvelaire, A., 419.
Crandall, F. M., 203, 358.
Crawford, J., 323.
Crichton, R. W., 375.
Crocker, Radcliffe, 308, 318.
Croom, J. H., 29.
Curtze, 413.
Cuthbert, 479.

Dagincourt, E., 414.
Dalziel, 219.
Dana, 20.
Dana, C. L., 390.
Daniel, A. S., 308.
Danyau, 375, 394.
Date, W. H., 318.
d'Aulnay, G. R., 230, 255.
Daunic, 200.
Davidson, 283.
Davidson, T., 414.
Decaisne, 272.
Delamare, 283.
Delestre, M., 221.
Demelin, 72.
Demme, R., 375, 376, 443.
Depaul, 353.
Diday, 225.
Diehl, 72.
Diehl, J. C., 219, 220.
Diener, 375.
Dodd, A. H., 326.
Doehle, 244.
Dogliotti, A., 200.
Dohrn, 219, 220, 329, 414.
Doléris, A., 159, 160, 386.
Döllken, 103.
Donath, J. F. W., 473.
Doutrelepont, 244.
Drappier, 275.
Drennen, 250.
Drummond, W. B., 373.
Dubrisay, 222.
Duci, 144.
Duclert, 182.
Dürk, H., 200.
Düring, E. von, 250.
Düttel, P. J., 4, 188, 189.
Duménil, 353.
Duncan, J. Matthews, 184, 274, 283.
Durante, 231, 354, 374.

Durozier, 285.
Duval, D. F., 136.
Duval, M., 186.

Eberle, O., 235.
Eberth, C. J., 199, 353.
Eckardt, 230.
Ecker, A., 323.
Eden, 38.
Edis, A. W., 320.
Edmunds, W., 166.
Edwards, 32.
Ehrlich, 484.
Elder, G., 138, 140, 141, 318, 438.
Elliot, G. T., 315.
Englisch, J., 353.
Engström, E., 28.
Ercolani, G. B., 230.
Ernst, P., 199.
Esmarch, F., 300.
Etienne, G., 200, 201, 272.
Everke, C., 298.

Fabris, F., 380.
Falk, F., 267.
Fauvelle, 324.
Fede, F., 337, 338.
Fehling, H., 147, 268, 269, 271, 353.
Feis, O., 414.
Felkin, W., 203.
Féré, Ch., 20, 46, 170, 272, 274, 276, 435, 486.
Ferguson, J. H., 223.
Ferrari, P. L., 181.
Ferro, R. von, 353.
Ferroni, 139, 140, 144, 169, 447.
Fienus, T., 322.
Fieux, 279.
Filippi, A., 353.
Filomusi-Guelfi, G., 266.
Finger, 244.
Finizio, 170.
Finkelstein, 62, 366.
Finlay, C., 198.
Fischer, A., 347.
Fischl, R., 228.
Flechsig, 102, 103.
Flemming, C. E. S., 354.
Flensburg, C., 162.
Florschütz, H., 473.
Flower, B. O., 485.
Foa, P., 221.
Fordyce, W., 200, 355, 356, 357, 358, 360, 361.
Foulis, J., 120.
Fournier, A., 225, 247, 253, 254, 255, 257, 478.
Fournier, E., 240, 241, 243, 276, 478.
Fox, G. H., 318.
Fox, Tilbury, 328.
Fraenkel, 200, 317.
Fraenkel, E., 473.
Fränkel, E., 230.
Franqué, O. von, 353, 357, 424.
Frascani, V., 199, 380.
Frenkel, 200.
Frerichs, 283.
Freund, 200.
Freund, M. B., 267.
Freund, W. A., 29, 30.
Fricker, E., 400.
Friedländer, S., 265.
Friedreich, 391.
Fröbelius, 375.
Fuhr, 290, 296.
Fürst, L., 324.
Fürth, 225.
Fussell, M. H., 384.

Gärtner, A., 213.
Gärtner, F., 70.
Gallavardin, 200.
Galton, F., 485.
Ganiayre, 262.
Gardini, 138, 139, 140.
Garrod, A. G., 373.
Gascard, A., 230.
Gauthier, G., 164, 166.
Genevet, 376,
Gérard, G., 133.
Gerhardt, 375.
Gessner, 363.
Geyl, 48, 324.
Ghika, C., 164.
Gibb, 414.
Giglio, J., 199, 446.
Giles, A., 473.
Gillespie, A. L., 152.
Gillette, W. R., 270, 271.
Glenn, J. H., 219.
Gley, 195, 334, 484.
Göckel, C. L., 320.
Goldberger, H., 329.
Goldscheider, A., 328.
Gradwohl, R. B. H., 218, 219.
Graetzer, 173, 202.
Grancher, J., 370.
Grandidier, 65.
Grandis, V., 149, 150.
Gream, G. T., 269.
Gréhant, N., 268.
Griffith, J. P. Crozer, 49, 200, 340.
Grigg, W. C., 413.
Grimsdale, T. F., 479.
Grindon, J., 198.
Grotthof, F., 354.
Gubler, A., 232, 233.
Guéniot, 353.
Guillemet, V., 403.
Guillemonat, 201.
Guinard, L., 163.
Gulland, G. L., 87, 142.
Gusserow, 153, 163.

Hahn, C., 455.
Hall, 446.
Hall, J. N., 372.
Hallopeau, 315.
Hallopeau, H., 328.
Hanks, H. T., 320.
Hanot, V., 215, 216, 220, 443.
Hansson, 386, 387.

Harbitz, F., 354.
Hardouin, 362.
Hart, D. B., 397, 426.
Harvey, A., 163.
Haspels, J., 473.
Haus, G. A., 307, 313.
Hayne, L. B., 365.
Hebra, H. von, 329.
Hecker, 88, 89, 90, 91, 353.
Hecker, R., 236.
Hegele, 473.
Heil, K., 386.
Helme, T. A., 162.
Hennig, 372, 446.
Hennig, C., 230, 324.
Henrotin, F., 27.
Herrgott, 210.
Herrgott, A., 354.
Herman, G. E., 285, 361.
Hervey, 234.
Hervieux, E., 230.
Herzog, 27.
Heubner, 225.
Hildebrandt, 199.
Hildebrandt, H., 340.
Hink, W., 353.
Hippocrates, 4, 201.
Hirst, B. C., 64, 221, 354, 472.
His, 80.
Hochsinger, C., 225, 236, 244.
Hochstetter, 329.
Hochwelker, H., 163.
Hoess, F., 348.
Hoeven, P. C. T. van der, 440.
Hoffa, 50.
Hoffmann, A., 473.
Hoffmann, F., 5.
Hofmeyer, 268.
Högyes, A., 268.
Holmsen, F., 383.
Hönck, E., 293.
Horn, F., 473.
Houel, 307.
Hourlier, O., 422.
Hubrecht, 154.
Huc, E., 192.
Hudelo, L., 232, 233.
Hueter, G. F. G., 320.
Hugounenq, L., 142, 147, 148, 149.
Huntingdon, 390.
Husband, A., 283.
Hutchinson, J., 7, 47, 225, 247, 250, 256, 318, 327.
Hutchison, R., 138, 140, 141.

Ilott, H. J., 424.
Inglis, A., 479.
Ireland, W. W., 103.
Ithen, 394.

Jackson, G. T., 323.
Jaggard, W. W., 407.
Jahn, J. F., 308, 313.
Jakesch, W., 294.
Jamieson, W. A., 318, 332.
Janiszewski, T., 199.
Jany, C., 358.
Jardine, R., 281.
Jeannel, 397.
Jefferson, 32.
Jenner, E., 193.
Jennings, D. D., 463.
Jilden, 357.
Joachimsthal, G., 326.
Johannessen, A., 354.
Jones, B., 414.
Jones, J., 198.
Jones, J. D., 330.
Jopson, J. H., 301.
Joseph, M., 328.
Josephson, 473.
Jullien, 244.
Jungbluth, 404.
Justus, 235.

Kader, B., 53, 54.
Kaltenbach, R., 197.
Kannegisera, N. S., 414.
Karvonen, J. J., 236.
Kassowitz, 225, 244.
Katz, 164.
Kaufmann, E., 335, 336, 346, 348, 349, 350.
Keane, A. H., 323.
Keber, 266.
Keiller, A., 307, 375, 479.
Keim, G., 216.
Kerr, J. Munro, 463.
Kiderlen, 200, 217.
Kilham, 71.
Kirchberg, A., 353.
Kirchberg, J. A. A. F., 353.
Kirstein, E., 285.
Klebs, 285.
Klein, J. H., 353.
Klem, G., 354.
Knapp, L., 419.
Knorr, 414.
Kockel, 181, 209, 210.
Kölliker, 160.
Koettnitz, A., 419.
Kormann, E., 270.
Kostial, T., 272.
Krause, L., 386, 387.
Krebs, 324.
Kristeller, 380.
Krukenberg, 152.
Kruska, E., 326.
Kubassof, P., 271.
Küchenmeister, F., 425.
Kulenkampff, D., 300.
Küss, G., 181, 209, 210.
Kyber, E., 310, 311, 312, 313.
Kynoch, J. A. C., 400, 470.

Lafont-Marron, H., 353.
Lamadrid, J. J., 271.
Lambertz, 107, 120.
Lambinon, H., 419.
Lampe, R., 354.
Lancereaux, 276.
Lang, 317.

Lange, M., 165, 281, 414.
Langendorff, 160.
Langerhans, 313.
Langhans, 124, 125.
Lannois, 163.
Latis, M. R., 223.
La Torre, F., 168.
Laurens, 190, 191, 192.
Lauro, V., 353.
Laveran, 203.
Lawrence, J. Z., 323.
Leale, 197.
Lebedeff, 197.
Lécard, A. J., 353.
Lecorché, 283.
Lederer, I., 353.
Lefour, 262, 382.
Legrand, H., 260, 263.
Legros, 190.
Legry, 222.
Lehmann, 181.
Lempereur, A., 422, 423.
Lepidi, 203.
Leroux, 203.
Leter, L., 276.
Letulle, 158.
Leusser, 473.
Levaditi, 149, 201, 282.
Levi, 141.
Levy, 200.
Levy, E., 221.
Liebreich, F. R., 314.
Linck, P., 394, 395, 407.
Lincoln, 262.
Lindfors, A. O., 298.
Lisi, 223.
Lisle, J. de, 244.
Little, 389, 390, 391.
Livingstone, B., 313.
Lizé, A., 263.
Lobstein, 145.
Löhlein, H., 29, 375.
Loeffler, 211.
Lombroso, C., 323.
Lomer, R., 479.
Londe, 209.
Lop, 195, 419.
Lorain, P., 59, 60.
Lorenz, 50, 51.
Lovett, R. W., 51.
Lucas, J. C., 198.
Luce, J. B., 326.
Ludwig, H., 152, 223.
Lusk, W. T., 271.
Lustgarten, 244.
Luzet, Ch., 220.
Lynn, 189.

Macdougall, J. A., 440.
Macé, 231.
Macvie, S., 282, 457.
Magitot, E., 323, 325.
Mainzer, M., 303, 304.
Mairet, 274.
Makins, G. H., 354.
Malgaigne, 375.
Mall, 86.
Mamuroffski, 198.
Mamby, A. R., 320.
Mansfeld, 353.
Marchand, F., 222, 353.
Margarucci, O., 354.
Margoulieff, 192, 205.
Marquis, E., 271.
Martel, 285.
Martin, A., 413.
Martin, E., 358.
Mason, R. O., 340.
Massa, C., 223.
Masson, D. T., 486.
Mathewson, G., 239.
Matthes, V. W., 329.
Mattison, J. B., 270.
Mauriceau, F., 355.
Mayer, L., 375.
Maygrier, C., 456, 471.
Meckel, A., 298, 299.
Mejan, T., 192.
Mekerttschiantz, 407.
Melischer, L., 268.
Mercelis, 71.
Merkel, F., 99, 114.
Mermann, 144.
Mettenheimer, H., 99, 107, 113.
Meurer, 473.
Michelson, 315.
Michelson, P., 324.
Miklucho-Maclay, N., 327.
Milligan, D., 196.
Milroy, 301.
Milton, 410.
Minot, C. S., 55, 80, 85, 87, 120, 121.
Mirto, D., 264.
Miura, I. M., 265.
Moir, J., 479.
Molènes, P. de, 326.
Moncorvo, 174, 198, 203, 301, 303, 304, 441.
Moore, B., 161.
Moqué, A. L., 486.
Moreau, 362.
Mori, E., 353.
Morisani, D., 222.
Morrow, P. A., 304.
Mossé, A., 200, 376.
Mott, F. W., 92.
Moussous, 370.
Mraček, F., 228.
Mueller, A., 380.
Mueller, H., 353.
Müller, A., 353.
Müller, L. W., 414.
Müller, S., 336.
Müller, W., 375.
Mundé, P. F., 270.
Munnich, A. J., 315.

Nachtigäller, 289.
Nattan-Larrier, 158, 201.
Nazaroff, 446.
Neelsen, F., 298.
Negri, 417, 445.

Neisser, 244.
Nelson, D. T., 267.
Netter, 221.
Neugebauer, F., 134, 135, 323, 386.
Neuhaus, 250.
Neuhauss, R., 199.
Neumann, G., 348.
Newman, 283.
Nicholson, H. O., 137, 282.
Nicloux, M., 140, 156, 273.
Nissl, 103.
Nonne, M., 301.
Nutting, J. H., 353.

Oestreicher, 307.
Ogilvie, G., 247.
Ohmann-Dumesnil, 314.
Okel, 307.
Ollive, 471.
Ollivier, P., 218.
Olshausen, 360, 361.
Onodi, 169.
Opitz, E., 134, 177, 354, 383, 404.
Orloff, 425.
Orme, 320.
Osler, W., 201, 295, 303, 388.

Paal, H., 353.
Paci, 50.
Padgett, H., 372, 446.
Palazzi, G., 218, 223, 266, 267, 273, 274, 281, 362, 411.
Palm, H., 194.
Paris, 282.
Parker, C. W., 486.
Parkinson, C. H. W., 413.
Parreidt, J., 323.
Parrot, J., 225, 238.
Parry, L. A., 326.
Partridge, E. L., 271.
Paterson, 89.
Paterson, R., 285.
Paton, D. Noel, 473.
Paul, C., 260, 261, 262.
Paullini, C. F., 202.
Peaslee, 270.
Pedicini, M., 230.
Peiser, E., 134.
Pello, P., 354.
Pennato, P., 204.
Penrose, 32.
Perez, M., 315.
Perret, 447.
Perrin, E. R., 323.
Perroncito, E., 222, 223.
Pestalozza, 136, 137, 144, 169, 447.
Petersen, E., 228.
Petit, 219.
Petit, L., 236.
Pflug, 375.
Philipeaux, 267.
Phillips, W. F., 479.
Piasecki, 272.
Pickell, 324.
Piéry, 194, 195.
Pinard, 459, 471.
Pinkuss, 354.
Pitres, 354.
Plauchu, 200.
Playfair, G. R., 203.
Plottier, A., 264, 266, 271, 273.
Pocock, F. E., 224.
Pohlius, 322, 325.
Pollmann, 285.
Polosson, 376.
Porak, 158, 180, 183, 260, 263, 264, 265, 266, 267, 334, 340, 348, 354, 362, 383, 463.
Porta, L., 375.
Pott, R., 293.
Pradel, 272.
Preiss, E., 473.
Preuschen, F. von, 70.
Preyer, W., 126, 143, 145, 146, 147, 163, 170.
Priestley, W. O., 328, 425.
Prochownick, L., 473.
Profeta, 247, 248.
Pulewka, 265.

Queirel, 217.
Quinquaud, 268.
Qvisling, N., 386.

Radwansky, 386, 387, 388.
Raineri, G., 295.
Ranke, J., 323.
Rapin, 463.
Raynaud, L., 397.
Recklinghausen, R. von, 326.
Regnault, F., 348.
Reher, H., 199.
Reid, W. L., 58, 283.
Reifferscheid, K., 418.
Reijenga, J., 473.
Reinbach, G., 304.
Remy, S., 386.
Rénon, 209.
Rennert, O., 262, 263.
Resinelli, G., 200, 363, 406.
Restelli, L., 265.
Reubold, 144.
Reusing, H., 162.
Ribbert, H., 379.
Ribemont, 113.
Ribemont-Dessaignes, A., 320.
Richer, P., 351.
Richter, 307.
Ricker, G., 217.
Rieder, 390.
Riehl, G., 257, 478.
Rischpler, A., 186.
Ritter, 73, 319.
Robinson, G., 160.
Roger, H., 164.
Rolleston, H. D., 364, 365.
Romano, S., 222.
Romberg, M., 353.
Roque, F., 262.
Rose, 304.
Rosenblath, W., 222.
Rosinski, 230.

Rossa, E., 161, 223, 420.
Rostowzew, M. J., 222.
Roth, J. H., 354.
Rouget, J., 397.
Royer, C., 323.
Ruge, C., 230, 422.
Rumpe, R., 348.
Runge, M., 65, 66, 68, 69, 145.
Russel, P., 202, 203.

Sachse, 394.
Saintu, O., 382.
Salaghi, M., 354.
Salisbury, J. H., 244.
Salus, 449.
Salvetti, C., 354.
Sanchez-Toledo, 213.
Sangalli, G., 222.
Sänger, 284, 285, 294, 296, 414.
Sänger, W. M. H., 353.
Sarra, R., 304.
Sarraute, I.-G. 425.
Sartorius, C. F., 353.
Sarwey, 216.
Satullo, S., 399.
Savory, W. S., 163.
Schaefer, 145, 224.
Schaeffer, O., 386.
Schäffer, O., 99, 110, 115.
Schaller, L., 162.
Scharfe, H., 133, 235.
Scharlau, 353.
Schatz, F., 163.
Schede, M., 326.
Scheib, 354.
Schenk, 375.
Schiller, H., 407.
Schlesinger, E., 236.
Schlidlowsky, E., 353.
Schloss, O., 303.
Schmey, F., 354.
Schmitt, 471.
Schmorl, 181, 209, 210.
Schneider, A., 348.
Schnitzler, J., 304.
Scholz, L., 353.
Schröder, 145.
Schuhl, 320.
Schultz, 386.
Schultze, 413.
Schultze, B. S., 329.
Schulz, G. K. A., 353.
Schütz, E., 294.
Schütze, 70.
Schwab, 230.
Schwalbe, 99.
Schwarz, F., 337, 338.
Schwarzwäller, G., 353.
Schwendener, B., 354.
Schwyzer, G., 380.
Seegen, 283.
Seeger, 292.
Sentex, L., 405, 422.
Seulen, 290.
Sevestre, 362.
Seydel, C., 265.
Sfameni, P., 139, 141, 149, 150, 151.
Shuttleworth, 462.
Siebold, C. T. von, 323.
Siefart, 285, 294.
Simon, M., 222.
Simpson, A. R., 3, 352, 375, 479.
Simpson, Sir J. Y., 186, 236, 268, 307, 362, 375, 479.
Sireday, 262.
Skene, 271.
Skirving, A. A. S., 406.
Smith, M., 353.
Smith, Protheroe, 289.
Smith, W. R., 313.
Sonntag, E. H., 347.
Souty, 308.
Spannochi, T., 27.
Sperling, M., 394, 395.
Spiegelberg, O., 375.
Spietschka, T., 303, 304.
Spillmann, L., 348.
Squire, 196.
Squire, Balmanno, 326.
Stef, H., 264.
Steinbüchel, 414.
Steinthal, 303.
Steinwirker, H., 298.
St. Florent, V. D. de, 390, 391.
Still, G. F., 366.
Stilling, H., 336, 340.
Stoeltzner, W., 346.
Stokes, C. E., 401.
Storp, J., 348.
Strassmann, 407.
Strassmann, P., 112, 133, 163, 264.
Stratz, 197.
Straube, 309.
Strauch, H., 295.
Straus, I., 222.
Stricht, O. van der, 142.
Stricker, W., 323, 326.
Stroebe, 236.
Stumpf, 414.
Sullivan, W. C., 274, 275, 276.
Sutton, Bland, 307, 326, 344.
Švehla, K., 164, 166, 167.
Swan, R. L., 394.
Swiecicki, von, 473.
Symington, J., 336, 348, 349, 350.

Tait, Lawson, 293, 295.
Tarnier, 455.
Taruffi, C., 353, 375, 377, 380.
Taylor, W. T., 203.
Thiel, 230.
Thiemich, 147.
Thiercelin, 209.
Thiry, 226.
Thoma, R., 121.
Thomas, H. M., 48.
Thompson, J. A., 413.
Thomsen, 391.
Thomson, A., 87, 117, 118, 119.
Thomson, H. A., 336, 348, 349, 350.
Thomson, J., 25, 347, 348, 353, 363, 365, 367, 373, 384.

Thorburn, J., 479.
Thorner, M., 221.
Thost, 318, 319.
Thurnam, J., 327.
Tidy, M., 464.
Tissier, 235.
Tissot, J., 169, 414.
Tizzoni, 198.
Tschistowitsch, T., 354.
Tomes, C. S., 323.
Tourdes, G., 413.
Tourette, G. de la, 237.
Townsend, C. W., 340.
Tridondani, E., 417.
Tripier, L., 353.
Trousseau, A., 59, 60.
Truzzi, E., 358, 419.
Tuke, Hack, 462.
Turner, G. A., 58.
Turner, Sir W., 117.

Unna, P. G., 85, 318, 325.
Urtel, H., 353.

Valentin, A., 328.
Vanoye, 244.
Varaldo, 139, 142, 156, 204.
Varnier, 448.
Verneuil, 203.
Vicarelli, G., 146, 418, 419.
Vierordt, H., 371.
Villa, F., 348.
Vinay, Ch., 283, 284, 285.
Virchow, R., 234, 292, 293, 295, 323, 353, 357.
Vitanza, R., 198.
Viti, A., 221.
Vrolik, G., 308, 336, 340.

Wagner, 234.
Waitz, 303.
Walker, N., 325.
Wallich, V., 217, 230.
Warner, F., 315.
Wassmuth, A., 307.
Wasten, 134.
Watelet, 315.
Weber, 144.
Weber, F., 376.
Weber, F. P., 372.
Weber, M. J., 353.
Webster, J. C., 27, 425.
Wegner, G., 237.
Weir, J. J., 323.
Westphal, W., 380.
Widal, 217.
Widal, F., 199.
Williams, J., 283.
Williams, J. D., 211.
Williamson, T., 366.
Wilson, 323.
Winckel, F. von, 64, 65, 100, 283.
Winfield, J. M., 314.
Winkler, 424.
Winkler, N. F., 347.
Winslow, K., 203.
Winter, L., 260, 263.
Wolff, B., 484.
Wurster, 146.
Wyss, 353.

Ygonin, 272.
Young, P. A., 413.

Zagari, G., 223.
Zalackas, C., 460.
Zängerle, 200.
Zanier, G., 140.
Zariquiey, 372.
Ziegenspeck, 112.
Zilles, R., 230.
Zweifel, P., 268, 269.

INDEX OF SUBJECTS

PAGE

Abdomen of Fœtus, anatomy 112
Abortion 425
etiology of 426
frequency of 455
in fœtal death 425
in neofœtal period 84
Absence of Skin, congenital 328
Acanthoma of Skin 330
Accumulation of Microbes and Toxins in Placenta . . . 180
Acetonuria, in pregnancy 418
Achondroplasia 334, 347
Acromegaly, cause of 167
Adaptive Mechanism at Birth 38
Adrenals in Fœtal Syphilis 236
Age-Incidence of Morbid Processes 5
Agglutinating Principle in Fœtal Typhoid 200
Ainhum (?) in the Fœtus 397
Albumoses of the Liquor Amnii 152
Alcohol, passage from mother to fœtus 273
Alcoholism, effect upon the fœtus 272
Alimentary System, diseases of, in fœtus 355
Allantoic Placenta 154
vessels 121
Alopecia, congenital 326
Amnii, liquor 125
amount 86, 88, 89
chemical analysis 151
functions 153
in fœtal syphilis 231
in neofœtal period 83
meconium in 161
nutritive properties 153
renal origin 162
sugar 223
temperature 146
transmission of disease through 182
Amnioma of Skin 330
Amnion, anatomy of 125
Amniotic Adhesions in Fœtal Fractures 177
in fœtal wounds 178
Amniotic Origin of Congenital Amputations 397
fractures 394
wounds 395
Amniotitis 405
Amputations, congenital 396
spontaneous 178, 396

PAGE
ANATOMY OF FŒTUS 99
of neofœtal period 80
ANENCEPHALY AND FŒTAL MOVEMENTS 169
ANIMALS, fœtal ichthyosis in 314
fœtal rickets in 351
ANNEXA, fœtal, diseases of 175, 398
ANTECONCEPTIONAL PERIOD OF GERMINAL LIFE 9
ANTENATAL DIAGNOSIS 431
factor in gynecology 22, 23
in neonatal pathology 42
fragility of bones 48
hygiene 465
life, divisions 6
scheme 7, 10
ANTENATAL PATHOLOGY, and anatomy 17
and general pathology 17
and psychology 20
definition 2
emergence 3
interest in 12
journal 13
lectureship 13
literature 3
novelty 1
practical importanee 2
relations 16, 21
subdivisions 12
ANTENATAL PEMPHIGUS 327
prevention 14, 19
therapeutics 451, 460, 465
ANTHRAX, fœtal 222
AORTA OF FŒTUS, anatomy of 111, 116
"APOPLEXIES" IN THE PLACENTA 398
APPENDICULAR CIRCULATION IN THE FŒTUS 131
APPENDIX 489
APPENDIX VERMIFORMIS OF FŒTUS, anatomy of 115
development of 90
ARSENICAL POISONING IN THE FŒTUS 266
ARYTHMIC CHARACTER OF FŒTAL CARDIAC CYCLE 135
ASCITES, fœtal 355
in syphilis 237
ASPHYXIA, fœtal 163, 411
neonatorum 75
"ASTERION" REGION OF SKULL 104
ASYMMETRY OF FŒTAL HEAD 101
ATAXIA, Friedreich's 391
ATHEROMA, antenatal 374
ATROPHIC STATE OF SUBCUTANEOUS TISSUE 305
AUTOMATIC CHARACTER OF FŒTAL CARDIAC ACTION 134

BACILLUS OF SYPHILIS 244
BACTERIA, transmission through the placenta 157
BACTERIOLOGY OF FŒTAL ANTHRAX 222
erysipelas 197
pneumonia 221
sepsis 217
typhoid 199
BAUMGARTEN'S THEORY OF LATENCY 213
BIBLIOGRAPHY OF ANTENATAL RIGOR MORTIS 413
author's works 489
congenital goitre 375
congenital prolapsus uteri 386
fœtal bone disease 353
obliteration of the bile-ducts 365
BIRTH, functional changes at 39
readjustment of functions at 38, 39

BIRTH—*continued.* PAGE
separation—results of 37, 38
traumatism of 35
BIRTH-RATE, fall in 13, 456
BLADDER OF FŒTUS, anatomy of 116
distension of 379
hypertrophy of 381
BLENORRHŒA NEONATORUM 51, 52, 53
umbilici 62
BLOOD, development 86
distribution 131
chemistry 141
histology 139
in neofœtal period 83
in syphilis 235
BOGENFURCHE 82, 86, 87
BONE DISEASES, fœtal 334
BONES, antenatal fragility of 48
in fœtal syphilis 237
BRAIN OF FŒTUS, anatomy of 101
changes in, in neofœtal period 82
development of 85, 87, 88, 89, 91, 92
BRONCHOCELE, intrauterine 374
BRONZED HÆMATIC DISEASE 64
BUCCAL CAVITY OF FŒTUS, anatomy of 103
secretions in the fœtus 159
BUHL'S DISEASE 63, 64, 65
BUNGE'S LAW 148, 448

CÆCUM OF FŒTUS, anatomy of 114
CALCAREOUS DEPOSITS ON PLACENTA 151
CANCER, maternal, state of fœtus in 282
CAPUT SUCCEDANEUM 36, 37
CARBONIC OXIDE POISONING IN THE FŒTUS 267
CARDIAC ACTION IN THE FŒTUS 133
circulation in fœtus 129, 135
impulse, palpation of 136
CARDIOGRAM OF FŒTUS 137
CEPHALHÆMATOMA NEONATORUM 44, 45
CEPHALOMETER IN ANTENATAL DIAGNOSIS 447
CEREBELLUM, development of 89
CERVIX UTERI, antenatal laceration 32
CHALDEA, teratological records 4
CHEMICAL EXAMINATION OF EXCRETIONS IN ANTENATAL DIAGNOSIS . . 448
CHEMICAL SUBSTANCES, transmission through the placenta . . 156, 157
CHEMISTRY OF THE FŒTAL LIVER 159
urine 162
of the fœtus 147
liquor amnii 151
meconium 161
placenta 150
vernix caseosa 160
CHLOROFORM, influence upon the fœtus 268
CHLOROSIS AND MALFORMATIONS 20
CHOLERA IN THE FŒTUS 198
CHONDRODYSTROPHIA FŒTALIS 335, 347
CHOREA, congenital 390
CHORION, anatomy of 125
development of 83, 86
in neofœtal period 83
villi of, structure of 124
CIRCULATION IN THE FŒTUS 127
changes in, at birth 132
extra-corporeal 127
intra-corporeal 129
CIRCULATORY CHANGES AT BIRTH 41
system, diseases of 369

PAGE
Classification of Fœtal Bone Diseases 336
morbid states 174, 175, 176
movements 169, 170
Clavicle of Fœtus, anatomy of 109
ossification of 81
Cleidotomy 109
Clinical History of Congenital Elephantiasis 301
bone disease 337, 339, 348, 352
congenital hypertrichosis 324
fœtal ascites 356
death 414
endocarditis 373
general fœtal dropsy 289
hydramnios 401
ichthyosis 307, 315
malaria 202
measles 196
obliteration of the bile-ducts 363
variola 189
Cloaca, development of 81, 87
Closure of the Foramen Ovale and Ductus 133
Clouding of Cornea, congenital 391
Coal Gas Poisoning in the Fœtus 267
Colles' Law in Syphilis 163, 249
"Collodion Fœtus" 315
Colon of Fœtus, anatomy of 115
hypertrophy of 367
Comparative Embryology 17
fœtal pathology 17
histology of placenta 182
teratology 17
Complications of Fœtal Variola 192
Composition, chemical, of fœtal blood 141
Congenital Absence of Skin 328
alopecia 326
bullous dermatitis 74
cystic elephantiasis 297
elephantiasis 300
goitre 374
hypertrichosis 321
pemphigus 327
syphilis 248
torticollis 53
Conjunctivitis, gonorrhœal, of new-born 52
Convolutions of the Umbilical Cord 400
Copper, poisoning with, in pregnancy 266
Cornea, congenital clouding of 391
Coronary Sinus of Placenta 123
Corpuscles, red, in the fœtus 139
white, in the fœtus 140
Cranio-Pharyngeal Canal in Fœtus 105
Craniotabes 337
Cranium of Fœtus, anatomy of 100
development of 87
Cretin, goitrous 166
Cretinism, congenital 335
Cyanosis, pernicious icteric 64
Cystic Elephantiasis, congenital 297

Dasytes 322
Death of Extrauterine Fœtus 424
Death of the Fœtus 409
pathology of 176
Decidual Membranes, anatomy of 125
development of 86, 87
in neofœtal period 83

PAGE
DEFINITION OF ANTENATAL PATHOLOGY 2
congenital elephantiasis 300
congenital goitre 374
congenital hypertrichosis 321
congenital obliteration of bile-ducts 363
fœtal ascites 355
fœtal ichthyosis 306, 315
fœtal keratolysis 319
general fœtal dropsy 289
hydramnios 400
tylosis palmæ 318
DEFORMITIES, embryonic in origin 185
DEGENERATION, fibro-fatty, of placenta 399
DERMATITIS, congenital bullous 327
exfoliativa neonatorum 72
DERMOIDS IN THE FŒTUS 174
DESQUAMATION, physiological, in new-born 73
DEVELOPMENT OF FŒTUS 84, 86, 88, 89, 90, 91, 92, 93
DIABETES, maternal, state of fœtus in 283
DIABETES MELLITUS IN FŒTUS 223
DIAGNOSIS, antenatal 431
of fœtal death 416
fœtal endocarditis 372
fœtal morbid states 430
general fœtal dropsy 296
hydramnios 402
intranatal 449
neonatal 432
obliteration of the bile-ducts 365
postnatal 450
DIAPHRAGM IN FŒTUS, anatomy of 108
development of 86
DIET IN PREGNANCY 472
of mother and chemistry of fœtus 147
DIFFICULTIES OF ANTENATAL DIAGNOSIS 430
DIGESTION IN THE FŒTUS 160
DIGESTIVE CHANGES AT BIRTH 40
DIGITS, development of 85
DIPLOTERATOLOGY 12
DISEASES, fœtal 173, 188
and malformations 186
idiopathic 175, 288
of the fœtal annexa 175, 398
skeleton 334
DISEASES, transmission of, from fœtus to mother 184
through the placenta 156
DISEASES, transmitted 175
DISLOCATIONS IN THE FŒTUS 395
in the new-born infant 49
spontaneous of knee 214
DIVISIONS OF ANTENATAL LIFE 6
pathology 12
DROPSY, general, of the fœtus 288
DUCTUS ARTERIOSUS, anatomy of 111, 112
closure of, at birth 133
DUCTUS THYREO-GLOSSUS 83
DUODENUM OF FŒTUS, anatomy of 114
DYSTROPHIES OF ALCOHOLISM 243, 276
of fœtal syphilis 239
of fœtal tuberculosis 214, 243

EAR OF FŒTUS, anatomy of 104
anteversion of 85
development of 84, 87
ECLAMPSIA, maternal, effect on Fœtus 278
on placenta 281

PAGE
Eczema Neonatorum 55
Effects of Fœtal Syphilis 254
Elastic Fibres in Skin, development of 90
"Elastic Skinned Men" 305
Elephantiasis, congenital 174, 300
cystic 297
Embryology, comparative 17
Embryonic contrasted with Fœtal Life 79
factor in fœtal pathology 185
pathology 12
period of life 7, 10
Emergence of Antenatal Pathology 3
Endarteritis, in fœtal syphilis 235
Endocarditis, fœtal 369
streptococcic, in fœtus 198
tubercular 209
Environment, influence of, upon fœtal diseases 176
intrauterine 7
Epidemic Cerebro-Spinal Meningitis in Fœtus 218, 220
Epidermolysis Bullosa Hereditaria 74, 327
Epitrichium 85
Eponychium 85
Erroneous Views regarding Antenatal Treatment . . . 452
Eruption, characters of, in fœtal variola 192
Erysipelas in the Fœtus 176, 197
neonatorum 59
Erythroblasts in the Fœtus 139
Erythrocytes in the Fœtus 139
"Esaus" 322
Essential Icterus Neonatorum 67
Ether, influence upon the Fœtus 269
Etiology of Abortion 426
congenital goitre 376
congenital hypertrichosis 324
cystic elephantiasis 300
fœtal ascites 366
fœtal bone disease 337, 339, 352
fœtal death 427
fœtal endocarditis 371
fœtal ichthyosis 314, 317
fœtal keratolysis 320
tylosis palmæ 318
Eustachian Tube of Fœtus, anatomy of 104
Eustachius, valve of, in fœtus 111
Excretions of the Fœtus 161
Exercise in Pregnancy 475
Exophthalmic Goitre, cause of 166
Extrauterine Fœtus, death of 424
pregnancy 27
Extremities of Fœtus, anatomy of 120
Eye, development of 84, 86

Face, in neofœtal period 81
Face Bones, ossification of 82, 85
Face of Fœtus, anatomy of 103
Facial Paralysis in New-born 46, 47
Factor, embryonic, in fœtal pathology 185
environmental, in fœtal pathology 177
placental, in fœtal pathology 179
Fallopian Tubes of Fœtus, anatomy of 119
Family History in Antenatal Diagnosis 438
Family Prevalence, and ovarian cysts 29
Fat of the Fœtus, origin of 87, 89, 147
Father, influence of, in fœtal malaria 203
upon fœtal weight 168
Femur, ossific nucleus in epiphysis of 91, 92

PAGE
FIBROIDS OF UTERUS, antenatal cause 27
FILTER, placenta as a 181
FŒTAL ASCITES 355
development 84, 86, 88, 89, 90, 91, 92, 93
diseases, first work on 4
growth 84, 86, 88, 89, 90, 91, 92, 93
heart beat in labour pains 136
ichthyosis, grave form 306
,, mild form 315
keratolysis 319
life, contrasted with embryonic 79
general characters of 78
placental influence in 78, 79
semi-parasitism of 78
FŒTAL PATHOLOGY 12
classification 174
comparative 17
embryonic factor in 185
general principles 172
FŒTAL PERIOD OF LIFE 7, 10
FŒTAL PERITONITIS 25, 26, 362
rickets 335
tubercle 206
FŒTICIDE, therapeutic 13, 460
FŒTUS, anatomy of 99
anthrax of 222
asphyxia of the 163
cardiac action in the 133
chemical composition of 147
cholera in the 198
circulation in 127
compressus 178, 424
cystic elephantiasis of 297
death of the 176, 409
diabetes mellitus of 223
distension of bladder in 379
elephantiasis of the 174
endocarditis in the 369
epidemic cerebro-spinal meningitis in 218, 220
erysipelas in the 197
excretions of the 161
general dropsy of the 288
growth of the 167
hypertrophic dilatation of bladder in 381
idiopathic diseases of 288
immunisation of 195
influenza in the 198
malaria in the 201
measles in the 196
medication of 476
movements of 169, 170
nephritis in the 378
nutrition of the 145, 152
papyraceus 424
parotitis 198
pertussis in the 198
physiology of 126
pneumonia of 221
position of primary lesions in 182
potential morbidity of 179
purpura of 219
rabies of 223
relapsing fever in the 198
respiration in the 143
rheumatic fever of the 223
scarlet fever in the 196

FŒTUS—*continued.* PAGE
secretions of the 159, 160
sensation in the 170
sepsis of 217, 220
syphilis of 225, 477
temperature of 145
toxicological states of the 259
traumatism in the 393
tuberculosis of 206
typhoid fever in the 199
vaccinia in the 194
varicella in the 198
yellow fever in the 198
FONTANELLE OF GERDY 46
FORAMEN OVALE, anatomy of 111
closure of, at birth 133
FRACTURES IN THE FŒTUS 177, 393
in new-born 48
FRAGILITY OF BONES, antenatal 48
FREQUENCY OF FŒTAL ENDOCARDITIS 371
FRIEDREICH'S ATAXIA 391
FUNCTIONAL CHANGES AT BIRTH 39

GALL-STONE, antenatal 69
GASTRIC SPASM, congenital 365
GASTRO-INTESTINAL CIRCULATION IN THE FŒTUS 131
GENERAL DROPSY OF THE FŒTUS 288
GENITAL ORGANS, diseases of, in fœtus 384
malformations 24
GENITAL TUBERCLE 81, 85
GERMINAL PATHOLOGY 12
period of life 9, 10
therapeutics 484
GLUCOSE IN FŒTAL BLOOD 141
GLYCOSURIA IN THE FŒTUS 162
GOITRE, congenital 374
exophthalmic, cause of 166
GRANULOMA OF UMBILICUS 61
GROWTH OF FŒTUS 41, 84, 86, 88, 89, 90, 91, 92, 93, 167
GUMMATA IN FŒTAL SYPHILIS 234
GYNECOLOGY, antenatal factor in 22, 23
diagnosis 28
etiology 27
jurisprudence 31
morbid anatomy 24
prognosis 30
relation to antenatal pathology 22
symptomatology 26
therapeutics 30

HABITUAL FŒTAL DEATH 410, 419
HÆMATEMESIS NEONATORUM 69
HÆMATOMA OF STERNO-MASTOID IN NEW-BORN 53
HÆMATOPOIESIS IN THE FŒTUS 142, 164
HÆMATOZOON OF MALARIA 203
HÆMOGLOBIN OF THE FŒTAL BLOOD 140
HÆMOGLOBINURIA NEONATORUM 63
HÆMOPHILIA, maternal, effect on fœtus 286
of new-born 63
treatment of 480
HÆMORRHAGE FROM THE UMBILICUS 65
HÆMORRHAGES IN THE PLACENTA 398
HÆMORRHAGIC SYPHILIS 227
HAIR, development of 85, 88
"HAIRY MEN" 322
"HAMILTON" BED IN EDINBURGH MATERNITY 470

PAGE
"Harlequin Fœtus" 307
Head of Fœtus, anatomy of 100
new-born infant, anatomy of 100
Head-moulding, in labour 36
Heart, changes in, in fœtal syphilis 235
disease in new-born infant 75
malformations of 370
maternal, state of fœtus in 285
neofœtal period 83
Heart of Fœtus, anatomy of 110
inflammation of 369
structure of 111
Heat-regulating Mechanism in Fœtus 146
Hepatic Changes at Birth 41
circulation in the fœtus 130
Heredity, heteromorphic 215
morbid 486
of uterine fibroids 27, 28
Heteromorphic Heredity 215
Hexenmilch 55
Hibernating Animals and Human Fœtus 147
Hip, congenital dislocation 49, 50
Hirsuties Adnata 321
Hospital, pre-maternity 466
Hydramnios 400
character of liquor amnii in 177
in fœtal syphilis 231
Hydrocephalus, congenital 389
in fœtal syphilis 237
Hydronephrosis in the Fœtus 383
Hydrophobia in Pregnancy 223
Hydrops Sanguinolentus 239, 422
Hydrorrhœa Gravidarum 418, 440
Hygiene, antenatal 465
intranatal 463
of pregnancy 471
Hymen, development of 88
Hyoid Bone, anatomy of 107
Hypersiderosis of Fœtus 149
Hypertrichiasis 322
Hypertrichosis Congenita 321
general 321
local 326
lumbar 326
Hypertrophic Dilatation of the Bladder 381
Hypertrophy, congenital, of the colon 367
Hypophysis Cerebri of Fœtus, anatomy of 105
function of 167
Hyposiderosis of Pregnancy 149
Hypospadias, diagnosis of 29
Hypotrichosis, congenital 326
Hystrix, ichthyosis 318
Huntingdon's Chorea 390
Hutchinsonian Triad of effects of Congenital Syphilis 254

Ichthyosis, fœtal 177
grave form 306
mild form 315
hystrix 318
syphilitic 238
Icterus Neonatorum 67
Idiopathic Diseases of the Fœtus 175, 288
Idiopathic Icterus Neonatorum 67
Immunisation, fœtal, mechanism of 195
Immunity against Syphilis 246
variola 194

PAGE
IMMUNITY, transmission to fœtus 483
IMPRESSIONS, maternal, in fœtal pathology 174
INCUBATION OF FŒTAL MEASLES 196
variola 190
INFANT, syphilis of the 225
INFANTILISM IN WOMEN, characters 29
INFECTION AND TRAUMATISM 23, 24
neonatal 57
INFECTIONS, intranatal 51
INFLUENZA IN THE FŒTUS 198
INSPIRATION, first, cause of 143
INTESTINAL PROTRUSION INTO UMBILICAL CORD 81
INTESTINE, secretions of, in the fœtus 160
INTESTINES OF FŒTUS, anatomy of 114
in fœtal syphilis 236
INTRACONCEPTIONAL PERIOD OF GERMINAL LIFE 9
INTRANATAL CEPHALHÆMATOMA 44
diagnosis 449
infections 51
life, importance 6
pathology 5
physiology 34
syphilis 226
traumatisms 44
treatment 463
INTRAUTERINE EVIRONMENT AND DISEASES 176
life, changes in 84
divisions 6
pathology 2
IODINE, absence of, in the fœtus 166
IRON OF THE FŒTUS, origin of 148
IRREGULARITY OF FŒTAL CARDIAC ACTION 135

JAUNDICE, congenital 363
of the new-born 43
JOINTS, development of 85
JUSTUS BLOOD TEST IN SYPHILIS 235

KERATOLYSIS, fœtal 319
neonatorum 72
KERATOMA PLANTARE 318
KIDNEY, in neofœtal period 82
KIDNEYS, anatomy of 115
cystic degeneration of 383
fœtal syphilis 236
inflammation of, in fœtus 378
KNEE, spontaneous dislocation of 214
KNOTS ON UMBILICAL CORD 121, 400
KNOWLEDGE OF FŒTAL PATHOLOGY, limitation 173

LABIA MAJORA AND MINORA, anatomy of 120
LABOUR, effects of, on head of fœtus 101
head-moulding in 36
pressure effects of 35, 36, 37
LACERATION, antenatal, of cervix uteri 32
LÆHME 65
LANGHANS' LAYER OF VILLUS 124
LANUGO, development of 86, 89, 90
LARVAL STAGE OF CONGENITAL TUBERCLE 213
LARYNX IN FŒTUS, anatomy of 107
LAW OF COLLES 249
of Profeta 246
LEAD-POISONING IN THE FŒTUS 260
LENGTH OF THE FŒTUS, causes of variations 168
LESIONS, placental, lethal effect 183
primary, in the fœtus 182

PAGE
LETHAL EFFECT OF PLACENTAL LESIONS 183
LEUCOCYTES, development in fœtus 142
transmission through the placenta 157
LEUCOCYTOSIS IN THE FŒTUS 140
LEUKÆMIA, maternal, state of fœtus in 284
LIFE, antenatal, divisions 6
scheme 7, 10
embryonic 7, 10
fœtal 7
general characters of 78
germinal 9, 10
neofœtal 9
neonatal 7
LIMBS, in the neofœtal period 81
of fœtus, anatomy of 120
LIMITATIONS OF KNOWLEDGE OF FŒTAL PATHOLOGY 173
LITERATURE OF ANTENATAL PATHOLOGY 3
congenital goitre 375
congenital prolapsus uteri 386
fœtal bone disease 353
rigor mortis 413
LITHOPÆDION 425
LITTLE'S DISEASE 389
LIVER, anatomy of 113
changes in, in fœtal syphilis 232
chemical composition of 159
development of 83, 86
in neofœtal period 83
"LIVING SKELETONS" 305
LOCHIA, umbilical 60
LONG BONES, ossification of 82
LUNGS, anatomy 111
changes in, in fœtal syphilis 234
in neofœtal period 83
LYMPHANGITIS OF UMBILICUS 62
LYMPHATICS, development of 89
LYMPHOCYTOSIS IN THE FŒTUS 141

MACERATION IN FŒTAL DEATH 178, 421
MACROCEPHALY AND LEAD-POISONING 262
MALARIA, fœtal 201
clinical history of 202
pathology of 203
treatment of 204
MALFORMATIONS AND CHLOROSIS 20
and fœtal diseases 186
in fœtal syphilis 240
in offspring of tubercular mothers 215
in offspring of women suffering from typhoid fever 201
of genital organs 24
treatment 31
of the heart 370
of the nervous system 389, 392
MALIGNANT ICTERUS NEONATORUM 69
MAMMARY GLANDS, development of 90
secretion in the fœtus 160
MARRIAGE, legal restriction of 14
regulation of 485
MASTITIS NEONATORUM 54
MATERNAL HISTORY IN ANTENATAL DIAGNOSIS 434
impressions, in fœtal pathology 174
physical examination in antenatal diagnosis 442
symptomatology in antenatal diagnosis 439
temperature, effect upon fœtus 146
MATURITY OF FŒTUS 91
MEASLES IN THE FŒTUS 196

PAGE
MEASUREMENTS OF HEAD OF FŒTUS 101
MECHANISM OF ABORTION 426
fœtal death 411
immunisation 195
MECONIUM, appearance of 91, 92
composition of 161
MEDICATION, antenatal 476
MEDICINES, passage through placenta 476
MELÆNA NEONATORUM 69
MEMBRANES OF FŒTUS, anatomy of 125
MENINGITIS, epidemic cerebro-spinal, in fœtus 218, 220
MENSTRUATION OF THE NEW-BORN 54
MERCURIAL POISONING IN THE FŒTUS 263
METABOLISM, fœtal, regulation of 164, 165
in the placenta 184
MICROBES, accumulation of, in placenta 180
transmission of, through placenta 181
MICTURITION DURING FŒTAL LIFE 162
MILIARIA, nasal, in fœtus 92
"MISSING LINKS" 322
MITTELSCHMERZ, cause of 26
MODIFICATION OF FŒTAL DISEASE BY ENVIRONMENT 176
"MOLES" 408
MONSTROSITIES 12
formation of 185
in fœtal syphilis 240
in the offspring of the phthisical 215
MORBID ANATOMY OF CONGENITAL GASTRIC SPASM 366
of congenital goitre 375
of fœtal ascites 358
of fœtal bone disease 337, 339, 340, 348, 352
of fœtal ichthyosis 308, 315
of fœtal syphilis 229
of general fœtal dropsy 292
of obliteration of the bile-ducts 364
of oligohydramnion 408
MORBID HEREDITY 486
MORBID PROCESSES, age-incidence 5
MORBIDITY, potential, of the fœtus 179
MORBUS CŒRULEUS 371
MORPHINE, effect upon the fœtus 270
MORTALITY, potential, of the fœtus 180
MOULDING OF THE HEAD IN LABOUR 36
MOUTH, development of 84
MOVEMENTS, fœtal 89, 144, 169, 170
MÜLLERIAN DUCTS, changes in 82, 86
MUMMIFICATION IN FŒTAL DEATH 178, 424
MUSCULATURE OF FŒTUS 120
MYELINATION OF TRACTS IN BRAIN 102
MYOTONIA CONGENITA 391
MYXŒDEMA, congenital 305

NACKENGRUBE 81
NÆVUS PILOSUS 326
NAILS, development of 85, 88, 89, 91
NECK OF FŒTUS, anatomy of 107
NEOFŒTAL PERIOD OF LIFE 9, 80
NEONATAL DIAGNOSIS 432
infection 57
pathology, antenatal factor in 42
investigation 33
nomenclature 33
period of life 7, 10, 34
readjustments, disturbed 66
NEONATAL SYPHILIS 226, 227
NEOPLASMS IN THE FŒTUS 174, 175

PAGE
NEPHRITIS, fœtal 378
NERVOUS MALADIES, fœtal, treatment 479
NERVOUS SYSTEM, diseases of, in fœtus 388
in fœtal syphilis 237
NEW-BORN INFANT, asphyxia 75
desquamation in 73
diseases of 6
dermatitis exfoliativa 72
dislocations in 49
eczema in 55
erysipelas in 59
facial paralysis 46
fractures in 48
hæmatoma of sterno-mastoid 53
hæmoglobinuria in 63
hæmophilia of 63
jaundice 43, 67
keratolysis 72
mastitis in 54
melæna in 69
menstruation in 54
œdema in 74
omphalorrhagia 65
ophthalmia in 51
pemphigus in 74
prematurity 62, 463
puerperal fever 59
purpura of the 219
sclerema in 74
sepsis in 60
sphygmograms of 138
syphilis of the 225
tetanus 57, 58
NICOTISM, effect upon the fœtus 272
NOMENCLATURE OF FŒTAL BONE DISEASES 335
of neonatal diseases 33
"NORMAL" HEAD OF FŒTUS 101
NOURISHMENT, transmission through the placenta 156
NUCLEATED RED CORPUSCLES IN THE FŒTUS 139
NUCLEON IN FŒTAL BLOOD 141
in the placenta 150
NUTRITION OF THE FŒTUS 145, 152

OBELION, region of cranium 46
OBLITERATION OF BILE-DUCTS, congenital 363
OCCIPITO-ATLANTOID JOINT IN FŒTUS 106
OCCUPATION IN PREGNANCY 475
ŒDEMA NEONATORUM 74
ŒSOPHAGUS OF FŒTUS, anatomy of 112
development of 90
OLIGOHYDRAMNION 381, 406
OMENTUM OF FŒTUS, anatomy of 113
OMPHALITIS NEONATORUM 61, 62
OMPHALORRHAGIA NEONATORUM 65
ONYCHOGRYPHOSIS IN FŒTAL ICHTHYOSIS 308
OPHTHALMIA NEONATORUM 51, 52, 53
OPIUM, influence upon the fœtus 269
ORGANOGENESIS 7, 10
OS TRIBASILARE 346, 349
OSMOSIS IN THE PLACENTA 158
OSSIFICATION OF THE CLAVICLE 81
face bones 82
long bones 82, 85
of sternum 82
vertebræ 82, 88
OSTEO-CHONDRITIS, syphilitic 238

PAGE
OSTEOGENESIS IMPERFECTA 49, 334, 340
OSTEOPSATHYROSIS 335, 340
OVARIES OF FŒTUS, anatomy of 119

PALPATION OF FŒTAL HEART BEAT 136
PANCREAS OF FŒTUS, anatomy of 114
secretions of 160
syphilis 236
PARALYSIS, facial, in new-born 46
PARASITISM OF FŒTAL LIFE 78
PARA-THYROIDS, function of, in the fœtus 165
PAROTITIS IN THE FŒTUS 198
PARS COMMUNICANS OF AORTA 112
PATERNAL HISTORY IN ANTENATAL DIAGNOSIS 437
influence in fœtal malaria 203
in syphilis 252
upon the weight of the fœtus 168
PATHOGENESIS OF ACANTHOMA OR AMNIOMA 333
cephalhæmatoma 45
congenital absence of skin 329
amputations 396
elephantiasis 304
congenital gastric spasm 366
goitre 376
hypertrichosis 325
prolapsus uteri 387
PATHOGENESIS OF FACIAL PARALYSIS IN NEW-BORN 47
fœtal ascites 360
asphyxia 412
bone disease 337, 339, 350, 352
fractures 394
ichthyosis 314, 317
keratolysis 320
syphilis 243
variola 189
general fœtal dropsy 294
hydramnios 404
hypertrophy of bladder 382
obliteration of the bile-ducts 364
oligohydramnion 407
placental hæmorrhages 399
PATHOLOGY, antenatal, and anatomy 17
and botany 17
and dermatology 20
and embryology 17
and general pathology 17
and gynecology 21, 22, 32
and legal medicine 20
and medicine 19
and neonatal pathology 21
and obstetrics 19
and orthopedics 20
and pediatrics 19
and physiology 17
and psychology 20
and public health 19
and surgery 20
PATHOLOGY, antenatal, definition 2
interest in 12
journal 13
lectureship 13
literature 3
novelty 1
practical importance 2
relations 16, 21
subdivisions 12

PAGE
PATHOLOGY, embryonic 12
PATHOLOGY, fœtal 12
classification 174
comparative 17
embryonic factor in 185
limited knowledge of 173
placental factor in 179
principles of 172
scope of 172
PATHOLOGY, germinal 12
PATHOLOGY, neonatal ; antenatal factor in 42
investigation 33
nomenclature 33
PATHOLOGY OF BLOOD IN FŒTAL SYPHILIS 235
congenital prolapsus uteri 385
cystic elephantiasis 298
fœtal ascites 358, 360
asphyxia 412
bone disease 337, 339, 342, 348, 352
death 176, 420
endocarditis 371
ichthyosis 308, 315
malaria 203
syphilis 229
tuberculosis 212
typhoid 199, 201
general fœtal dropsy 292
heart in fœtal syphilis 235
hydramnios 403
hypertrophy of bladder 381
obliteration of the bile-ducts 364
placenta in syphilis 230
placental hæmorrhages 399
tylosis palmæ 318, 319
PECULIARITIES OF FŒTAL MORBID STATES 176
PELVIS OF FŒTUS, anatomy of 116
development of 87
PEMPHIGUS, antenatal 327
neonatorum 74
syphilitic 227, 238
PEPTONURIA, in pregnancy 419
PERIARTERITIS IN FŒTAL SYPHILIS 235
PERITONITIS, fœtal 25, 26, 236, 362
PERMEABILITY, placental 182
PERNICIOUS ICTERIC CYANOSIS 64
PERSISTENCE OF FŒTAL CARDIAC ACTIVITY 134
PERTUSSIS IN THE FŒTUS 198
PETRIFICATION OF DEAD FŒTUS 425
PHOSPHATES IN THE FŒTUS 149
PHOSPHORUS IN THE PLACENTA 151
poisoning in the fœtus 265
PHYSICAL EXAMINATION IN ANTENATAL DIAGNOSIS 442, 444
PHYSICAL SIGNS OF HYDRAMNIOS 401
PHYSIOLOGICAL READJUSTMENT AT BIRTH 38, 39
traumatism of birth 35
PHYSIOLOGY OF THE FŒTUS 126
of mother in pregnancy 127
of neofœtal period 80
of neonatal life 34
PILOSISM 322
PITUITARY BODY, functions of, in fœtus 167
PLACENTA, allantoic 154
anatomy of 122
changes in fœtal death 423
chemical composition of 150
circulation in the 127

PLACENTA—*continued.* PAGE
comparative histology of 182
connections, in neofœtal period 84
development of 88, 89, 90, 91, 92, 93
disease of, treatment of 479
excretion through the 163
fibro-fatty degeneration of 399
in fœtal anthrax 222
in fœtal syphilis 230
in general fœtal dropsy 294
hæmorrhages in the 398
lesions of, lethal effect 183
life history of 122
metabolism in the 184
nutritive functions of 155
pathology of, in eclampsia 281
separation of the 37, 38
sepsis of 217
teratology 17
toxicity of 281
tuberculosis of 181, 209
vessels of 123
vitelline or omphaloidean 154
PNEUMONIA, fœtal 221
in fœtal syphilis 234
POISONS, effect of, on the fœtus 259
storing up of, in placenta 180
POLYTRICHIA 321
POST-MORTEM CHANGES IN THE FŒTUS 178
POSTNATAL DIAGNOSIS 450
pathology 5
treatment of antenatal morbid states 461
POTENTIAL MORBIDITY OF INTRAUTERINE LIFE 179
PREGNANCY, diet in 472
exercise in 475
extrauterine 27
hydrophobia in 223
hygiene of 471
occupation in 475
physiology of 127
vaccination during 194
PREGNANT WOMEN, hospitals for 470
PRE-MATERNITY HOSPITAL, plea for 466
PREMATURE INFANTS 62, 463
PREMATURE LABOUR 455
in fœtal death 427
PRESSURE EFFECTS OF LABOUR 35, 36, 37
PREVENTION, antenatal 14, 19
PROCHOWNICK'S DIET IN PREGNANCY 473
PROFETA, law of 246
PROGNOSIS IN FŒTAL ENDOCARDITIS 373
fœtal ichthyosis 314
hydramnios 403
obliteration of the bile-ducts 365
tylosis palmæ 319
PROJECTION OF ANTENATAL INTO POSTNATAL PATHOLOGY 2
PROLAPSE, congenital, of uterus 25, 384
PROPHYLAXIS OF TUBERCLE 216
PROTECTION OF THE FŒTUS BY THE PLACENTA 180
"PTERION" REGION OF SKULL 104
PUERICULTURE 13, 465
PUERPERAL FEVER OF THE NEW-BORN 59
PULMONARY CIRCULATION IN THE FŒTUS 130
PULSE OF FŒTUS, characters of 137
PUPILLARY MEMBRANE, development of 90
PURPURA, fœtal 219

PAGE
PYLORUS, congenital hypertrophic stenosis of 365
PYOCYANIC DISEASE, immunity against 195

QUICKENING 169

RABIES, FŒTAL 223
RACHITIS CONGENITA 335
fœtal 335
RARITY OF FŒTAL TUBERCULOSIS 210
RATE OF FŒTAL HEART BEAT 135
READJUSTMENTS, neonatal, disturbed 66
physiological, at birth 38, 39
RECTUM OF FŒTUS, anatomy of 119
REGIONS OF THE SPINE IN THE FŒTUS 106
REGISTRATION OF STILL-BIRTHS 464
RELAPSING FEVER IN THE FŒTUS 198
RESPIRATION IN THE FŒTUS 143
intrauterine 169
pulmonary, cause of 40
RESPIRATORY MOVEMENTS OF FŒTUS 144
RETENTION OF DEAD FŒTUS 427
RHEUMATIC FEVER IN THE FŒTUS 223
RIBS OF FŒTUS, anatomy of 109
RIGIDITY, congenital spastic 389
RIGOR MORTIS IN THE FŒTUS 178, 413
RITTER'S DISEASE 63, 72

SACRUM OF FŒTUS, anatomy of 117
ossification of 107
SALIVARY GLANDS, changes in the neofœtal period 82
secretion in the fœtus 159
SALTS IN THE FŒTAL BLOOD 141
"SANATORIA DE GROSSESSE" 470
SAPONIFICATION OF DEAD FŒTUS 424
SCAPULA OF FŒTUS, anatomy of 109
SCARLET FEVER IN THE FŒTUS 196
SCHEME OF ANTENATAL LIFE 7, 10
SCLEREMA NEONATORUM 74
SCOPE OF ANTENATAL DIAGNOSIS 431
SEBACEOUS GLANDS, development of 88
secretion in the fœtus 160
SECRETIONS OF THE FŒTUS 159, 160
of the placenta 158
SENSATION IN THE FŒTUS 170
SEPARATION RESULTS OF BIRTH 37, 38
SEPSIS, fœtal 217, 220
neonatorum 60
SEROUS MEMBRANES, secretions of, in the fœtus 160
SERUM TEST FOR FŒTAL TYPHOID 200
SEX, microscopically recognisable in neofœtal period 82
SEXUAL GLANDS, development of 82, 86, 87, 90
SHOULDERS OF FŒTUS, measurements of 109
SIGMOID FLEXURE OF FŒTUS, anatomy of 115
SINGULTUS, fœtal 144, 169, 441
SINUS OF MECKEL OF PLACENTA 123
SKELETON, fœtal, diseases of 237, 334
SKIAGRAPHY IN ANTENATAL DIAGNOSIS 448
SKIN, congenital absence of 328
development of 85
in fœtal syphilis 238
SMALLPOX IN THE FŒTUS 176, 188
SPASM, gastric, congenital 365
SPHYGMOGRAMS OF NEW-BORN INFANT 138
SPINA BIFIDA AND CONGENITAL UTERINE PROLAPSE 387

PAGE
SPINAL CORD IN FŒTUS, anatomy of 106
development of 85, 88
SPINE OF FŒTUS, anatomy of 106
SPIRALITY, fœtal, of Fallopian tubes 30
SPLEEN OF FŒTUS, anatomy of 114
in syphilis 236
ST. KILDA, the scourge of 57
STENOSIS OF PYLORUS, congenital hypertrophic 365
STERNUM OF FŒTUS, anatomy of 109
ossification of 82
STIRRAGE 169
STOMACH OF FŒTUS, anatomy of 113
contents of 160
development of 83, 86, 87
STORING UP OF SUBSTANCES IN THE PLACENTA 158
STRUMA CONGENITA 374
"SUCKING-PADS" IN FŒTUS 103
SUDORIPAROUS GLANDS, development of 88
SUGAR IN THE LIQUOR AMNII 223
SULPHURIC ACID, poisoning with, in pregnancy 267
SUPRA-RENAL CAPSULES OF FŒTUS, anatomy of 115
development of 86
functions of 166
in syphilis 236
SYLVIAN FISSURE 82, 87
SYMPTOMATIC ICTERUS NEONATORUM 67
SYMPTOMATOLOGY OF CONGENITAL ELEPHANTIASIS 303
of congenital gastric spasm 366
of congenital goitre 376
of congenital hypertrichosis 324
of congenital prolapsus uteri 386
of fœtal ascites 357
of fœtal bone disease 337, 339, 348
of fœtal death 415
of fœtal ichthyosis 307, 315
of fœtal keratolysis 320
of general fœtal dropsy 290
of hydramnios 401
of obliteration of the bile-ducts 363
of oligohydramnion 408
of tylosis palmæ 319
SYNCYTIUM OF VILLUS 124
SYNONYMS OF CONGENITAL HYPERTRICHOSIS 321
of fœtal ichthyosis 307, 315
of fœtal rickets 335
SYPHILIS, embryonic 228
SYPHILIS, FŒTAL, diagnosis 238
dystrophies 239
effects 254
limitation of 225
morbid anatomy of 229
nature of causal agent of 244
pathogenesis of 243
placenta 228, 230
transmission 245
treatment 257, 477

TAIL, in the neofœtal period 81
"TAILS" 326
TEETH, development of 87, 89, 91
formation of, in neofœtal period 82
in congenital hypertrichosis 324
TELEGONY, mechanism of 185
TEMPERATURE OF THE FŒTUS 145
of the liquor amnii 146
TERATOGENESIS 17

PAGE
TERATOLOGICAL RECORDS OF CHALDEA 4
TERATOLOGY 12
comparative 17
isolated position 6
of plants 17
TERATOMATA 174
TERATOSCOPY 4
TESTICLE, descent of 90, 91
in fœtal syphilis 237
TETANUS NEONATORUM 57, 58
THEORY, Baumgarten's, of latency 213
THERAPEUTIC FŒTICIDE 13
THERAPEUTICS, antenatal 14, 15
germinal 484
of fœtal diseases 451
of malformations of genitals 30, 31
THIRD GENERATION, syphilis of 254
THOMSEN'S DISEASE 391
THORACIC DUCT OF FŒTUS, anatomy of 112
THORAX OF FŒTUS, anatomy of 83, 108
THROMBO-ARTERITIS OF UMBILICUS 62
THYMUS OF FŒTUS, anatomy of 109
changes in, in fœtal syphilis 235
development of 86
function of 164
in neofœtal period 83
physiology of 484
regulator of growth 164
THYROID GLAND IN FŒTUS, anatomy of 107, 108
development of 86
enlargement of 374
function of 164
hypertrophy of 165
in neofœtal period 83
regulator of metabolism 165
THYRO-MUCOIN IN FŒTAL THYROID 166
TOBACCO POISONING, effect upon the fœtus 272
TONSILS, development of 87
TORSION OF UMBILICAL CORD 120, 400
TORTICOLLIS, congenital 53
TOXICOLOGICAL STATES 175, 259
TOXINES, transmission through the placenta 157
TRACHEA IN FŒTUS, anatomy of 107
development of 87
TRANSITION CHANGES IN NEOFŒTAL PERIOD 83
organism 80
traumatic, of birth 35
TRANSMISSION OF DISEASES FROM FŒTUS TO MOTHER 175, 184, 188
of fœtal malaria 203
of microbes through the placenta 181
of substances from fœtus to mother 163
of syphilis, mode of 244
through the liquor amnii 181
through the placenta 156
TRAUMATIC MORBID STATES OF THE FŒTUS 175, 393
TRAUMATISM AND INFECTION 23, 24
intranatal 35, 44
TREATMENT OF CONGENITAL DISLOCATION OF HIP 50, 51
elephantiasis 305
gastric spasm 367
hypertrichosis 325
fœtal ascites 362
death 428
endocarditis 373
keratolysis 320
nervous maladies 479

TREATMENT—*continued.* PAGE
syphilis 477
general fœtal dropsy 297
hæmophilia 480
hydramnios 406
intranatal, of fœtal disease 463
obliteration of the bile-ducts 365
recurrent placental disease 479
tylosis palmæ 319
TREMOR, hereditary 390
TRIBASILAR BONE IN FŒTAL RICKETS 346, 349
TRICHAUXIS 321
TRICHOSTASIS 325
TUBERCLE, fœtal, bacteriology of 181, 208
cases of 207, 208
characters of 212
dystrophies of 214
evidence of existence of 207
heredity in 215
latency of 213
malformations in 215
pathology of 208
prophylaxis of 216
rarity of 210
TUBERCULOSIS OF THE FŒTUS 206
of the placenta 209
TUMOURS OF FŒTUS 175
genital organs 25
TWIN-BEARING, heredity of 438
TWINS, difference in temperature of 146
syphilitic infection in 247
variola in 190
TYLOSIS PALMÆ ET PLANTÆ 318
TYMPANIC CAVITY OF FŒTUS, anatomy of 104
TYPHOID FEVER IN THE FŒTUS 199
serum test in 200

ULCER, congenital 329
umbilical 62
UMBILICAL ARTERIES, anatomy of 116
cord, anatomy of 112, 120
development of 86, 88, 90, 91, 92
intestine in 81
morbid conditions of 400
syphilis of 231
lochia 60
vesicle, function of 154
vessels, changes in, at birth 41
UMBILICUS, blenorrhœa of 62
granuloma of 61
hæmorrhage from 65
lymphangitis of 62
ulcer of 62
URACHUS OF FŒTUS, anatomy of 112
UREA IN FŒTAL BLOOD 141
UREIER 82
URETERS OF FŒTUS, anatomy of 116
URETHRA OF FŒTUS, anatomy of 120
URINARY SYSTEM, diseases of, in fœtus 378
URINE, fœtal 92
chemical composition of 162
excretion of 161
UTERUS, changes in, in fœtal death 425
congenital prolapse of the 384
fœtal, anatomy of 119
pregnant, temperature of 146

PAGE
VACCINATION OF THE FŒTUS 193, 194
VAGINA OF FŒTUS, anatomy of 119
development of 87, 89
VAGINAL GLANDS, secretion of, in the fœtus 160
VAGITUS UTERINUS 143
VALUE OF FŒTAL LIFE, estimation of 455
relative 457
VARICELLA IN THE FŒTUS 198
VARIOLA OF FŒTUS 176, 188
clinical history 189
complications 192
diagnosis 193
eruption 192
incubation period 190
pathogenesis 189
prognosis 193
stages 192
treatment 193
VERNIX CASEOSA, composition of 160
development of 89, 91, 92
VERTEBRAL COLUMN OF FŒTUS, anatomy of 106
ossification of 82, 85, 87, 88, 106
VESICLE, umbilical 83, 154
VESSELS, changes in, in fœtal syphilis 235
congenital atheroma of 374
vitelline 154, 155
VESTIBULAR BAND IN FŒTUS 120
VIEUSSENS, limbus of 111
VILLI, changes in structure in pregnancy 38
chorionic, structure of 124
VITELLINE CIRCULATION IN NEOFŒTAL PERIOD 83
placenta 154
VOLVULUS, congenital 367

WEGNER'S SIGN OF FŒTAL SYPHILIS 237
WEIGHT OF THE FŒTUS, causes of variations 168
WHARTON'S JELLY OF UMBILICAL CORD 121
WIDAL SERUM TEST FOR TYPHOID 200
WINCKEL'S DISEASE 63, 64
WOLFFIAN BODIES, development of 82, 86
WOUNDS OF THE FŒTUS 178, 395

XANTHOCYTES IN THE FŒTUS 139

YELLOW FEVER IN THE FŒTUS 198
YOLK-SAC, function of 154

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