Laws of physiology / translated from the Italian of Il Signor Dott. B. Mojon, with additions, and a physiological table of man ... by George R. Skene.

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Classification of animals, and the progressive obliteration of their special organs down to the extinction of them.

ANIMALS
MAY BE DIVIDED INTO

CLASS I.
VERTEBRATED.
A vertebral column, forming the base of the articulated and internal skeleton. A heart; red blood.

ORD. I. *WITH WARM BLOOD, HEART WITH TWO VENTRICLES, PULMONARY RESPIRATION, BRAIN AND NERVES.*

- **GENUS I.** *MAMMALIA*: Viviparous; with teats. Four articulated members pending from the skeleton. Lungs. Hair on some part of the body.
- **GENUS II.** BIRDS.—*AVES*: Oviparous; without teats. Diaphragm incomplete. Four articulated members pending from the skeleton. Lungs adherent. Feathers on the skin. Without teeth; a single ovarium, and ovary duct.

ORD. II. *WITH COLD BLOOD, HEART WITH ONE SINGLE VENTRICLE, BRAIN AND NERVES.*

- **GENUS I.** REPTILES.—*AMPHIBIA*: Oviparous. Four articulated members, or two, and even none, pending from the skeleton. Lungs during life, or only in the last stage. Skin naked, or covered with scales.
- **GENUS II.** FISHES.—*PISCES*: Oviparous; without teats. Bronchia during life, or at least in the first stage. Fins. Skin without hairs or feathers.

CLASS II.
INVERTEBRATED.
Without a vertebral column, and true skeleton; many without heart. Blood white.

ORD. I. *WITH ARTERIAL AND VENOUS VESSELS, BRAIN IN SOME, IN OTHER MEDULLA OBLONGATA.*

- **GENUS I.** *MOLUSCÆ*: Oviparous; body flabby, not articulated nor ringed, with variegated mantle. Bronchia. Simple nerves; no ganglion.
- **GENUS II.** *ANELLIDES*: Oviparous; body flabby, elongated, annulated; without articulated claws; not subject to metamorphosis. Bronchia.
- **GENUS III.** *CRUSTACEA*: Oviparous; body and members articulated. Skin crustaceous; not subject to metamorphosis. Bronchia.

ORD. II. *WITHOUT ARTERIES AND VEINS, WITH LONGITUDINAL MARROW AND NERVES.*

- **GENUS I.** SPIDERS.—*ARACHNIDES*: Oviparous; eight articulated claws. Eyes in the head; not subject to metamorphosis. Stigmata and trachea.
- **GENUS II.** INSECTS.—*INSECTA*: Oviparous. Subject to metamorphosis. In their perfect state, with eyes in the head: articulated members. Stigmata and trachea.
- **GENUS III.** WORMS.—*VERMES*: Gemmoviparous; body soft, long, contractile, regenerative; not subject to metamorphosis. Without eyes, and articulated claws. Stigmata slightly visible.

ORD. III. *WITHOUT HEAD, AND PARTICULAR ORGANS FOR FEELING AND CIRCULATION.*

- **GENUS I.** *RADIARIA*: Gemmoviparous; body regenerative, without head, eyes, articulated claws, and disposed in form of rays. Trachea acquiferous. Skin coriaceous or crustaceous
- **GENUS II.** *POLYPES*: Gemmiparous, and Fissiparous; body almost wholly gelatinous, regenerative, and not having any other special interior organ than an intestinal tube with a single aperture.

In the last order, which terminates the genus *Monadi*, there is absence of every special organ, and generation is no more than fissiparous.

General Table of all the Functions of the Animal Machine.

CLASS I.
FUNCTIONS PRESERVATIVE OF LIFE, AND RELATIVE TO THE INDIVIDUAL.

ORD. I. *FUNCTIONS OF ANIMAL LIFE.*

- **GEN. I.** SENSATIONS
  - In general
    - Pleasing.
    - Painful.
    - Internal.
    - External.
  - In particular
    - Sight.
    - Hearing.
    - Smell.
    - Taste.
    - Touch.
- **GEN. II.** INTELLECTUAL FACULTIES
  - Perception, imagination, memory, attention.
  - Ideas, judgment, reasoning, will, &c.
  - Of sleep, dreams, waking, somnambulism.
- **GEN. III.** MUSCULAR CONTRACTION
  - Fixed attitudes
    - Station.
    - Prostration, &c.
  - Voluntary movements
    - Walking, running, jumping.
    - Sustaining or raising weights.
    - Swimming, flying, &c.
- **GEN. IV.** VOICE, AND ITS MODIFICATIONS
  - Speech, ventriloquism, singing, declamation.
  - Howling, mewing, bellowing, neighing, whistling, hissing, grunting, barking, &c.
  - Sighing, laughing, weeping, coughing, sobbing, snoring, yawning, &c.

ORD. II. *FUNCTIONS OF ORGANIC LIFE.*

- **GEN. I.** DIGESTION
  - Its necessity.
  - Alimentary substances.
  - Hunger and thirst.
  - Chewing, inspitting, swallowing.
  - Alteration of the alimentary paste
    - In the mouth.
    - In the gullet.
    - In the stomach.
    - In the intestines.
  - Rumination.
  - Separation of nutritive substance from the excrementitious.
  - Absorption of the nutritive matters. *Passage of the Chyle*
    - In the lacteal vessels.
    - In the mesenteric glands.
    - In the thoracic duct.
    - In the venous system.
  - Excrementitious substances
    - Their quality.
    - Peristaltic movement of the intestines.
    - Intestinal gases.
    - Their evacuation.
- **GEN. II.** CIRCULATION OF THE BLOOD
  - Arterial and venous, *Action of the*
    - Heart.
    - Arteries.
    - Veins.
    - Capillary system.
  - In warm blooded animals.
  - In cold blooded animals.
  - In the human fœtus.
- **GEN. III.** RESPIRATION
  - Connexion of respiration with life.
  - Inspiration and expiration.
  - Chemical phenomena, relative to the
    - Air.
    - Blood.
- **GEN. IV.** ABSORPTION AND TRANSUDATION
  - Action of the absorbing and transuding vessels.
  - Lymphatics.
  - Serous.
  - Synovial.
  - Medullary.
  - Cellular
    - Fat.
    - Lymph.
- **GEN. V.** SECRETION
  - In general
    - Action of the secerning organs.
    - Excretion of humours.
  - In particular
    - Tears, wax of the ears, mucus of the nostrils, spittle, gastric juice, bile, pancreatic humours, urine, sperm, &c.
- **GEN. VI.** NUTRITION
  - Assimilating matters
    - Chyle.
    - Blood.
  - Its modifications.
  - Considered in
    - Infancy.
    - Youth.
    - Adult age.
    - Old age.
  - Decay, and senile death.
- **GEN. VII.** CALORIFICATION
  - Its phenomena in animals
    - Warm blooded.
    - Cold blooded.
  - Causes productive of animal heat
    - Respiration.
    - Digestion.
    - Absorption.
    - Motion, &c.
  - Causes capable of diminishing animal heat
    - Sleep.
    - Hunger and thirst.
    - Inaction.
    - Ligature, compression, &c.

CLASS II.
GENERATIVE FUNCTIONS, AND THOSE WHICH HAVE RELATION TO THE SPECIES.

ORD. I. *FUNCTIONS PECULIAR TO THE MALE SEX.*

- **GEN. I.** PHENOMENA AND ORGANIC CHANGES THAT TAKE PLACE IN MAN AT THE AGE OF PUBERTY. *Relative to the*
  - Sanguineous system.
  - Complete growth of the body.
  - Development of the beard.
  - Change of the tone of voice.
  - Incitement to coition.
- **GEN. II.** USE AND FUNCTIONS OF THE GENITAL PARTS IN MAN
  - Erection of the penis.
  - Secretion of sperm
    - Its passage through the deferential vessels.
    - Its abode in the seminal vesicles.
    - Its emission.
- **GEN. III.** EFFECTS OF CASTRATION IN THE HUMAN BODY. *Relative to the*
  - Intellectual faculties.
  - Ensemble of all parts of the body.
  - Vocal organs.
  - Non-development of the beard.
  - Cellular tissue, and cuticle.
  - Impossibility of generating.

ORD. II. *FUNCTIONS PECULIAR TO THE FEMALE SEX.*

- **GEN. I.** PHENOMENA THAT OCCUR IN WOMAN AT THE AGE OF PUBERTY. *Relative to the*
  - Greater development of the breasts.
  - Covering of hair on the pubes.
  - Menstrual discharge
    - Its beginning.
    - — periodicity.
    - — necessity.
    - — qualities.
    - — total cessation.
  - Incitements to coition.

ORD. III. *FUNCTIONS RELATIVE TO THE UNION OF THE TWO SEXES, AND TO THE PRODUCT THAT RESULTS.*

- **GEN. I.** OF GENERATION
  - Copulation.
  - Of viviparous and oviparous animals.
  - Of hermaphrodite animals.
- **GEN. II.** OF PREGNANCY AND THE FŒTUS
  - Relation of the mother to the fœtus
    - The placenta.
    - Umbilical cord.
    - Amnios and cerion fluids.
    - The membranes surrounding the fœtus.
  - Period of pregnancy.
  - Phenomena relative to the state of the uterus and breasts
    - The moment of conception.
    - During pregnancy.
    - In birth.
  - Of birth
    - Its epoch.
    - Its mechanism.
    - Causes producing it.
  - Difference between the organization of the fœtus and that of the adult.

A Physiological Table of Man.

- *SENSATIONS*
  - IMPRESSING
    - Touch.
    - Sight.
    - Hearing.
    - Taste.
    - Smell.
  - EXPRESSING
    - Contraction.
    - Volition.
    - Passions.
    - Desires.
    - Aversions.
  - SYMPATHIZING, OR IDEAL
    - Memory.
    - Association.
    - Attention.
    - Imagination.
    - Reason.
- *NUTRITIVE FUNCTIONS*
  - CIRCULATION
    - Arterial.
    - Venous.
    - Placental.
    - Pulmonary.
    - Hepatic.
  - SECRETION
    - Alimentary
      - Salivary.
      - Gastric.
      - Pancreatic.
      - Biliary.
      - Mesenteric.
    - Excrementitious
      - Urinary.
      - Perspiratory.
      - Transpiratory.
      - Unctuous.
      - Sebaceous.
    - Preservative
      - Lachrymal.
      - Serous.
      - Mucous.
      - Synovial.
      - Seminal.*
  - DIGESTION
    - Mastication.
    - Deglutition.
    - Chylification.
    - Absorption.
    - Ejection.
- [illegible]NSITIVE ORGANS
  - Impressive
    - Skin.
    - Eye.
    - Ear.
    - Palate.
    - Nose.
  - Expressive
    - Secerning glands.
    - Involuntary muscles.
    - Physiognomic muscles.
    - Articulating muscles.
    - Voluntary muscles.
  - Sympathic
    - Brain.
    - Lesser-brain.
    - Spinal marrow.
    - Simple nerves.
    - Ganglionic nerves.
- SUPPORTING ORGANS
  - Muscles.
  - Tendons.
  - Ligaments.
  - Membranes.
  - Integuments.
- STRUCTURAL ORGANS
  - Teeth.
  - Bones.
  - Cartilages.
  - Nails.
  - Hair.

* Ovary in woman.

LAWS

OF

PHYSIOLOGY;

TRANSLATED FROM THE ITALIAN

OF

IL SIGNOR DOTT: B. MOJON,

PROFESSOR EMERITUS IN THE ROYAL UNIVERSITY OF GENOA, AND MEMBER OF MANY LEARNED BODIES.

WITH

ADDITIONS,

AND

A PHYSIOLOGICAL TABLE OF MAN.

DEDICATED BY PERMISSION

TO SIR ASTLEY PASTON COOPER, BART. F.R.S.

SURGEON TO THE KING.

BY GEORGE R. SKENE,

MEMBER OF THE ROYAL COLLEGE OF SURGEONS IN LONDON, AND OF THE MEDICAL AND CHIRURGICAL SOCIETY, &c. &c. &c.

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MDCCCXXVII.

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TO

SIR ASTLEY PASTON COOPER,

BART. F.R.S.

SURGEON TO THE KING.

SIR,

In permitting me to dedicate this Work to you, allow me also to avail myself of this opportunity of publicly expressing my high sense of your professional talent, and esteem for your private virtues. Equally conscious of the distinction of your patronage, and my obligation for the lasting honor you confer,

I am, Sir,

Your obedient Servant,

GEORGE R. SKENE.

7, *Jermyn-street, St. James's.*
February, 1827.

THE

TRANSLATOR'S PREFACE.

In offering the "Laws of Physiology" to the consideration of inquiring men, I ought to make some apology for the liberty taken with the Laws compiled by Sig. B. Mojon, and at the same time state the reason of my selecting his work as one fit to adorn the shelves of a British library, which I will endeavour to make sufficiently satisfactory to gain the good opinion of my fellow-labourers in science.

Already, when a pupil, I had formed the determination of collecting the phenomena of existence, and giving them to my fellow-students hereafter, under the ripened shape of future experience. But I found one branch of my intention suddenly hastened to a conclusion by receiving Sig. B. Mojon's record of Physiological phenomena, and from the elegance and correctness of its numerous facts, I resolved to translate "Leggi Fisiologiche, compilate da B. Mojon."

Some discoveries having recently been made, I deem it expedient to add them, and am also induced to relate some observations, which are marked by Roman numerals to distinguish them from the scientific Italian.

Works of science generally require an introductory discourse, and that necessity cannot be avoided by the translator, as new matter necessarily demands elucidation, particularly when the first perusal of many laws will not convey the clear idea that mature reflection, after frequent perusals, must necessarily give.

These considerations naturally indicate the obligation an annotator is under of giving expositions of those things he ventures to add to the works of others, and forms an ample apology for trespassing on the time of an indulgent reader, with an Introduction.

THE

ITALIAN EDITOR'S ADVERTISEMENT

TO

THE THIRD EDITION.

This work, which has already been received with applause by the Italians in two editions now exhausted, has been translated into Spanish by the celebrated Ortega, Professor of Botany in the Royal Gardens of Madrid, and into French by Dr. Michel, Chief Physician to the Military Hospital of Rome. Its merit is sufficiently established on the universal judgment of the learned, to be above every encomium, as well as every individual censure. In offering to the public this third edition, it will be enough to mention that it has been revised by the Author, and not only retouched and ameliorated, but in many places increased; so that it contains the choicest ideas and the most recent discoveries that have enlarged the domain of physiological science.

THE

AUTHOR'S PREFACE.

The knowledge of all the functions performed by animated beings constitutes Physiology, properly so called. The accurate analysis of this science has clearly demonstrated, that the facts, which it treats of, are supported by exact experiments and irrefragable truths: nevertheless there are yet certain persons who pretend that Physiology is a science of hypotheses. The vital principle, according to some, altogether annuls the laws of physics in the living machine: the science of organizations is to them in embryo; they maintain that man never will be able to comprehend its mysteries. They repeat whatever has been said from the time of Hippocrates to the present hour, against medicine. If Borelli, Malpighi, Morgagni, Boerhaave, Haller, Hunter, Lavoisier, Reil, and many others, had allowed themselves to be imposed on with this language, physiological science would not have thrown a

new light on the mechanism of our organs; their functions would still be indeterminate, and the multitude of facts that it develops relative to circulation, the secretions, absorption, generation, &c. would remain hidden from us. The fundamental laws of sensibility and irritability, far from being reduced to dogmas, would at most be considered as hypothetical probabilities. Thanks to this science, the phenomena of vision are demonstrated with the aid of physics: and the eye, if we may so speak, is no more than a dioptrical machine; the ear but an acoustic instrument; the muscular forces and the progressive movements of man and animals are subjected to calculation; and the impelling force of the humours in the angeiological system is measured. Chemistry, resting upon Physiology, proves the phenomena of sanguification and calorification, those of respiration and digestion: and placing animal economy among the strict sciences, an end has at length been put to the rage for referring all the actions of the living body to a single principle; a principle which is abstract, ideal, and purely imaginary.*

* The author here refers only to the vital principle of Barthez, and the vitalists, not wishing these physiological laws to be considered in

Man is certainly not born to be an eternal riddle to himself; the physiology of the eighteenth century has so far emancipated itself, that there is no longer reason to fear a retrogression of the human mind.

"It belongs to the sagacious inquirer into physics," says the erudite Tommassini, "to penetrate within the substance of bodies, to examine their nature and properties; to determine the influence of many of them on living systems. The assigning their true place to the movements and operations that characterize the animal body, depends on the examination of that which it has peculiar to itself, or in common with other beings: moreover it is certain, that an eye accustomed to contemplate the wonderful phenomena of nature, will not be discouraged at the difficult investigation of those which belong to animal substance and to the living body." *

In reducing the laws of this science to a code, I do not pretend to lay down the facts that belong

any other light than as a code of the functions which are physically performed in the extensive animal kingdom. He does not wish to occupy himself with the immortal portion of man, relinquishing that office to those who treat of Revelation, as he dares not investigate a matter that belongs to religion.

* Lezioni critiche di fisiologia e patologia, vol. i.

to physics, in a strict parallel with those pertaining to Physiology. Physical laws are immutable. On the other hand, the laws of Physiology are subject to many variations: but this does not prevent their being presented like the former, under the form of axioms, in all cases where experience has determined the various modifications to which the materials of the animal machine are subjected by organization; and with reason, Richerand says, that if the causes of the different phenomena are yet unknown, the phenomena are not so; and that Physiology is perhaps the richest of all sciences, in facts verified by observation.* I shall esteem myself happy, if I have attained the object of explaining, in the work I present to the public, these same facts with that rigid brevity, which, little anxious about words, occupies itself wholly with things.

Some authors felt the advantage that physical sciences would derive, if they were explained under the form of axioms, as being the language most suited to them. Hence different selections of laws belonging to various sciences appeared to public view. Linck, in Germany; Humboldt,

* Nouveaux élémens de physiologie.

in Prussia, published those which relate to Botany.* Fourcroy explained, in France, all the doctrine of chemical affinities in ten laws only;† Haüy developed those of crystallization: and it is by the example of these writers, that I have determined to publish those which I have compiled on animal physics. Besides, if Hippocrates, Boerhaave, and Stall, reduced the diseases of the human body to aphorisms; if Sauvages, Linnæus, Vogel, Sagar, Cullen, Pinel, &c. determined the most essential characters of them, as a means of classifying them like objects of natural history; if La-Rochefoucault, Donnant, Tracy, and others, reduced great part of the human passions to so many maxims, not to say axioms, why may not I then reduce to aphorisms or maxims, the science of animal physics, which is much better known, and less inconstant in its caprices than pathology and metaphysics? In the analytical view which I present to the public, I have endeavoured to relate all the facts which constitute the matter of physiological science. I have explained the peculiar characteristics of the func-

* *Humboldt*, Aphorismi ex doctrina physiologiæ chimicæ plantarum. Berolini, 1793.

† Syst. des conn. chim. *artic.* Affinités.

tions of animal organization, and their true connexion with other general or partial phenomena; having given up reasonings which want experience for a base, because it has not been my object to ascend to the primitive faculties inherent in the matter which constitutes living beings. The desire to simplify too much the science of organizations is an incongruity.

I have adhered to the classification that Professor Grimaud formerly proposed in his Physiological Lectures, since perfected by the glowing genius of Bichat. All the functions of the animal machine are divided into two great classes, individual and specific; the one comprehends the functions which preserve life, and relate to the individual: the other those which propagate it, and have relation to the species. The functions of the individual begin with itself, and are divided into two orders; the first, which with Bichat I shall call that of *animal life*, or of *relation*, embraces those which put us in relation with external bodies; these are the sensations, the intellectual faculties, the voluntary movements, the voice, and the nervous transmission. The functions of the second order bear the name of *organic* or of *internal life;* and are digestion, circulation,

respiration, absorption, exhalation, the secretions, nutrition, and calorification.

The second class, which comprises the generative (or specific) functions, commencing only at the time of puberty, is divided into three orders; two relative to each sex in particular, and the third to their union and the fruits of it.

By the internal functions, the animal appears in nature, as the tree in a forest; passive in its relation with beings, it knows not their existence, nor probably its own; a somewhat complicated vegetable, it would die on the spot of earth on which it is born. But the external functions develop themselves; the animal feels and moves; all nature is the cause of what it experiences; all beings are included in its aims; all the universe is its dominion. The specific functions which form the second class, open the striking and sensible scene which fixes the epoch of puberty; a moment in which nature appears to forget the other organs, and to occupy herself solely with those whose existence dates only from that instant. The individual is nothing to her, she has only preserved it for the sake of the species which it is now fit to propagate; without the species man would perish in one century; he now lives

the contemporary of all ages. But old age comes on, accompanied by languor, followed by decrepitude; and the period of death is arrived: thus man dies for the species, long before he dies as an individual.*

I have not restricted myself to the operations that exclusively belong to some species of animals; but I have compared the functions of many classes, and of very many species, and have also included the bases of their organic composition; because to establish fundamental principles and general laws on the functions of living beings, it is necessary to extend the analysis to a vast number of facts, principally drawn from the whole of comparative anatomy, as the richest source for perfecting human Physiology. De Buffon says, that if it was not for the existence of animals, the nature of man would be yet more incomprehensible. There are facts that indicate facts; and the omission of one of these might destroy the edifice of many established laws. I know that the separating the functions of a living being is the same as reducing it to the condition of dead bodies: all parts of a living machine are confederate, and

* See Bilon, aperçu sur l'ensemble de la méd.

each function needs the aid and concurrence of the others: from this mutual connexion there results a mutual dependance of each on all, and of all on each in particular: nevertheless, I have endeavoured to separate them without destroying them, in order that the *ensemble* which constitutes the essence of them may remain. It belongs, indeed, to the learned reader to arrange those functions, which in many phenomena of the animal economy are, if we may say so, accessory, or covered with the veil of mystery; my principal aim being, only to explain the essential ones, and those almost demonstrated to evidence. I do not recognize for physiological truths any other than those which are established on the immediate consequences of the facts peculiar to them: for if any cases might be opposed to what I hold as tenets of the animal economy, they must be looked upon as aberrations from the laws which regulate life, and thence come within the dominion of pathological facts.

My guides in this labour have been those authors who explain the science of organic economy like profound anatomists; having embodied the maxims of Swammerdam, Duverney, Haller, Whytt, Hunter, Monro, Walter, Ludwig, Vic-

d' Azyr, Camper, Daubenton, Barthez, Kite, Goodwing, Bordeu, Darwin, Blumenbach, &c. The works of Dumas, Richerand, Cowper, J. Bell, Reil, Sœmmering, Bichat, Cuvier, Dumeril, Gall, &c., have also furnished me many data. And those derived from the excellent works of Malpighi, Morgagni, Poli, Spallanzani, Cottunio, Scarpa, Mascagni, Presciani, Fontana, Gallini, Caldani, Malacarne, Morelli, Tommassini, &c., have not been less valuable to me. Nor have I neglected to draw from those chemical facts which throw so much light on the phenomena of life, and are due to Crawford, Lavoisier, Girtanner, Fourcroy, Vauquelin, Chaptal, G. Mojon, Guyton, Chenevix, Brugnatelli, Berthollet, Thomson, Thenard, Berzelius, Orfila, and Davy.

Many laws will appear either strange or new, because placed for the first time under the eyes of the public. Some of them are the result of my own experiments and observations, made in the rich collections of human and comparative anatomy that I have had the opportunity of frequenting in the first universities of Europe; others are due to lectures and conferences had with Cuvier, Hallé, Richerand, Chaussier, Sabattier, Portal, Lacepede, Dumas, Baumes, Barthez,

Scarpa, Azzoguidi, Mascagni, Prochaska, Ritter, Hartman, &c.

I foresee that, in the work which I present to the public, some omissions will be found, and also, perhaps, some hypotheses; therefore, in exposing my labours to the eye of the critical reader, I must implore his indulgence. In what I have advanced, I have often been guided by the greatest physiologists; at least I shall be content to have erred with them. With all its imperfections, this work may yet contribute something to the doctrines of animal organization, and be useful to the physiologist by enabling him to dispense with turning over voluminous treatises in order to verify, or to bring to mind, facts which time often obliterates. It must be confessed, that some recent physiological works, however good they may be, are so exceedingly prolix that in order to meet with any clear principles, one is forced to track them, not seldom, through a crowd of minute or superfluous reasonings.*

* Note of the Italian editor.—Here we may insert what has been said by the Bibliothêque Médicale and the Journal de l'Empire :—

"L'ouvrage de M. B. Mojon a encore l'avantage qu'il constate d'une manière précise, l'état actuel de la physiologie; et désormais l'on pourra s'en servir comme d'une base certaine pour mesurer les progrès qu'elle pourra faire dans la suite. Tants de titres assurent

I do not pretend that the physiological laws that I have established are the only ones, and that these ought to be considered as the result of a final attempt. Perhaps new experiments will throw new lights on the science of man, and many facts will cease to be regarded as fundamental truths, whilst others hitherto unknown, or scarcely suspected, will be manifested to us. The analytical and experimental methods having been substituted for vague inductions and hypotheses, we have reason to hope that the science of life, far from stopping where it now is, will find no other limits, as Dumas says,* than those of nature.

aux *Lois Physiologiques* une place distinguée parmis les bons écrits de ces derniers temps et garantissent à leur auteur le suffrage de tous les hommes éclairés." A. A. Royer-Collard, D. M. P.—Vide Bibliothêque Médicale, tom. xv. p. 144.

"Les lois physiologiques de M. B. Mojon qui viennent d' être adoptées en Italie par S. A. I., le vice-roi, comme *un ouvrage classique qui lui manquait encore*, nous présentent dans un cadre étroit un langage scientifique, concis et savant, des idées neuves et justes, des faits exacts,—en un mot, une profonde sagacité, des préceptes, etc."—Journal de l' Empire, 15 Octobre, 1806, No. III.

* Discours sur les progrès futurs de la science de l' homme.

THE

TRANSLATOR'S INTRODUCTION.

THERE are many laws added to those of Signor Mojon, which are so new in their statements, that it is expected they will, on the first view, appear to be mere assumptions founded on hypotheses; but the reader who takes time to compare them with his own observations, will find them limited to mere records of facts that are frequently overlooked by the naturalist, who records only the evidence of his senses; many of these facts have been recently observed, and owe their discovery to the advancement made in physiology during the last fifteen years. It is presumed their novelty will furnish a sufficient inducement for the physiologist to give his attention to the circumstance of their truth—for, as truth is the correct perception of facts, many of these laws will be found to vary from received opinions, which are not the result of correct perception, but of fertile imagin-

ings; which ever tend to establish falsehood, when correct perception, or the coincidence of our sensations with facts, cannot result.

Perhaps the reader will do well to re-peruse this introduction after he has read the laws, as a free communication with the subject matter of the book, will add greatly to the result of the study of the laws themselves, and clear many points which at first are too closely analysed to be at once agreed with. The discussions on these additions would fill too many pages, were they pursued as much as they are capable of being. From this, however, I will abstain, as I am anxious to give as much as the small size of the volume will admit of, without fatiguing the necessary attention required on subjects of such great importance.

Law VI. (page 3.) is given as an analysis of instinct, a term that has perplexed many, and by none is it clearly explained. This term is simply applied to an innate quality of living beings, that is, sensation or knowledge of certain results from certain motions; as the removal or approximation of the being, or of its parts, to or from a given place; and also the pleasing, congenial, and painful varieties of sensations that result from

the application of certain bodies to certain organs.

Law VII. (page 7.) may at first appear questionable; but when the reader bears in mind that a glass of brandy, or any stimulant in the stomach, is marked by an accelerated pulse, and that an emetic depressant is followed by a contrary effect, producing nausea and lowered pulse, he will, I fear not, acknowledge the truth of this statement.

In this Law, and Laws XII, XIII, XXXIII, LXXX, and LXXXVI, the followers of Mr. Abernethy's doctrine, of the digestive organs being the primary cause of disease, will find matter bearing strongly on that gentleman's valuable observations and hypotheses; for they show the sympathy existing between the stomach and the heart, which is also proved by the distribution of the par vagum nerves. And Laws VIII. and XII. show the effects of the influence of the heart, by its circulating blood, over the brain and all organs of sense, as well also the effect of the circulation on secerning functions; whilst the latter part of Law LXXXIII. namely, that the peristaltic action of the intestines is in *inverse* ratio to the contraction of the stomach, will account for the fact that vomiting accompanies great purging, and that constipation of the bowels is attended by ex-

cited arterial circulation, and, where there is not fever, there is great appetite, which are owing to the continued contraction of the stomach; as, for instance, in cases of furious mania, &c. Yet when the stomach is so distended from food as to become oppressive, the appetite ceases, because the stomach will not hold any more food, although the state of even contraction continues. But the moment that that contraction of the stomach ceases, when its contracting power is passive, the pulse slackens in rapidity, and the abdominal muscles and diaphragm are in a state of active and excited contraction, by the pressure of the stomach's unwieldy mass, which they force violently out, constituting the act of vomiting.

In Law VIII. (page 8.) there must be a distinct line drawn between that sensation which is the result of sensibility and contact of matter, and the painful sensation felt in spasm, neuralgia, gastralgia, hysteria, asphyxia, and the horrid moments of cramp preceding death, &c., all of which are attributed to distension of the vessels in nerves producing pressure on the nerves, which, it is needless to remind the reader, produces a painful feeling, referrible to the nerves themselves; as when

the extremities, using common language, are "asleep."

Painful sensation is owing to pressure in the nerves by the atony of the arterial circulation, after a previous excitement which has gorged the vessels, now no longer capable of contracting, and circulation almost ceases in their extremities, as in inflammation after contusion, or in asphyxia when the vessels are alike gorged, producing horrible pain as they contract in the patient recovering from drowning; for this depends alone on sanguineous distension, which may always be much mitigated by abstraction of blood from the distended veins.

Mr. Hunter appears to have had an idea that pain was an excess of sensation; for he says,*— "One can easily form an idea of an alteration in the structure of parts giving sensation, *which may even be carried to pain;* but that the simple action of parts should produce sensations, and even violently, is but little known, or at least has been, I believe, but little attended to; all these effects, I think, may justly be included under the term spasm,—at least we are led by analogy to suppose that they belong to that class." He also

* *Hunter* on Adhesive inflammation, page 285.

says,*—" Pain," from inflammation, " increases every time the arteries are dilated;" which corresponds with Laws VIII. and XI.

Let it be understood, that in Laws IX, X, XI, pleasing, congenial, and painful varieties of sensation are not distinct sensations of pleasure, indifference, and pain, but are only degrees of excitement by the contact of matter, which, at first, may be congenial with the existence of the function of an organ; and on being more powerful, may become pleasing, and by increasing that excitement the sensation becomes painful. This is proved by the gentle application of the fingers to the skin simply producing a congenial degree or variety of the sensation of touch; by tickling or increasing the excitement it becomes pleasing, which, carried a little further by continuing the cause and increasing the excitement, becomes painful: all these three degrees of sensation in the excited organ being pleasing, congenial, or painful varieties of sensation in ratio to the exciting cause.

The state of the organ during a painful variety of sensation is evidently that of great excitement, when the arterial vessels are gorged with blood, and render the sensibility of that organ extreme;

* *Hunter* on Adhesive inflammation, page 287.

if this gorgement of blood is not relieved by exciting some other organ, so as to give a new direction to the blood, and rest to the organ's function, the vessels, unable to contract, produce painful sensation in it, and often inflammation suspending its function.

This statement is applicable to all the organs of sense, and is elucidated by the moderate, increased, and highly-exciting effect of the intensity of lights, sounds, savours, and odours: as, for example, a moderate light is congenial with the sensation of sight; increased, it is pleasing; and still further increased, it becomes painful: yet the sensation of colour is the only sensation experienced, and which becomes pleasing, congenial, or painful, in ratio to the intensity of the colour or colours; but let it be understood, that the degree of sensibility of the organ will affect the required intensity of the qualities of bodies to produce these effects, which accounts for the pleasures of individuals in their various modes of gratification — some preferring colours, others sounds, others titillations, and others tastes and smells, according to the degree of sensibility of the different organs of sense.

In Law XII. (page 9.) sensibility is divided into

two kinds : of the first, mental sensibility, little need be said, as there cannot be a doubt raised against it; but the second, secerning sensibility, may require some proofs before credence can be obtained for it. Then, in the first place, we find that all organs are composed of nervous matter, whose sensibility is capable of excitement and depression, and that when the circulation of the blood is increased, the mental sensibility or that of external life, is increased in proportion, and that the secerning powers or functions are suspended, as in high fever, when we have extreme mental sensibility and the secerning powers suspended, and we find the circulation much increased; and when the extreme mental sensibility subsides, the circulation is less rapid, and vice versa; which is followed by increased discharges from the glands, as the sudorific, mesenteric, salivary, and the glands for the digestive functions, often ending in diarrhea and death. Also, that the different glands have, each and all of them, a particular distribution of nerves, coming from a ganglion forming the sympathetic nerve; a bond of union with the other nerves of animal life, which nerves are subject to the influence of the disease of the gland, destroying their functions. Besides this, we find the most

learned authors ascribe their functions to peculiar sets of nerves, as De Bordeu, who, in his learned *Recherches anatomiques sur les glandes*, says, "La tension que les chatouillemens et les petites irritations proportionées au ton du nerf procureront, fera la *sécrétion;* le sphincter de chaque orifice dirigée par des nerfs, pour ainsi parler, attentifs et insensibles à tout ce qui ne les regarde point, ne laissera passer que ce qui aura donné de bonnes preuves; tout sera arrêté, le bon sera pris, et le mauvais sera renvoyé ailleurs." Bichat adopted these ideas,* and Richerand† has given, almost word for word, the opinions of De Bordeu; and Fouquet, an authority of no mean consideration, has ably elucidated his opinions.‡ Besides these authors, there are many others more ancient, and highly reputed, whose opinions coincide with this statement.

The cause of the cessation of secretion during excited circulation, appears evident from the following reason, viz., the increased circulation of the blood is owing to increased contraction, and, by consequence, a diminution of the minute arteries, preventing a passage of the blood into

* *Bichat*, Anatomie générale. 1801.

† *Richerand*, Elémens de physiologie, tom. 1.

‡ Encyclopedie de *Diderot* et *d'Alembert*.

the glands, thereby preventing also the gorgement of the secerning vessels, which would destroy their healthy secerning sensibility. This will account for the phenomenon of bile existing in the arterial blood, as in jaundice, when the liver is subject to increased circulation and inflammation; for the minute vessels are closed, and a free circulation takes place between the larger communications. A similar result is met with in all the other glands, which may be observed in the slightest cases of fever or inflammation of a gland. Yet this does not prove the existence of secerning sensibility, but of the effect of inflammation; but when we see that the salivary glands never secrete urine, and that glands are provided with a distinct set of nerves, which, being destroyed, their function ceases, we can no longer be in any doubt as to the existence of secerning sensibility. When the increased contraction of the small arteries is overcome by relaxation, or exhaustion of irritability, then the gland begins to secrete in increased ratio, assuming that form of disease called chronic inflammation, as in diabetes, ptyalism, &c.

It may be necessary to enter into some explanation of Law xv. The vibrations of bodies are

in ratio to their solidity and elasticity, which produce short quick vibrations, that are communicated to the tympanum in ratio to the atmospheric pressure, which is the surrounding and communicating medium; and if the volume of air between the tympanum and the vibrating body be small and confined, its elasticity is increased, as is found by putting a piece of wood (as a stethoscope) against the ear, and sharply striking the other end of it.

The four small bones in the cavity of the tympanum communicate the pressure on the tympanum to the *fenestra ovalis*, which vibration continues through the scalæ to the *fenestra rotunda*, where it terminates in the cavity of the tympanum. The first bone, the *malleus*, has a long process resting against the internal side of the membrana tympani, which, when pressed against by the vibrating air, depresses that process in the segment of a circle, whilst the other end, or hammer-head-like portion, makes the segment of a circle on the *incus*, depressing it in ratio to the extent of the segment. The *incus* has also a process, but much longer, which makes a corresponding impression, but multiplied from its length on the *obiculare os*, and so to the *stapes*,

which is pressed in an increased ratio against the *fenestra ovalis.* The stapes has a muscle which replaces it against the os obiculare; after having depressed the membrane of the*f enestra ovalis,* the *malleus* has also muscles which replace its process against the tympanum after its depression. This apparatus does not exist in the ears of fishes, and appears unnecessary to them on account of the medium in which they live being denser than atmospheric air; consequently the vibrations which strike their auditory nerves are much stronger, and always the same.

There is a natural question, Why should air be in the cavity of the tympanum, and a moveable bony communication between the tympanum and *fenestra ovalis?* This is ventured to be explained thus: the bones give an increased vibration, which would not be the same were they of one piece, as the tensity of the tympanum is tight or slack according to the rarefication of the air in the tympanum, and the atmospheric pressure external to it; and, in ratio to this tensity, is the distance between the tympanum and fenestra ovalis; *as* this distance varies, *so* must the length vary of the communicating medium, (the bones,) which length is greater or less according to the depres-

sion of the tympanum, which is in ratio to its tensity. Therefore as this distance varies, the muscles, by their mobility, accommodate the bones to the extent of the distance.

After the long-received opinion that the tongue is the sole organ of taste, Law XVII.(page19.) isput forth with a positiveness that will be considered rash, contradicting former education. But various experiments, which may be repeated by every individual,* have established the opinion I have ventured to lay down in a law. When the tongue is shoved out, and the lips closed, proofs are then given that the tongue is not susceptible of savours, but is susceptible of certain painful sensations from acids, galvanic fluid, or biting stimulants, &c. And anatomy does not warrant the opinion that any nerve in the tongue is the organ of taste; for the only effect that has been proved by the experiments of Mr. C. Bell and M. Magendie, is, that the sensibility or consciousness of contact is destroyed by the division of the fifth nerve, and that the animal is no longer conscious of the application of biting stimulants, &c., or even of pressure. These effects of stimulants are not savours, but extremely

* See Medical and Physical Journal, Dec. 1812, vol. 28, article on Taste and Smell, by Dr. *W. Proult.*

fine sensations of touch. Mustard or acid applied to the skin produces similar effects, but not so delicate, owing to the different sensibility of the part, from its covering tissue. The special quality of savour or taste seems to be perceived by the olfactory nerve, which is lost to view in the palate and fauces; whilst the general or stimulating quality of bodies seems to be perceivable, in a great degree, by the tongue.

It will be seen that a new classification of sensations is given at page 22. I am induced to do so, as there exist so many discrepancies between mental philosophers and physiologists, whom I wish to reconcile, and thus to establish a comprehensive philosophy. Following the method pursued by that great philosopher, Locke, relinquishing all knowledge but experimental, I have examined myself, and only record the correct evidence of my sensations; if it accords with facts, I have but related truth, however it may be at variance with prejudice and received opinion.

It gives me much pleasure to find that that great observer of mental entity, M. Destutt de Tracy, has led the path in France to the adoption of a rational mode of mental inquiry. He has described *thought* as a series of ideas or percep-

tions; so that to think is to feel,—to feel is to think. The faculty of thinking, he says, contains four elementary faculties,—*sensibility*, properly so called, *memory*, *judgment*, and *will*; *these* three latter are called species of sensibility.*

From this philosophy I have differed less than from any other. Thought is consciousness of sensation, a sensation is a feeling, to feel is to think, to think is to be conscious, to be conscious is to have *sensations*. All these are synonymous modes of expression; therefore allow me to adopt *consciousness*, as consisting of sensations which are divided into three classes, as you will perceive at page 23, et sequenter.

In support of my definition of an idea in Law xxxiv., it will be well to add the opinions of Dugald Stewart, who says,—"An idea is the duration of a sensation, or being conscious of an impression on any sensitive organ. This, I think, is proved by Locke's doctrine that all our ideas are derived from our sensations; and that it is *impossible* for us to think of any thing which has no resemblance to something previously known to us by our own consciousness."† The brain is

* Elémens d'idéologie, par M. le Comte *Destutt de Tracey*, pair de France. 1824.

† Philosophical Essays, by *Dugald Stewart*, page 552.

now generally admitted to be the pathic organ of our ideas, and therefore I have ventured on the publication of this Law, and consider the sensations of that organ, sympathetic affections produced by the sensation of another organ of sense.

The latter part of the above quotation is particularly applicable to Law XL. on imagination, and gives an additional strength to the division of the ideal sensations into the arrangement made. But possibly another quotation may be made with advantage, from the same celebrated author, who says, — "An idea of an object may be associated long after the object producing the sensation is removed; or, in other words, a sensation may be remembered, which is but being conscious of the sensation produced by the object removed."

It may here be seen, that Mr. Stewart does not draw any difference between association and memory,—a thing to be regretted, as the former kind of sensation is always produced by the one immediately preceding it; whereas memory, or a sensation renewed, may be produced without having any reference to the one immediately preceding it. But for association, or a sensation suggested by the one preceding it, to occur,

it is necessary that there be a capability of memory, or of a sensation being renewable.

It is felt that this part of physiology would fill a volume of itself, were it discussed as it requires: but that must be excused, as the intention of the work would be defeated. Unsupported by argument, it is thrown on a generous people to find countenance among its readers; for good argument is but the putting evidence well together, which may hereafter be applied to the arrangement of these facts. The physiological table in the Appendix will give, at one view, the whole of the classification, and the laws may be selected and arranged accordingly.

Volition, as defined in Law LIII., may not be so clearly understood as the following short explanation may help to make it. Its exercise presupposes intention; but action with motive does not constitute will, but is the effect of will. For the motive may exist, yet action does not take place, owing to the noncapability of muscular contraction.

In adding the degrees of heat according to Fahrenheit's scale, I have taken the opportunity of adding the degrees of heat according to my brother's thermometer, as made by Mr. Ronketti,

14, Museum Street, which I always use, as being founded on better data than any yet in general use.*

Law LXVI. presupposes that the partial state of relaxation of the stomach exists in nausea, and that in vomiting the stomach is totally passive. As far back as 1686, Chirac proved that the stomach was passive in vomiting; and the experiments with a bladder in place of a stomach, by Magendie, prove that vomiting is independent of the stomach's contraction. If this be admitted, the reverse or active state will be found to be accompanied by rapid circulation of blood, as in the first stages of fever, (as already alluded to in Law VII., and further in Law LXXX.,) when there is intense thirst. Yet the deficiency of gastric juice may also contribute to the sensation of thirst; but that deficiency appears always the result of the intensity of arterial circulation.

With respect to the use of carbon in the stomach, I intend hereafter to give a variety of facts: these will relate to the treatment of nervous diseases connected with the stomach, where it has formed the principal basis of the treatment.

* Revue Encyclopédique, t. 30., Mai 1826. London New Monthly Magazine, 1826. Medical and Physical Journal, 1826, &c.

The mention of this circumstance, therefore, may explain why Law LXXIII. is introduced. Mr. Hunter mentions that, in eructations of air from the stomach, which he conceives to be the seat of its generation, there is a sensation of heat.* This corresponds with the circumstance of the development of carbonic acid gas in that organ; and it is strongly corroborated by the universal fact, that after drinking carbonated waters there is an increase of heat and perspiration, evidently showing that the development and expiration of an increased quantity of carbon is attended with the phenomenon of increased heat. The giving off carbon from an aneurismal sac, by the union of oxygen with the blood, appears to be the cause of the increased heat, as also in inflammation; although the nerves may have some special power of retaining it, as is noticed by Sir Everard Home,† in his experiments on animal heat.

It may add importance to the fact of the presence of carbon in the stomach, in reminding the reader that to prevent water from putrifying, the barrels to contain it during a long sea voyage are always charred, and there is a similar effect in preventing animal matter from putrifying, for, if

* Heat of parts in inflammation, p. 291.

† Philosophical Transactions.

game is soaked in water containing charcoal, putrifaction is arrested, and the before putrid meat is then rendered palatable. It appears also, that as long as carbonic acid gas can be confined by pressure in vegetables or vegetable liquors, fermentation does not take place; but on allowing the escape of the carbonic gas, there is an absorption of oxygen, and a development of heat in ratio to the absorption of oxygen.

In mineral and alkaline substances that contain carbonic acid gas, where oxygen is united with them, there is a development of heat, and the carbonic acid gas escapes, as is seen in mixing sulphuric acid with carbonate of lime or potass, &c.

In Law LXXXII. (page 73) it is stated, that the number of respirations are twelve in a minute, and the pulse six to one; however this may be at variance with Sir H. Davy, who gives twenty-six or twenty-seven, Hales twenty, and Dr. Thompson nineteen, it is the result of repeated self-examination about four hours after breakfast, and also in bed before breakfast, and nearly accords with Menzies, who says fourteen in the minute, * and Magendie, who says fifteen. This difference may be owing to the time after a meal that the

* *Menzie's* Dissertation upon Respiration.

observations were made, and they have been confirmed in the case of another individual. It is true that after a full dinner, or during great excitement, the number of respirations approaches that given by Sir H. Davy, and the pulse corresponds; for I have observed the respirations varying from sixteen to twenty-two, and the pulse varying in a similar degree from 106 to 130; but the pulse seems to lose in proportion as the respirations increase. The number of respirations of the patient have often served to indicate the frequency or slowness of the pulse, when circumstances prevented my ascertaining it correctly. The diminution of pulsations as the respirations increase in the minute, appears to be owing to the inspiration instantly following the expiration in excitement; but in ordinary breathing, there is a passive state of the lungs after each expiration, before inspiring, during which time one, or even two, pulsations out of the six take place. So that in very rapid respiration, the pulse commonly beats four or five times, as stated in Mojon's Law 378. But when the body is erect, and there is no particular excitement, the inspirations correspond with the expirations, having an equal number of pulsations to each.

When there is a very slow pulse, there is a remarkable difference in this phenomenon. A gentleman far advanced in life, whom I am now attending, has a pulse of only 40 beats in the minute, which has been so, with very slight variation, all his life; yet, in this case, there are 20 respirations in the minute, with a pulsation to each inspiration and expiration; and in increasing the pulse to 44, the respirations have also increased in a corresponding degree: that is, to 22 in the minute. But this is an anomaly, and may be from disorder, as he has been attacked with symptoms of apoplexy, and is now threatened with a return of those symptoms. It appears, then, that disease, excitement, and depression, form exceptions to the general phenomenon of the healthy state.

The pulsations of the corporeal arteries appear to be stronger during expiration than during inspiration; but this fact is not always observable when the pulse is rapid, and the respirations frequent and short. If a large plume or elastic body is breathed on, or placed in the current of inspired air, there is an oscillating motion observable, corresponding to the contractions of the heart; it is very observable when the respirations

are slow and the pulse full. Mr. J. Hunter* mentions, that during inspiration the vena cava superior readily empties itself, and that during expiration there is a degree of stagnation. A pulsation is seen in this vein when the heart contracts violently, particularly during expiration. Dr. Barry has made some valuable experiments on the effects of respiration on the venous columns of blood,† which show the truth of Mr. Hunter's remarks.

Law LXXXIV., (page 76.)—It appears to be a law of life, that no *secretion* can take place without a gland to perform it; therefore such being a general fact, the watery vapour of transpiration must come from a gland, and that gland appears to be the thyroid, particularly as a watery fluid is found in its cells. I cannot conceive that the lungs afford this vapour, although many physiologists suppose it to be given off by the extremities of arteries, and some by a particular set of exhaling vessels: both of these opinions are irreconcileable, as all secretions seem to be the result of the power of certain ganglionic nerves, to attract or assume to themselves or their

* *Hunter*, Treatise on the blood, page 187.

† Dr. *Barry*, Researches on the blood.

tubes in glands such atoms as are controllable by their principle of life or sensibility.

In Law LXXXV. an affirmation is made with much deference to the opinions of the Hunters and others. But the very many facts, proving that the lacteals and lymphatics are not absorbents, lead me to lay down an assumption as a law, on the evidence of those facts which may here be alluded to; although with great conviction that these opinions may be as incorrect as those of others.

Flandrin repeated the most conclusive experiment of Hunter, and did not find the same result. Magendie also repeated the experiment of J. Hunter, and does not give the same result; and Mr. Mayo has ably explained the tinged appearance of the lacteal vessels after death, which J. Hunter attributed to the absorption of matter. Dr. Barry in this country has shown, beyond all doubt, that veins are the absorbents of the body; whilst the experiments of Dr. Ségalas prove that the lacteals do not absorb from the intestines, but that the poison takes effect immediately after restoring the venous circulation. The experiments of Sir Everard Home with rhubarb* prove that the lac-

* Philosophical Transactions.

teal vessels do not contain that vegetable when introduced into the stomach, although it is found in the blood, urine, and bile. The fact, that alcohol is absorbed by the *veins*, and *not* by the *lacteals*, has been established beyond all doubt. From these experiments, I maintain that the lacteals are not absorbents, and that the thoracic duct is not a receptaculum chyli, but a terminating tube to the returning mesenteric and gastric mucous glands and their ducts, for such I venture to call those conglobate glands and lacteals. Having now denied the received opinion as to the function of the lacteals, and openly attacked the theory of others, the question will be asked, What are they, if they do not transmit chyle? It is with extreme reluctance I have gone thus far; but that it may not be said that the theory of others has been denied, without putting forth any thing as tenable, permit me to lay before the reader the theory now ventured to be established on an imperfect fabric, which my time and object will not admit of being fully discussed. Then let us suppose that the gastric and mesenteric conglobate glands separate a thick muco-gelatinous fluid from the blood, which is passed by ducts to the internal superficies of the digestive canal, for

the purpose of keeping that superficies soft, and dissolving the matter next it; that this fluid is emptied on this superficies in ratio as its surface is excited by the presence of matter. And that when matter is not there, the superficies or internal coat of the canal is contracted, and thereby the orifices of these ducts are no longer open for the secreted muco-gelatinous fluid to escape, it not being wanted: when that is the case, these vessels are gorged, and return the fluid back by another set, or carry it back immediately from the gland by vessels passing directly from the glands and ducts into the vessel called the thoracic duct, which again return the fluid separated from the blood, and not in use, back to the circulation. What would be the result, if these glands ceased to separate this fluid?—Hard and dry matter in the intestines, as is seen in tabes mesenterica, constipation, &c. What would be the result, if these glands separated too much fluid, either from chronic inflammation or intestinal excitement?—Slimy stools, as is seen in dysentery, purgings, &c. Why is bloody serum found in these tubes after long starving?—Because the fibrin of blood has all been deposited in supporting life, and the blood has

become thin and saline, so that red globules of it pass through these glands, and are returned, with the bloody and saline secretion, back to the circulation by the thoracic duct.

These glands all possess a large artery and vein, and have a peculiar distribution of nerves; the valves in the returning ducts prevent a retrograde motion of the muco-solvent fluid when over-abundant. If it were not returned, the intestines would be filled with slime, and their coats much enfeebled.

There is a remarkable coincidence between the function now attributed to the mesenteric glands, and the observation of that distinguished anatomist Mr. Cruikshank, who says, that if total obstruction of the mesenteric glands occurs, "we should meet with a stagnation of chyle in the first set of lacteals;" that is, nearest the superficies of the intestine; "yet I *never* saw such stagnation in any case whatever."* This is such strong evidence in favour of the opinion that the muco-gelatinous fluid passes from the gland to the intestine, that it leaves no doubt in my mind as to the validity of the theory now given. Dr. Mason Good mentions, that those who die of this disease "seem to

* *Cruikshank*, Anatomy of the absorbing vessels, page 115.

be carried off by hectic fever, or some other cause of irritation, rather than by actual innutrition."* The opinion of Morgagni and Dr. Hunter, that, in old persons, the glands in the mesentery are obliterated, corresponds with the circumstance of the food being of a softer and more liquid nature, not requiring the mucus of these glands to lubricate the villous coat of the intestines, or to assist in dissolving the alimentary matter.

It will be seen that it is said, in Law LXXXIX. (page 86), that the chyle passes by the thoracic duct, which is at variance with the foregoing. When that Law was written, it was given as the opinion of others: for this I hope to be excused; as I had not resolved, when that sheet was struck off, to publish these opinions, since which the determination has been made, and now with diffidence offered for the attack of adverse opinion; trusting that it will meet with some supporters, even in its very imperfect state.

The lymphatic glands appear to be the glands which afford perspiration, from the circumstance that they are most abundant where perspiration

* Dr. *Mason Good*, Study of medicine, Parabysma Mesentericum.

is most copious; we also find that an odour is found in the glands of the axilla, corresponding to the odour of the sweat of that part. Besides, the experiments of MM. Lavoisier and Seguin* have proved that the skin does not absorb, and also that the blood and urine show no trace of the absorption of turpentine, as performed by Drs. Clapp and Dangerfield.† The experiments of MM. Magendie and Delille, on the absorbing power of the veins, independent of all other parts, demonstrate that the veins are the absorbents of the body, which, I believe, takes place in consequence of the surrounding pressure‡ producing capillary absorption in the extremities of those returning vessels.

The conglobate glands, dispersed so partially in the different flexible parts of the body, appear to be the secerners of perspiration, a fluid very similar to the serum of the blood, and which undergoes chemical changes on being exposed to the air, rendering it different from the fluid unexposed.

* *Magendie*, Précis elementaire de physiologie.

† Dr. *Milligan's* Notes to his Translation of Magendie's Compendium of Physiology.

‡ See Dr. *Armstrong* on Scarlatina simplex and Phthisis pulmonalis.

When the skin is not corrugated by external or internal stimulants, the perspiration transudes through its pores in greatest abundance, where the lymphatic vessels are in greatest number; and it appears that when the pores of the skin are shut, either by external excitement or by local inflammation, the perspiration does not transude, but is carried by the valvular lymphatic vessels, back into the venous circulation; that of the superior extremities, which is of a more odorous nature, by two distinct ducts, while that of the lower extremities is returned by the mesenteric vessels into the thoracic duct.

If the perspiration had not vessels to return it to the blood when the pores were closed, the secerning vessels would be gorged and burst. If the perspiring glands cease to perform their function, either from local inflammation or from fever, the skin becomes dry and chaps. The secretion is in ratio to the moderate circulation of the blood and distension of the arteries,—a fact observable in all secretions, and particularly alluded to in Laws VIII. and XII., and is every day put in practice in the exhibition of sudorifics. When these glands are inflamed, either from sympathising with inflamed parts, or in general

inflammation, as in plague, &c., they often suppurate; and then there is not any secretion of perspiration* lubricating the corrugated cuticle, and preserving it whole and flexible without pain. These glands, like the mesenteric, are provided with arteries and veins, and also with peculiar nerves, as well as all those conglobate glands that communicate with serous or mucous surfaces.

It may be asked, why should the vessels communicate so completely all over the body, and not enter at once into the nearest veins? This difficulty may be answered thus: the parts of the body do not always perspire equally, therefore a free communication with other parts not perspiring will draw off the over abundant perspiration in their vessels, thus relieving the necessity of an *excited* and *increased* secretion from the glands in the *part freely perspiring*.

In those parts which do not perspire freely, we do not find these glands,—as the outside of the thighs, legs, arms, and sides. But, in the serous cavities we find glands affording evidences, that their function is that of secreting a lubricating fluid, and not of absorbing the fluids in these ca-

* *Sydenham* on the Plague.

vities. Indeed, venous imbibition or absorption is so fully established by the many hundred experiments performed by Flandrin, Lavoisier, Seguin, Segalas, Tiedemann, Gmelin, Magendie, Home, Andrews; Lawrence, and H. Coates of America, Ribes, Delille, Fodera, H. Mayo, Barry, &c., and by opinions of authorities of more ancient date, as Ruysch, Boerhaave, Meckel, Swammerdam, and Haller, (who was aware of Mr. J. Hunter's theory,) that its truth seems to be placed beyond all doubt, confirmed as it is by the evidence of such conclusive facts.

In Law 510 there is a remarkable fact recorded, which is another evidence in support of the function ascribed to the lymphatics; for there you find that the skin continues fine and smooth in the eunuch, and the increase of the fluid in the lymphatics is so great, as to give the appearance of these glands ceasing to perform the imagined office of absorption: and also that the synovial secretion is in excessive quantity, which corresponds with the supposition that the glands communicating with the synovial and lubricated surfaces secrete these fluids, instead of absorbing them.

When the lymphatic or *sudorific* glands have a diseased action, the secretion is often sanguineous;

as is seen in the plague,* which goes on to suppuration in the glands themselves, constituting buboes. The glands also suppurate from sympathizing with their diseased ducts, as in buboes from ulcers or morbid secretions; they also simply inflame, either from extreme arterial gorgement, or from sympathizing with the excitement of the extremities of their ducts, as in sympathetic buboes, in gonorrhœa, &c.

It appears that the theory of transpiration and transudation is founded on the opinion, that the minute extremities permit these secretions to pass to the surfaces which exhale them. This opinion is founded on the sole circumstance of finding a fluid in the respired air, and another fluid on the surface of the body, which could not be accounted for but in two ways; the one, that it is thrown off by the extremities of arteries; the other, that it is discharged by a particular set of exhaling vessels.

The opinions in favour of each theory are noticed by Signor Mojon, in page 76. Yet there is nothing demonstrable; for microscopic examination does not show the existence of the exhalent vessels, nor of the transudation of arteries, which, in the only cases of perceptible transuda-

* *Russell* on the Plague.

tion from them, arises from the erasure of the cuticle, when a gummy lymph is transuded, forming a scab, or from erosion of flesh, when there is a transudation of pus.

The cuticle is a surface of minute pores, communicating with the integuments, which contain innumerable lymphatic ducts, evidently showing that, as no absorption has been traced, transudation must be the result of this communication; particularly as we have a set of glands connected with these ducts. If these glands were for the purpose of rectifying or mollifying the fluid supposed to be carried into them, what becomes of the residuum or impure part? That has never been explained, nor can such office be demonstrated. It is mere supposition, and less tenable than the opinion that, as there is a gland, there must be a secretion; for in all observable secretions within the external surface of the body, we find a gland affording them.

The perspiration, in Law 402, is said to be in compound ratio to the force of the blood. This does not accord with the phenomena of fever, and may safely be contradicted; for we find the perspiration only returns with the decrease of the force of the blood. Yet it will be asked, How

then, in extreme exercise, is there an increased perspiration, when there is excited force of the blood? To explain this, appears, at first sight, impossible; still, when we reflect, we perceive that as the demand for blood increases in one part, from its consumption, the circulation diminishes in force in another; so that, as the muscles consume blood, the circulating force diminishes in the glands, and the function of those glands is in ratio to the moderate circulation of blood.* Thus, then, glands affording sweat are increasing their office in ratio to the increase of muscular action; because the muscular contraction diminishes the force of the blood in the other parts of the body, by consuming it in increased proportion.

If the perspiration transuded from the arteries, it would lead us to look for sanguineous sweat when the force of the circulation is greatly increased. In scarlatina, when the minute arterial vessels are distended with blood, we have no sanguineous transudation; but as the circulation diminishes, the glandular organs recover their function, and sweating returns. In the *conjunctiva,* on the increase of the circulation, we see a

* See Laws VIII. and XII.

complete mesh-work of blood-vessels; yet when ulceration begins, the transudation is not sanguineous, or serous, but is purulent.

In Law LXXIX. it is said, that the venous blood of the intestines principally yields the bile as it passes by the vena porta; which is deduced from the fact of the bile being found in the two mesenteric veins, which appear to imbibe the same bile that has already been purified by the liver, and again emptied into the intestines, whereas in the blood of the cæliac vein there are but slight, if *any*, traces of bile found in it. However, it is a curious fact, that the vena porta conveys the blood from all parts of the alimentary canal, where the nutritive matter remains long enough for absorption to take place, and where it does not remain long enough for *absorption* to take place, as in the lower part of the rectum, œsophagus, &c., the blood does not pass through the liver, but is poured by separate veins into the corporeal venous circulation.

The Physiological Table, at the end of the volume, is intended to give a general view or classification of the organs forming the human machine, and the functions of those organs combining to preserve that machine in the living state of being.

There are two functions omitted, which are peculiar to woman,—the secretion of milk, and the menstrual discharge. Although the former might be added with some claim for its being a function of man, yet as it appears to be a phenomenon of rare occurrence, and unnatural to his purposes of formation, I have omitted the function, but the mammillary glands would range under the head of glands among the sensitive organs, and in a physiological table of woman, their function, with the menstrual discharge, may be added; the former among the alimentary secretions; the latter might be considered under the head of placental circulation, as it particularly relates to the fœtus, and is of such doubtful formation, that it may with justice be omitted in the classification of the secretions.

This brings the Introduction to the additions nearly to a close; and I fear some will say, with reason, it is high time; yet the opportunity is so tempting, particularly as there is matter in it which may call forth the censure of the correcting critic and satirist, that it induces me to give some further opinions on the functions of the uterus, as the correction for my supposed offences in invading received doctrines may elicit opinions from

men perhaps more competent to give them, and refute mine at the same time. There is also another inducement, which may perhaps be stronger than the one alluded to: yet it is not with a view of attacking, in a polemical discussion, the theory recently delivered by Dr. Barry in his physiological lectures, but simply of stating what appears tenable on the observations made, and the conclusions I am led to, from a consideration of the phenomena affording scope for these conclusions.

It has been always maintained by obstetric physiologists, and by the lecturers on that branch of knowledge, that the menstrual discharge is a secretion of the uterus, and that expulsion of the fœtus is produced by the contraction of that organ; yet, from observations which shall be mentioned hereafter, I am inclined to the conclusion, that the menses are an escape or oozing of a species of blood from the extremities of arteries, during a *relaxation* of the uterus, and that the period of parturition is the result of the *relaxation* of the gravid womb's continued contraction, which excites the diaphragm and abdominal muscles to expel the contents of the *then* foreign mass, as is seen in the act of vomiting.

Before entering into a discussion on the above, let

me state my opinion as to the circulation of the fœtus, which must also be considered while we are relating matter connected with the function of the uterus. In Law LXXVIII. the circulation of blood in the veins is stated to be the result of the pressure of the atmosphere, or of the surrounding medium on the body. So it is in the fœtus; this pressure is not of air, but of the surrounding medium, the liquor amnii, as is seen in a similar manner in the surrounding medium of fishes. And also, in Law LXXVII., the circulation of blood in the veins of crustaceous animals, is said to be from pressure occasioned by the resistance of the shell to the pilated artery; so it is in the egg, which may be said to be a crustaceous animal: it will be stated that the circulation in an egg does not take place till incubation is begun, and that the pressure is the same then as at first; but let it be remembered, that the resistance which is the pressing power, does not take place until the air in the egg begins to expand, and occupy more space in consequence of the increased heat from incubation, previous to which there is not pressure, as the bulk of the contents is equal to the capacity of the shell, and the contents are passive. During incubation the air presses on the contents

of the shell, which resist that pressure, propelling the blood back from the circumference to the centre; by the pressure also of the artery from the centre to the circumference, a circulation is maintained. The circulation in the placenta appears to be produced in the umbilical arteries, by the contraction of those vessels propelling the blood into the placenta; and in the umbilical vein, by the pressure of the uterus and the liquor amnii returning it back to the fœtus, renovated and fitted for its growth. The ovum of the hen, and of other oviparous animals, is separated and independent of the parent, before the placenta of the chick, or germ, is become subservient in maintaining its growth; but the circulation is kept up in a similar manner by the air in the egg pressing on the yolk, which answers the purpose of a placenta, affording nutriment to the germ. There is a strong resemblance between the germ of plants and that of oviparous animals, in the nutriment of the young plant being derived from a placenta independent of the parent; for the lobes of the seeds (*cotyledons*) form the placenta or nourishing provision to the plumula, until the radicle supersedes its use, particularly in the radish (*raphanus sativus*), lupin (*lupinus albus*), &c.,

which shoot their lobes up through the earth, forming a protection to the plumula, and probably are the respiring organs to it, till the leaves are fully developed. The lobes of the garden bean (*faba major*), &c., which is longer in forming small rootlets to afford nutritious channels to the moisture of the earth, for the nourishment of the plant, and of most of the monocotyledons, remain in the earth, affording nutriment to the plumula and the radicle. If you remove the lobes of a lupin directly after they have unbudded the plumula, the plant dies; evidently showing they form a principal part of their economy; and the same thing is the result of removing the lobes from those germs which derive nourishment from them when in the soil, as the bean and pea, &c.

Returning to the question of the expulsion of the fœtus, the first objection that will be made to the relaxing function of the womb, is the rupture of that organ by the fœtus, when the vaginal aperture is not sufficiently dilated. This may be answered in the same way, that rupture of the stomach takes place when there is not erosion of its parietes, as in the case of vomiting, or rather the effort (by the diaphragm, abdominal, and peroneal muscles) to vomit; producing that solution of its

continuity, and allowing its extravasated contents to fill the abdominal chamber. The next objection is the contraction of the cervix of the uterus in a labour pain. * This is purely the action of the *levator ani*, which forms a sphincter to the cervix uteri and bladder, as well as to the vagina itself, although the latter has an external muscle, so called. Indeed, in a parturient pain, all the muscles of the vagina are thrown into action; and as the frequency and force of the contractions of the diaphragm and abdominal muscles are excited, the resistance of the vaginal muscles is overcome.† These are the only two argumental evidences that can be placed in opposition to the relaxing function of the womb; and now let us see what are the evidences on which this relaxing function is attempted to be established.

In looking at the structure of the uterus, we do not find muscular fibres sufficiently substantial to warrant our entertaining the idea that that organ has a powerful contracting force, equal to expel its contents when pregnant. But these fibres seem sufficiently strong to perform the contractile function, which keeps the unimpregnated

* *Hamilton*, Theory and practice of midwifery.

† *Burns*, Principles of midwifery.

uterus in an even state of contraction between the periods of menstruation, and also to contract the expanded uterus after parturition, as well as to preserve an *even and continued pressure* on the contents of the womb during pregnancy.

When the gravid uterus ceases to contract or press on its contents, the period of parturition comes on in consequence of the contraction of the respiratory muscles. This appears borne out by the circumstance of sudden mental emotion bringing on parturition, when there is a total or partial relaxation of all the unconscious contracting organs, as in fainting, when the heart and stomach sympathise in their affection. This relaxation appears to be the consequence of the previous excitement, which will be followed by its subsequent alternation, in ratio to the exciting cause and its sensibility: and there is a singular fact bearing in favour of this opinion, namely, that as you diminish the fulness of the pulse by bleeding or opiates, you advance the parturition by assisting the dilatation (that is *relaxation*) of the *neck of the uterus*. In the first month of pregnancy, the mouth of the womb is not closed completely; which also shows, that it is in a continued state of even and constant contraction dur-

ing pregnancy; and that when the period of total relaxation arrives, the parturition is only retarded by impediments to the external passage of the fœtus.

It appears that the presence of the germ or ovum in the womb excites an even and constant state of contraction; yet this contraction is not so powerful as to prevent the increase of the volume of the ovum and womb, as, in a similar manner, the alimentary paste in the stomach excites a state of even and continued contraction, until that excitement is protracted too long by the presence or increase of the exciting cause, when exhaustion and relaxation follow, and the respiratory muscles of the abdomen come into action by the foreign body acting on them. The two cases appear to me so similar, that I no longer entertain a doubt of their being results of similar causes; and we observe a sympathy existing between the womb and stomach, which corresponds with the fact of vomiting during parturition.

The length or period of gestation appears to be the result of two circumstances which are attendants on the physical state of the womb; namely, the moment at which the sensibility of

the creature is *locally* or *generally* excited, and the relaxation which is consequent to that excitement. Thus then it seems that the womb has, at different periods, different degrees of contractile sensibility, from excitants, and that when these degrees of sensibility are produced, by local or general excitants, there is a sequent relaxation of the contractile irritability of the womb.

Supposing the womb to be pregnant, which goes on for a period of, say, seven months, at which time the female experiences a sudden general excitement, from the senses or the passions being unnaturally roused; the excitement is extended to all organs that immediately sympathize with each other, as the heart, stomach, womb, and brain; which excitement ceases after a time, and a relaxation of those sympathizing organs follows: the result is, fainting, from want of circulation of blood in the brain, &c.; sickness, from relaxation of the stomach sympathizing with the heart, &c.; parturient pains, from the relaxation of the womb sympathizing with the general relaxation of the stomach, heart, &c.; which parturient pains are the spasmodic contractions of the *respiratory muscles*, excited by the unwieldy womb acting

as a forcing body on their internal sides; and premature birth or abortion concludes the effects. A local excitement produces abortion in a similar manner, but the degree of local excitement required for this effect varies in ratio to the tone or sensibility of the female. The health may be very good, and the irritability of the nerves, consequently, at a low pitch, when a local or even a general excitement will not act sufficiently to produce a requisite degree of relaxation, so as to bring on labour. On the other hand, if the health be bad, the irritability of the nerves is at a high pitch or state of excitability, and the local or general excitement will produce a subsequent relaxation more rapidly, and in a greater degree.

The pregnant womb, in cases where the fœtus increases to a great size, and the usual period of gestation is exceeded, appears at a low state of excitability; for the presence and bulk of the ovum does not create an excitement sufficient to be followed by the relaxation causing parturition at the usual period of that phenomenon; but, from its atony, continues in its even contracting state of pressure on the ovum; so that the usual duration of gestation is owing to the ovum not acting locally as a sufficient excitement

to induce the relaxation of the womb, so as to make it act as a foreign body within the abdominal chamber; and in premature birth, the ovum or general excitants produces an excitement sufficient to bring on a premature exhaustion or relaxation of the womb's continued contraction, which is attended with parturition; but this degree of excitement will depend on the general irritability of the female, the intensity of the exciting cause, and the kind of excitement, either local or general. The period at which the ovum arrives at its final compressible bulk varies according to the species, as is seen in Law 560; but the period of relaxation may be induced, and varies in each species according to the state of local or general excitement; which may be exemplified by the administration of medicines that produce relaxation of the womb, as, for instance, the ergot of rye, which induces relaxation in a short time. The relaxation of the pressure, or continued contraction of the womb on the ovum, accounts for the circumstance of fœtuses often being still-born; as, by that pressure ceasing, the liquor amnii no longer acts as a pressing atmosphere on the fœtus; consequently, the blood ceases to return from the surface or extremities to the propelling

organ of the centre of circulation; and sensibility being in ratio to the circulation of blood, the sensitive functions are not in activity, until they are restored either by external or internal excitement; which is a fact often observable in sudden or protracted labours.

From what has preceded, it will be seen that a function ascribed to the uterus, besides that of being a receptacle for nourishing and perfecting the germ, is that of acting as a contractile organ in the venous circulation, for effecting in the fœtus the office performed by the external medium or atmospheric pressure on the independent animal. There is one other function of the uterus to examine, which it is necessary to do here, as the same arguments apply in accounting for that phenomenon, namely, the menstrual discharge, which physiologists are reconciled to consider as an exudation from the blood-vessels of the uterus. Yet they have not given a reason which can be a rule in all cases, why the secretion takes place at one time and not at another; for some say it is from plethora; and others answer this by saying, it does not exist in all cases; while others support the former argument by saying, that, in debilitated women, the strength of the womb is not

adequate to resist the distension of the uterine vessels. The uterus appears, when unimpregnated, to continue in a contracted state about a month, and during that time no menstrual discharge occurs; but about the end of that time, a discharge occurs which appears to be the result of a relaxation of its former state, which allows the vessels to open to the propelling force of the blood, and a discharge escapes. This discharge is often accompanied with pains (spasmodic contractions of the respiratory muscles) like those of parturition, which expel the contents of the uterus; these contents are generally a sanguineous fluid, and sometimes gelatinous substances, &c., which are formed in the uterus. And it appears that when this relaxation, which alternates with the state of contraction, ceases, and the uterus again resumes its state of contraction, it is able to continue for a month without being exhausted, not having an exciting ovum to continue its state of contraction; but when the debility is great, and the irritability of the female is more excitable, or has been unduly excited, either locally or generally, this exhausted state of the uterus alternates sooner than the usual period of a month; and on the other hand, where the strength is greater and the

irritability is less excitable, this state of relaxation of the uterus does not alternate so soon as in the other case, and may not take place for weeks after the usual period; consequently, the period of the appearance of the menstrual discharge varies accordingly. Both these states constitute disease of more or less consequence, according to the time between the discharges; and besides these mild forms of disease, there are two others which arise from the same causes: as, when there is a continued relaxation of the uterus, there is flooding of blood; and when there is a permanent contraction of the uterus, there is suppression of menses, giving rise to many diseases of a peculiar and dangerous nature. There is also a striking coincidence of the pulse with the state of contraction or relaxation of the uterus; for, where the case is not one of a disorganized nature, in permanent contraction of that organ, we find that suppression of menses is attended with a full pulse, and particularly in furious mania of women, which is generally attended with suppressed menses; and when the pulse is lowered, the menses often return, and the furious moments of mania gradually subside, till convalescence is established.

In the relaxed state of the uterus, when there is flooding, we find the pulse slow and feeble; and as we restore the tone of the circulation, the flooding ceases, as is exemplified in the use of opium.

There are many medicaments which appear to have a peculiar effect on the state of contraction or relaxation of the womb, counteracting either state, and are given with decided benefit; but their effect seems to act through the sympathy that exists between the brain, heart, and stomach.

The lochial discharge after parturition, also corresponds with these statements; for as the womb resumes its natural state of contraction, this discharge diminishes from a sanguineous appearance to a serous, till it finally ceases. The sanguineous discharge corresponds with the exposure of blood-vessels when there are erosions of flesh; and the serous or gummy discharge, as the lochia subsides, corresponds with the lymph or gummy discharge that exudes when there is simple erasure of the cuticle. A lymph or gummy discharge is often expelled from the uterus at the close of menstruation, and also at the first appearances of it. These discharges appear to be owing to the varying calibre of the uterine

arteries, and probably the same state of distended vessels may be the cause of purulent and serous discharges from mucous and serous canals when in a state of indolent inflammation.

The placenta appears to excite or produce its expulsion in ratio to its bulk; for I have found that the more the blood could be kept in it after separating the fœtus, the sooner do the respiratory muscles expel it, and consequently have objected to the practice, adopted by some men-midwives, of letting the umbilical vein bleed. This opinion has been proved by Sig. Mojon injecting the placenta, while attached to the womb, with cold water acidulated with vinegar,* and the result has established the fact that the bulk of the placenta is an exciting cause of its expulsion, as well as the stimulus of the cold injection. This has been practised by many in Italy with the same useful effect.

Trusting that the reader will excuse the time taken up in perusing these opinions, and that he will give them his dispassionate consideration, they are brought to a conclusion, to give place to matter worth the attention of every inquiring mind, and fitted for the capacity of most men.

* Medico Chirurgical Review, vol. ix. p. 632.

ERRATA

To be corrected before the book is read.

Page xvii *line* 2 *read* "Goodwyn" *for* "Goodwing"
xliv — 19 —— "colouring" *after* "of"
lix — 15 —— "dilated" *for* "pilated"
lxvi — 2 —— "foreign" *for* "forcing"
48 — 8 —— "bronchia" *for* "bronchiæ"
65 — 28 —— "principally" *for* "alone"
74 — 21 —— "Hewson" *for* "Howson"
94 — 9 —— "32" *for* "23"
— — 29 —— "34" *for* "32"
104 — 22 —— "by coition" *after* "place"
115 — 12 —— "and spinal marrow" *after* "brain"

LAWS OF PHYSIOLOGY.

GENERAL CONSIDERATIONS ON LIFE AND ITS PHENOMENA.

1. The aptness for a living existence requires a special organization of parts; thence an animated being will enjoy life, as long as their proper organization is not altered.

2. All the actions which constitute life produce movement, develop heat, and effect various combinations. These three characters serve to estimate the force of life; and in the regularity of their relations we recognise the proportions of health.

3. The having origin by generation, the being sensible, voluntarily moveable, the having a central organ of digestion, the growing by means of nutrition, and the ending by death; such are the general characters common to all living beings.

4. In all the stages of life, man and animals specially differ from inorganic matter, by the property of feeling the action of certain external agents, and being susceptible of some peculiar actions, so that the phenomena necessary to their living existence result therefrom.

5. The cause of the manner of being of each part of the living body, resides in the whole, whilst in inorganic matter each part possesses it in itself.

6. Every organ has a species of life peculiar to it, a particular action, and special properties; so that the general life is only, if we may say so, the result or total of the lives, particular to the organs or divers parts.

I. The existence of an organ indicates a particular function, the cessation of which tends to the cessation of the functions of all the organs of a being.

II. The consciousness of an organ is its life; the consciousness of all the organs of a being is the perfect life of the being; the function of the whole preserves or continues the life of the being.

III. The non-consciousness of an organ is its death; the non-consciousness of all the organs of a being is the death of the being; the non-function of the whole is a cessation of life, or death of the being.

7. The greater part of the phenomena that take place in the animal machine during the course of life, are the result of its vital force, depending most frequently on organization.

8. All the functions of the animal machine tend to the preservation of the individual, or to the propagation of the species.

9. The perfection of all the functions of a living body requires that of all the organs.

10. Animals are endowed with a particular in-

stinct that manifests itself even from birth, and which is not indeed the result of experience, but certainly of their organization.

IV. The innate consciousness of being able to produce motion, pleasure, and pain, constitutes instinct.

11. All those actions to which the mind concurs, without being conscious of any actual motive but of yielding solely to the impulse and invitation of some internal sensation, are actions produced by instinct.*

V. The actions instigated by the deficiency or desire of motion, of pleasure, and of giving pain, are the effects of instinct.

12. All the actions which are due to the force of instinct, that is, to an internal impulse, are much more marked and better executed in animals than in man; and more in the infant than in the adult.

13. There is no function of the living machine that does not want the aid and concurrence of the others.

14. All the symmetrical or paired organs of the animal machine, always alternate their action with repose.

15. The various parts which constitute the animal body, demonstrate, by reason of their particular structure, a particular manner of being

* *Araldi*, Sull' instinto. mem. della soc. med. di Bolog., t. 1.; *Samuel Reymarus*, Sur l' instinct des bêtes. Hamb. 4me Edit.; *Blumenbach*, Manuel d' histoire naturelle, t. 1.; *Cabanis*, Rap. sur le phys. et le moral de l' homme.

excited; and thence, to be put in action, require the application of different stimulants.

16. The action of any stimulant whatsoever on the animal machine, diminishes its effect in proportion as it becomes prolonged.

VI. The great excitement of an organ is always followed by a corresponding languor.

17. The effects of vital force are always equal among themselves, and to render them different a different organization is necessary; thence a stimulant on an organ will produce only those phenomena proportioned to the nature of the organ and of the stimulant.

18. Living beings, as far as regards their constitution and properties, are always in relation to the bodies by which they are surrounded.

19. The nature of an animal depends, in a great degree, on the energy and mode of each of its functions.

20. The physical wants of all living beings depend directly on organization, and are always proportioned to the power the animal has of satisfying them.

21. Life eludes the influence of many chemical laws, and defends the animal substance from putrefaction: therefore there is never putrefaction where there is vital force.

22. The animal released from the egg, or issued from the womb, after having received, through the medium of the fecundation of the germ, vital movement, and having acquired the conformation par-

ticular to the species to which it belongs, increases; is stationary some time; reproduces beings similar to itself: in the sequel it declines; some of its forms cancel themselves; and lastly it dies.

23. The forms that characterize organized living beings, show themselves by degrees, as the beings develop themselves, and become more and more marked in proportion as the acts of life are reiterated in the organs that it animates.

24. There is no animal whose cranial bones unite so tardily as those of man; whose teeth are so slowly unbudded from the gums; that takes more time to be able to sustain itself on its feet; lastly, that arrives so slowly at puberty and its perfect growth: there is none of the mammiferi, in comparison to the volume of the body, that enjoys life so long as man.

25. In the animal machine, decomposition and recomposition continually operate; so that, considered at two different epochs of its existence, it does not contain any of the same molecules.

26. All the functions of the living body depend on a reciprocal action and reaction of the fluids and solids that interchange and renew themselves. For, truly, the course of life carries with itself a perennial series of changes by which we are no longer perfectly the same in every successive instant of our lives.

27. In infancy and juvenile age the vital energy of all the organic systems is much more active than in advanced age.

28. The agility and ferocity natural to an animal, are in ratio to its own force and muscular agility.

29. The contraction of the animal fibre, when it is set in play sympathetically, supposes always a nervous action.

30. Those parts of the human body in which turgescence succeeds to the application of stimulants, are always furnished with much cellular tissue.

31. Many insects change their forms at certain determinate epochs of their existence.

32. Birds are annually subject to changing their feathers, and many other animals the wrapper that covers them.

33. The consistence of the epidermis of animals varies according to the medium in which they are enveloped, and the place where they are obliged to live.

34. The duration of life in animals is in direct ratio to the slowness of their growth, and in inverse ratio to the quickness with which the beings propagate themselves; or, the duration of life is in direct ratio to the period the animal remains in the womb of the mother, or in the egg.

35. Cold-blooded animals have a greater vital tenacity than warm-blooded animals.

36. Those animals that have the faculty of reproducing new organs, live longer than others.

37. Life is worn out by the continuation of the same causes that maintain it.

38. Sympathy between two different parts of the animal machine exists when there is an affection in one of these, which extends itself sensibly and frequently to the other; if in case, however, that such a phenomenon does not proceed from the laws of mechanism, or from the general and known order of the functions of the living body.

39. The organs that particularly sympathise together, are those which have a similar structure and function, and which are symmetrically or parallelly situated in the two lateral halves of the animal machine: besides these organs, the womb likewise sympathises with the breasts: the testicles with the organs of voice: the lymphatic glands with one another, &c.*

VII. The heart and stomach of animals correspond in their actions arising from excitants or depressants.†

40. It is by means of the sympathies that all the organs concur to the same result, and aid each other reciprocally.

41. As soon as we know, or suppose, in an organized being, the existence of sensations, propensities, and will; sympathy attracts us to it, or antipathy repels us from it.

* *Barthez*, Nouv. élém. de la science de l' homme. t. 1.

† *Whytt*, Essay on the vital and other voluntary motions, p. 48.

CLASS I.

FUNCTIONS PRESERVATIVE OF LIFE, RELATIVE TO THE INDIVIDUAL.

ORDER I.

FUNCTIONS THAT BELONG TO ANIMAL LIFE.

GENUS I.

OF SENSIBILITY IN GENERAL.

Pleasure and pain.

42. SENSATIONS alone inform us of our existence, and of that of the bodies that surround us.

VIII. Sensation is in exact ratio to the arterial action existing in the organ operating; consequently, extreme sensibility is attended with excited arterial action, and depressed sensibility is denoted by languid arterial circulation. The reverse takes place in secretion.

43. There is no sensation that does not produce pleasure or pain, desire or aversion.

IX. Pleasure consists in the moderate excitement of a demanding pathic organ, by the presence of an object for its function.

X. Congenial sensation consists in the medium between pleasing and painful varieties of any sensation, yet not indifferent to the being.

XI. Pain consists in a sensation being too excited, by the application of an object that is

detrimental to the existence of that organ's functions, or not conducing to its proper action.

44. There is no part of the living body which can be called absolutely insensible.*

45. All the sensations of which the animal machine is susceptible, can be reduced in ultimate analysis to the sensation of touch.

46. To distinguish any sensation whatever, it is necessary to compare it with a different sensation.

47. Animal sensibility is that property which is the most characterised in the nerves.

48. The nervous system is capable of an action peculiar and relative to the faculty of *animal life, external* or *sensitive*, and of another which regards the functions of *organic life, internal* or *vegetative*.

XII. Sensibility is of two kinds : *mental* sensibility, of which the being is conscious from its sensations; and *secerning* sensibility, of which the being is not conscious; being the operating power for separating fluids or solids from the blood. Increased mental sensibility depresses secerning sensibility; depressed mental sensibility increases secerning sensibility. †

49. Sensibility is in direct ratio to the nervous

* Such is the opinion of some ancient physiologists, as well as of the most modern : I cite the most accredited, because some oppose it; *Lucret.* De rerum. natur. lib. 1.; *Montagne*, Essai. lib. 1. ch. 20.; *Whytt*, Observations on the sensibility and irritability of the parts of men, and other animals; *Le-Cat; Lorry; Tandon; Dumas*, Principes de physiologie, t. 2.; *Chaussier*, Tables synoptiques; *Richerand*, Nouv. elem. de physiologie, t. 1.; *Bichat*, Anat. générale, t. 1.; *M. A. Petit*, Discours sur la douleur; *Bilon*, Dissert. sur la douleur; *Jacopi*, Fisiologia, t. 2.; *Cabanis*, Rapport sur le physique, etc., t. 2.; *Tommasini*, Lez. crit., etc.

† See Law VIII.

ramifications, and in inverse ratio to the quantity and density of the cellular structure that envelops them.*

50. The sensibility of soft parts augments in ratio to their tension.

51. The sensibility of hard parts increases in ratio as the force of cohesion, with which their molecules are allied, diminishes.

52. In the organs of the senses the proportion of nerves always surpasses that of the sanguineous vessels.

53. The sensibility of any part whatever is so much more acute, as its nerves are more denuded.

54. Every organ has a feeling proper to itself, and all the movements of the animal economy are the product of sensibility put in action.

XIII. The excitement of an organ when continued for a length of time, is followed by a passive state, often losing the power of being again restored to action.

55. Feeble sensations are not perceptible at all when they are followed by other stronger ones.

56. Any sensation whatever becomes weakened if it is protracted, although the cause that produces it continues to exist.

57. A sensation exists the same instant that the impression is made on a part, although the most remote from the common centre of the sensations.

58. Any sensation whatever does not cease at the same instant in which the object that excites it is removed.

* See Law 53.

59. In man the perfection of one sense is acquired, ordinarily, at the expense of others.

60. The inhabitants of warm countries enjoy a greater degree of sensibility than those of northern countries.

61. Sensibility is exquisite from the moment of birth, and diminished more or less rapidly until death.

62. Each organ of our senses, to put it in action, requires different and peculiar stimulants; since the same stimulant, applied to various organs, will produce on each of them particular or different effects according to the difference of this organization.*

63. Sensibility is in direct ratio to the feebleness of the causes which produce it, and in inverse ratio to their energy. †

64. When the animal system is affected with pleasure or pain, muscular and sensual movements are excited in it; the general tendency of which consist, either in possessing and retaining pleasure, or in avoiding or expelling pain. ‡

65. Every pleasing, or painful sensation, is in the first origin produced from the irritation made on the external organs. §

* *Ernesto Platner*, De secret. hum., lib. 2.; *Vrignauld*, Nouvelles recherches sur l'economie animale; *Cigna*; *Fabre*; *Blané*; *Soemmering*; *Darwin*, Zoonomia; *Gautier*, De irritabilitatis notione et natura; *Reil*, Mem. sulla forza vitale; *Roose*, Fondam. della dottr. sulla energ. della vita; *Tommasini*, Lez. crit. di Fisiol. t. 3; *Dumas*, Principes de physiol. t. 2; *Prochaska*, Instit. physiologicæ, etc. etc. † See Law VIII.

‡ *Darwin*, Zoonomia. See *Mojon's* Memoria sulla utilitatà del dolore. 1821. Mil. § See Laws IX, X, XI.

66. Pleasing or painful sensations are in direct ratio to the irritations we receive.

67. Moral pleasures and pains are intense in the ratio of the wants and relations that man feels himself to have with others.

68. Every moral pleasure, and a great part of the physical pleasures, consists in the quick cessation of pain, because it always precedes every pleasure; and may be considered as the principal mover of man.

69. A pleasure will be lively in proportion to the rapidity with which the preceding pain shall have ceased, and was violent.

70. Of two pains produced at one time, the more violent mitigates or silences the lighter.

71. The pain suffered in the parts provided with nerves coming from a ganglion, has a particular character, different from the pain felt in parts which are furnished from cerebral nerves.*

72. The sensation of pain and the excess of pleasure occasion the secretion of tears.

73. The cause that produces an excessive pleasure also often determines pain, but the contrary is never observed to take place. That is, pleasure is never observed to succeed excessive pain.

74. For every function, the exercise of which directly influences the preservation of the individual or species, nature has disposed the thing so, that first the want drags us to execute it, and thence follows, by way of reward, a certain degree of pleasing sensation.

* See *Hallé*, Leçons d' hygiène; *Chaussier*, Tableau néuralgique; *Bichat*, Anatom. generale, t. 1; *Bilon*, Discours sur la douleur.

Of vision, hearing, smelling, taste, and touch.

75. The variety of sensations of divers animals is owing to the number of their senses, and to the structure of the affected organs.

76. All animals with red blood have five senses.

77. A large cranium and a little face denote a voluminous brain, and both the organs of smell and taste little developed : and vice versa.

78. The eyes, organs of sight, vary in their number in different animals ; but in the vertebrated, and those with a double order of nerves, are always two in number.

79. Of all the senses, vision is that which furnishes to the mind the most varied, extended, and the quickest perceptions.

80. In order that any object be rendered perceptible to vision, it is necessary that the luminous rays which proceed from it strike the retina of the eye. These will not produce a sensation conformable to the object if they do not fall on the retina in that very order in which they are given off. It requires, then, that the rays which proceed from points of the body meet in a point of the retina; and that all these points of meeting be disposed in that same order in which they are found in the body whereof they present the image.

81. Vision enables us to distinguish the colour, and the direction of the luminous rays that penetrate into our eyes.

82. The length of our vision diminishes in proportion as the quantity of light augments around us, although that of the object remains always equal; so that the object itself that we see by day at the distance of 3.436 of its own diameters, if it remained illuminated in a dark night with the same quantity of light by which it was in the day, we should be able to discern it at a distance a hundred times greater, that is 343.600 diameters.

83. The diversity of colours makes known to us limits in heighth and breadth.

84. The different intensities of light, and the experience acquired by the sense of touch, make us judge of depth, actual distance, and inequality.

85. The luminous rays, in traversing the different humours of the eye, suffer various refractions and some reflections.

86. We judge of the line in which a luminous point is situated, from the direction of the rays that we receive from it.

87. The iris serves to oppose the entrance into the eye of too many luminous rays coming from the same object, and to prevent too intense a light from painfully affecting the retina; on that account the iris has the property of contracting and dilating itself.

88. When a body is observed very near, or

is too luminous, the pupil contracts; and vice versa.

89. The eyelids serve to cover the eye in sleep, and to cleanse it; they hinder little bodies suspended in the air from coming on the eye; they moisten it equably; they favour vision by diminishing the too great influx of luminous rays; and thereby render the act of seeing voluntary.

90. The globe of the eye is continually moistened by the tears; they serve to defend it from the too lively impression that is excited by the immediate contact of air, and also facilitate the movements of the eyelid, mitigating its rubbing against the eyeball. The tears then traversing the lachrymal canals, concur with the nasal mucus to moisten the pituitary membrane.

91. The eyebrows serve in some manner as accessaries to the eyelids, and express by their movements various passions; raising themselves in contentment and peace of mind; depressing themselves in grief and sorrow; corrugating themselves in anger, despite, and profound meditation, &c.

92. In the human fœtus, and that of many mammalia, before the seventh month, the pupil is covered with a membrane that is lacerated and disappears in the new born offspring.

93. The eyes, among all the organs of sense, are the first which appear in the fœtus, and are the most developed in the recently born infant.

94. The organs of vision of some animals pre-

sent varieties, which are in relation to the medium in which they live.

95. Many animals are not able to see the same object but with one eye at a time; and man himself employs but one, when he wishes to see an object very distinctly.

XIV. In taking correct levels, or observing the smoothness of surfaces, one eye is used; and if one is weaker than the other, the stronger becomes the principal organ of vision.

96. The density of each of the three humours of the eye is in inverse ratio to the diameter of the eye itself, taken from the cornea to the optic nerve; their density increases then by degrees from the circumference to the centre.*

97. The convexity of the crystaline lens is in inverse ratio to that of the cornea; and, in consequence, its density is then in inverse ratio to that of the aqueous humour.†

98. The ear is the organ destined to perceive sound.

99. The seat of hearing is found in the ultimate extremities of the auditory nerves, *portio mollis*, which swim in the gelatinous pulp contained in the membranous labyrinth.‡

* *Chenevix*, Philosoph. transact. 1802; *Thomson's* System of chemistry.

† *Chenevix*, Philosoph. transact.

‡ This law is deduced from reflecting that these parts exist in all animals, from man to the cuttle-fish. The other parts that are not found in all ears, are to be regarded only as accessaries to strengthen or modify the sensation of hearing. See *Scarpa*, De aud. et olfactu;

xv. The vibrations of surrounding mediums, that is sounds, produce depressions of the nervous pulp, and by the mechanism of land animals' ears the vibration is greatly increased. Water being more dense than air, the mechanism of the tympanum is not necessary to fishes.

100. The mammalia, birds, and also some cold blooded animals, apprehend and distinguish the qualities which relate to speech; that is, the voice and articulation.

101. The perfection of hearing in different animals is not uniform for all the qualities of sound.

102. The pavilion of the ears is specially destined to collect the sonorous undulations, and thereby to strengthen the sound.

103. Hearing and seeing are the two sensations which produce those impressions of which the recollection is the most durable, and which alone produce the ideas of beautiful and sublime.

104. The organ for perceiving smells is seated in the cavity of the nostrils.

105. All red-blooded animals, and those that respire by means of lungs, have olfactory organs situated in the air passages.

106. All things being the same, the delicateness of smell is in ratio to the extent of the pituitary membrane.

Cuvier, Leçons d' anatom. com. t. 2.; *Richerand*, Nouv. elém. de physiol. t. 2.; *Virey*, Nouv. dict. d' hist. natur. art. oreille; *Cladni*, Traité d'acoustique.

XVI. The delicateness of the sensation of smell is in proportion to the volatility of the matter, and the sensibility of the olfactory organ.

107. In order to perceive an odour, it is necessary that the odorous molecules of any body suspended in the air, or dissolved in a convenient vehicle, come in contact with the schneiderian membrane.

108. When an odour is grateful to us, we make short and frequent inspirations, and shut the mouth at the same time, in order that the air inspired pass entirely by the nasal canal: and, vice versa, we respire totally by the mouth, or suspend respiration, if an odour is ungrateful or noxious.

109. All sucklings, previously to swallowing any food, exercise on it their criterion of smell, this never being separated from that of taste; * and, in fact, there is generally a very constant relation between the pleasure experienced in smelling an odoriferous body, and the harmlessness of the same, as there is a suspicion of noxious qualities in a body that, when smelt, produces disgust and nausea.

110. The organ of smell has a sympathetic relation to the organs of generation; and often the smell alone, emitted by the genital parts of female quadrupeds, is enough to excite the males, as indeed the smell of a man is a great incentive to many women. †

* See Laws XVII and XVIII.

† Also that of woman to many men.—*Trans.*

111. The tongue, in most animals, is the principal organ for the sensation of taste.

XVII. The roof of the mouth and the palate are the sole organs of the sensation of taste.

112. The delicacy of the sensation of taste is in proportion to the number of nerves that ramify in the tongue, to its flexibility, and to the thinness and moisture of the membrane that covers it.

XVIII. The delicacy of the sensation of taste is in proportion to the sensibility of the olfactory nerve, the moisture of the palate, the solubility of the particles to be tasted, and the close application of the tongue to the roof of the mouth and fauces.

113. For a substance to have the quality of sapidity, it must be soluble at the ordinary temperature of saliva; thence it comes that all insoluble bodies are entirely insipid.

114. The extremities of nerves that terminate on the skin, constitute the general organ of touch.

XIX. The sensation of touch is the result of the resistance of a body to the motion of an organ, and of the pressure of that body on the organ.

115. The sensation of touch is common to all animals: this feeling is the first put in activity, and is the last to cease.

116. Tickling is a particular mode of touching, accompanied at first with pleasure, but which soon becomes troublesome and insupportable; it excites convulsive laughing. *

117. The perfection of the sense of touch de-

* See Laws IX, X, XI.

pends on the fineness of the cuticle, the quantity of its nerves, the extension of its superficies, its not being covered by insensible parts; and lastly, on the mobility, delicateness, and extent of the appendices by which the animal can examine bodies.

118. Of all animals, those which have the most exquisite sense of touch are worms and zoophytes, such as the actinites, medusæ, hydri or fresh water polypi.

119. Touch puts us into more intimate communication with external bodies, than all the other sensations: thence it follows, that this sensation is less subject than the others to lead us into error: it serves to verify and complete the impressions received on the other organs of sense.

120. The sense of touch furnishes us with an idea of the three dimensions of bodies, and their figure as solids.

121. We judge of the consistence and mobility, or immobility of bodies, from the degree of resistance they oppose to the pressure of our bodies.

122. From the degree of pressure the different parts of a body exercise on our skin, we know the inequalities of the body itself.

xx. By moving an organ of touch over a surface, we ascertain whether it be rough or smooth; without which, by pressing alone, we do not.*

123. The pressure or percussion that bodies

* *C. Bell's* Lectures on the nerves.

exercise on us, when they move, indicates the force that moves them, and in part its direction.

124. The sensation of heat and cold depends on the proportion that exists between the quantities of caloric that we receive or lose in a given time, and that which we received or lost in the preceding instant: but it is not indeed in direct relation to the absolute heat of the bodies, nor yet to the proportion between their heat and ours.

125. Bodies at a greater degree of temperature than that part of our body with which they are placed in contact, seem hot, and vice versa.

126. When we touch successively two bodies of different capacities for caloric, that which has greater capacity seems more cold, while both may be at the same degree of temperature; because that takes from us more caloric, in a given time, than the other.

GENUS II.

OF THE INTELLECTUAL FACULTIES.

Of the cerebral system, perception, imagination, memory, ASSOCIATION, *attention, shame, anger, jealousy, hope, &c., ideas, reason, judgment, will, sleep, and lethargy.*

127. THE intellectual faculties of animals are in direct ratio to the volume of brain and medulla spinalis.*

XXI. *Consciousness is a property of organized matter,* consisting of *sensation* in organs; being *pleasing, congenial,* and *painful varieties* of *sensation* to the vivacious beings.

XXII. Pleasing varieties of sensation, to a certain extent, are conducive to the health of vivacious beings; but by continuance become destructive of the sensitive function of an organ.

XXIII. Congenial varieties of sensation, are conducive to the health of vivacious beings, and require to be diversified in *kind,* as by continuance they become fainter in all organs.

XXIV. Painful varieties of sensation are de-

* See *Soemmering,* De basi encephali, pag. 17; *Voigts,* Magazin für den neuesten zustand der naturkunde, 2 b. 3 st.; *Gall. Cuvier,* Leçons d' anat. comp. t. 2; *Blumenbach,* manuel d' hist. natur. t. 1.

structive to the health of vivacious beings, but by their taking place, a desire of health or preservation is excited.

XXV. Sensation is varied by the continual desire of the being to experience some one of the three varieties.

XXVI. Sensations are of three classes:—Impressing,—Expressing,—and Sympathizing, ideal, or intermitting sensations; all of which are subject to *three varieties* of existence.

XXVII. The first class, impressing sensations, are produced by, or the result of, the contact of organs with matter, or the external excitement of organs; they inform the being of the qualities and states of that matter. They are of *five kinds;* the lumination or colour of matter, the vibration or sound of matter, the resistance or touch of matter, the solution or taste of matter, the aeriform or scent of matter.

XXVIII. The second class, expressing sensations, are produced by, or the result of, internal excitement of organs, and inform the being of the power and necessity of preserving itself, or of producing its species: they are of *five kinds;* muscular contraction, volition, the passions, desires, and aversions.

XXIX. Sensations of the third class, produced by, or the result of, the existence of the two first classes, are sympathetic, ideal, or intermitting sensations, and inform the being of the past, the future, and the probable cause and effect of cir-

cumstance: they are of *five kinds*; memory, association, imagination, attention, and reason.

XXX. A sensation, supposes the existence of an organ; the existence of an organ, indicates that of a function.

128. No animal has so much brain, compared to the nerves which come from it, as man; as also, of all animals, man is that whose cranium is largest relatively to the face.*

129. The relative volume of the nervous system of the brain, in man, is in the inverse ratio of what it is in most quadrupeds.

130. The cerebellum exists in all animals having a visible nervous system.

XXXI. The cerebellum exists in animals having a cranium; but not in all animals with a visible ganglionic nervous system.

131. The volume of the brain is proportionate to the size of the cavity of the cranium.

XXXII. The cavity of the cranium is in proportion to the volume of brain.

132. All the faculties of the cerebral nervous system enjoy a periodicity; sleep suspends them, and waking restores them; the faculties of the ganglionic nervous system are always more or less in action.

* See *Soemmering*, work quoted, id.; *Uber die koerperliche Verschiedenheit*, des Negers vom Europäer, pag. 59; *J. Gottfr. Ebell*, Observationes nevrolog. ex anatome comparata; *Vicq-d'Azir*, Trait. d'anat. et phys. t. 1; *Daubenton; Alex. Monro; Cuvier*, work quoted, t. 2; *Blumenbach*, De generis hum. varietate; *Gall* et *Spurzheim*, Anat. et physiol. du syst. nerv. vol. 1.

133. The paired organs receive their nerves from the same pairs of nerves in all animals, whatever may be the situation of those organs.

134. In man, and in animals with a vertebral column, the cerebral nervous system, or that of external life, is double and symmetrical in each side; and that of internal or organic life is always irregular.

135. The nerves extend their influence to every organ that has motion and life.

136. The energy of the brain is, generally, in proportion to the blood that enters it.*

137. The alternate motions of elevation and depression in the brain are syncronous with the systole and diastole of the arteries at its base.†

138. When any impression is repeated oftener than comports with the renewal of the sensorial faculty in the operating organ, the effect of this impression becomes gradually less.

139. The cerebral nerves, or those of animal life, are in a great part subordinate in their action to the will; and the gangliform nerves, or those of organic life, are affected independently thereof.

140. A given quantity of impressions calculated to produce an increase of exercise in the sensorial power, diminishes the quantity of that power, and vice versa.

* See Law VIII.

† *Richerand*, Mém. de la soc. méd. d'emulat. de Paris, an. viii; *Azzoguidi*, Discorsi fisiol. pag. 225.

141. The internal movements that take place in the animal machine, and that contribute to the digestion of aliment, to the production of secretions, to the repairing of losses, to the development and growth of the animal body, are executed without the attention or knowledge of the individual.

142. Modifications, and differences in the ideas and passions, correspond constantly to the modifications and differences of the organs.

143. Very lively mental irritations alter sensibly the action of the circulating, secreting, and digestive systems.

XXXIII. Lively mental irritations increase the circulation of the blood, which is followed by depressed secerning power in the sensibility of organs, and afterwards re-action of the latter with depression of the former.

144. The near expectation of a much desired event makes the heart palpitate.

145. Lustful ideas determine the blood to the cells of the corpora cavernosa; and augment the secretion of sperm.

146. Shame and anger redden the face, and afterwards render it pale.

147. Sudden terror, anguish, or horror, produce relaxation of the muscular system, and augment the secretion of the intestinal juices, by which diarrhæa is excited; the skin grows pale, and then wrinkled, and tumours take place,

148. The sight of relishing viands, and the mere hearing them spoken of, augment the se-

cretion of saliva in the mouth of a hungry person; as the idea alone of a disagreeable acrid substance augments a similar secretion.

149. Sorrow and joy carried to a high degree excite tears.

150. All ideas were originally acquired by means of our senses: and to these alone they are due.

XXXIV. *An idea is a sympathizing sensation of the brain with the sensation of an organ,* from a state, quality, or action of a body, which may be permanent for some time, and afterwards renew itself.

151. The first ideas we acquire are those which the sense of touch produces.

XXXV. Ideas are influenced by the physical disposition of the individual and circumstances.

152. The ideas and determinations (volitions) produced by the sensitive organ in virtue of the impressions which it receives, follow the same laws as the motions impressed by it on the muscular organ through those same impressions.*

153. The character of ideas and sentiment, in men, in women, and animals, regarding the same object, corresponds with their organization and manner of feeling.

154. Memory consists in the faculty of reproducing in the mind some idea, without its happening that the object to which it may be

* *Darwin*, Zoonomia, on the Medical Use, and on the Laws of Organic Life; *Tracy*, Extr. de l' Œuvr. de Cabanis.

referred, act on any of the external organs through the sensations.

XXXVI. Memory is the renewal of a sympathetic sensation, either as strongly, or fainter, than at first, without the object that first gave the sensation being present.

155. Memory is exact in proportion as the attention given to the perceived sensation was entire and repeated.

XXXVII. Association is the renewal of a sensation in consequence of some object being present that forms one or part of many sensations experienced at a former period; it is the principal means of producing speech or language, and requires memory.

156. The attention ought to be considered as an act of the will, capable of concentrating all the intellectual faculties on the same object for a given time, or of preparing and disposing an organ to feel better a given impression.

XXXVIII. Attention consists in suspending, or obliterating, all former ideas, and directing the perceiving part or organ to an object in order to experience a new sensation promised or expected.

XXXIX. Passions are the sensations of rage, hatred, contempt, jealousy, envy, grief, melancholy, fear, horror, surprise, shame, joy, hope, affection, gratitude, compassion, &c.

157. All our passions arise from our real or factitious wants. They influence the ideas, as

those by the medium of the external organs influence the passions.

158. Habit, or the frequent repetition of the same act, weakens, by its continuance, physical sensibility, and perfects the intelligence, rendering the direct movement of the will more easy and ready.

159. Imagination, or the power of multiplying, amplifying, combining, &c., simple ideas, is in direct ratio to the physical sensibility.

XL. Imagination is the sensation of ideas, multiplied, extended, and combined, &c., without its happening that the object to which they may be referred act on any of the pathic organs.

160. The imagination has a marked action on the physiognomy.

161. The ideas of imagination, as happens in a dream, or in delirium, are sometimes excited by the pleasure or the pain with which they were first associated.

162. The force and fire of the imagination, and of the spirits, are apparent after much eating and drinking, and are weakened by abstinence.

XLI. Reason is the sensation of observing the difference between objects, the effects of circumstances, the cause of effects; experience extends its capacity, and it requires the operation of the two first classes of sensations, as well as the perfection of memory, association, attention, and imagination.

163. When the object of our desires is present, or we are sure of possessing it, we then have a sensation of pleasure, which we call joy.

XLII. Joy consists in the sensations being excited, when the passions are conducive to the well-being of others or the individual.

164. Anger is always composed of pain from recent injury, and of aversion to the person who has committed it.

XLIII. Anger consists in the sensations being excited, when the passions produce actions detrimental to others, and to the well-being of the individual.

165. Envy is a fury that cannot suffer the good of others : it is specially occasioned by the desire of the goods possessed by another person, which in our belief he ought not to possess in preference to us.

XLIV. Envy consists in the sensations being excited, when the passions conduce to the amelioration of the individual, at the injury of others.

166. Jealousy, in all animals in a natural state, is a passion that ennobles the races, giving more advantage to the young and vigorous individual over the weak and infirm, and repelling these from the propagating act, in order to maintain the species in all its vigour.

XLV. Jealousy consists in the sensations being excited, by the desire of possessing, and feeling that the object when in possession or desired may be lost.

167. Desires and aversions are as numerous as pleasures and pains.

XLVI. The principal desires are gluttony, drunkenness, and venery.

XLVII. Desire consists in the sensations being excited, the object being absent which would produce pleasure, on its application to the excited sensations of the organs that are to operate.

XLVIII. Desire is in proportion to the size of the organ, the circulation of the blood, and the absence of the object.

XLIX. Aversion consists in the sensations being excited, when the object presented not fitting to produce pleasure on its application, or being contrary to the desire of the organ operating.

L. Appetites are sensations of the want of objects fitted for the operation of demanding organs.

168. In the first periods of existence the appetites and the desires are only determined by internal impressions.

169. Hope arises whenever the flattering idea of obtaining a thing is united with the desire of possessing it. It supposes always that the want of some good is felt.

LI. Hope consists in feeling that the absent object may be possessed by some means probable to concur in presenting it.

170. Fear is produced by the expectation of some event capable of producing the sensations of pain or aversion.

LII. Fear is the sensation, that injury is likely to be effected on oneself or an object of our benevolence.

171. Compassion is constituted by the pain that we derive from the sight of misery, and the desire of relieving it.

172. Comparison cannot be separated from judgment; and every judgment is always the effect of experience.

173. The sensation of one's own functions constitutes consciousness, or the sensation of sensations.

174. Volition is always determined by a sensation, or by the concurrence of many subjects or motives towards the strongest sensation.

LIII. Volition is the consciousness of being capable of producing contraction of muscles, so as to give position to the parts or whole of the vivacious being. Voluntary motion is the result of the operation of this sensation.

175. Every act of the will is always proportionate to the force of the sensible impression which is the source thereof*.

176. The action of the will in muscles is always mediate, they not being able to contract themselves at pleasure, but by means of the nerves.

177. The will has not any direct command over the organs of circulation, digestion, and secretion.

178. Man cannot create any thing; all his operations reduce themselves to imitation, or to combination.

* See *Beccaria*, Dei delitti e delle pene.

179. The absolute happiness of man consists in the satisfying all his desires.

180. We cannot love anything but in relation to ourselves; and we do nothing but follow our taste and our pleasure in all our operations.

181. Our hatred or our love is always an effect of the good or ill that is done to us.

182. All animals have two states of existence, which alternate with regularity; and are those of waking, and sleep or lethargy. In this last state the functions of animal life are as it were null; while those of vegetable life predominate.

183. All that is capable of enfeebling animal life, or of stimulating organic life, conciliate sleep, and vice versa; therefore the propensity to sleep is in ratio to the activity of internal life, and to the enfeebling or diminished action of external life.

LIV. Sleep is the result of a diminished arterial action in the brain, which does not propel the blood from the veins so rapidly as when awake. The breathing in sleep is slower both in inspiration and expiration, consequently the arteries and heart are also in a diminished state of activity; the consumption of oxygen, and also the production of carbon are less.

184. In taking sleep all the senses do not fall asleep at the same time, nor in all these is the sleep equally deep.

185. Among all the senses, the last to awake are those of taste and smell.

186. In sleep the pupil is contracted, and the iris is relaxed; and the eyelids are shut to defend the eye from the action of light.

LV. The eyes are directed with the cornea upwards *. This is owing to the action of the *inferior oblique* muscles.

187. Sleep, like all our wants and many of our functions, has a periodical character; alternating regularly with waking.

188. The duration of sleep in the human species is ordinarily a third or fourth of the day; but children sleep longer, and their sleep is more tranquil and sound than that of adults.

189. The occupations of the day are easily renewed in sleep, and it commonly happens that dreams turn on those things most interesting to the sleeper; since dreams are nothing else but the result of an internal irritation adapted to awaken those same ideas, which in waking hours were excited in us by a given impression made on our organs of sense.

LVI. The increased presence of blood, from position or other causes, in any part of the brain, excites that part and produces dreaming of a particular kind, according to the physical operation of that part; as for instance, when lying on the back the blood is often increased in the cerebellum, and the result is an amorous dream.

190. The action of external agents on the body

* See *Ch. Bell's* Lectures on physiology, &c.

during sleep, has often a direct influence on the production of dreams.

191. When the association of ideas that takes place in sleep is very clear and precise, and when there is united to it corresponding motions of muscles in animal life, somnambulism then takes place.

192. Cold is a circumstance most necessary to conciliate sleep in lethargic animals; then follow the absence of irritating causes and air little oxygenated.

193. In animals subject to periodical lethargy, once benumbed, their circulation and respiration abate, and they at last become almost insensible; the consumption of oxygen diminishes in proportion, and their animal heat descends to one or two degrees above Zero;* then hunger and thirst cease, and digestion is suspended.

194. When the lethargic animal is reawakened, its respirations, circulation, and natural heat, return in a very short time.

* To 34 or 36 degrees above Zero of Fahrenheit, and to .03 or .06 of a degree above Zero of Lieut. A. M. Skene's thermometer. *Trans.*

GENUS III.

OF VOLUNTARY MOVEMENTS.

Of muscular fibre in general; station; prostration; stepping, running, leaping; sustaining or raising weights; swimming; flying; and of the osseous system in motion, &c. &c.

195. ALL animals which have not distinct nerves, are also without visible fleshy fibres.

196. The fibre of white blooded animals differs only in colour from that of red blooded animals.

197. Contraction or forcible rebounding on the application of stimulants, is a property of muscular fibre.

LVII. Muscular contraction is the expressing sensation or effect of the presence of excitement experienced by muscular fibre.

198. Muscular contractility varies according to the age, sex, temperament, time of repose, or activity of the different passions, &c.

199. All muscles require the influence of nerves to move them*.

200. When fleshy fibre is put in contraction for a given space of time, it relaxes, although the exciting cause continue to act.

201. A stimulant applied to any muscle does

* See *Mojon's* Memoria sulla contrattilità della fibra animale. Genova, 1814.

not indeed produce a lasting contraction, but contractions and relaxations which succeed each other.

202. The muscular or irritable system of organic life, renders the organs, cavities, and vessels, susceptible of contraction on the touch of stimulants; therefore it presides over all those movements which do not want the action of the mind to accomplish them, and which animals have in common with vegetables.

203. Every movement is always determined by some impression.

204. The property of motion in muscular fibre continues longer in cold blooded, than in hot blooded animals.

205. The intensity of muscular contraction is in compound ratio to the organic force of the muscular tissue, and that of cerebral excitement.

206. Anger and the passion of lust, especially in animals at heat, augment greatly the development of the action of muscles; as also muscular mobility is so much more lively in proportion as the animal is young.

207. Muscles are always in a continual tendency to contraction.

208. The muscles most exercised are those which acquire the greatest strength and volume; provided the exercise be not carried to excess.

209. All muscular motions powerfully promote the course and distribution of the different animal humours.

210. There is no animal that is not irritable.

211. At the moment of contraction, the particles composing the contracted muscle have a greater cohesion than when it is relaxed.

212. The variety of movements in different animals is owing to the intimate mobility of their fibre, to the dispositions of their muscles, and of the part in which they are inserted.

213. A voluntary and violent muscular action performed immediately before death, renders the body more ready to putrefy.

214. The degree of shortening, of which a muscle is capable, is relative to the length of its fleshy fibres ; as the force with which it contracts, is in ratio to their number.

215. It is the nature of a voluntary muscle to execute most easily those motions which it is accustomed to make, and to act most readily with those muscles and sensations with which it is accustomed to combine its actions either simultaneously or successively.

216. Every moveable point of the animal skeleton is always between two opposite muscular forces.

217. When two antagonist muscles of equal force act contemporaneously on a part equally moveable in every sense, the opposite forces reciprocally destroy themselves, and the part remains immoveable.

218. The disposition of the voluntary muscular system is such, that one of its portions cannot

be contracted without the distention of another.

219. The extensor muscles are generally weaker than the flexors.

LVIII. The extensors of the inferior extremities are ordinarily stronger than the flexors.

220. If the extremities of a muscle are inserted on two points equally moveable, its contraction will approximate them one to the other, causing them to pass over equal spaces, and the spaces passed over will be unequal if the mobility be different.

221. Almost all the muscles are attached to two different points, so that movements are made about one of them, which remains fixed; whence follows, that the force of contraction of every muscle must be double that of the resistances which it overcomes.*

222. Nearly all the muscular movements in man belong to a lever of the third species.

223. The force of penniform and radiating muscles equals the sum of the diagonals of the parallelogram formed by the fibres which make an angle together, taken two and two.

224. The total action of muscles with parallel fibres, equals the sum of all the particular actions of these same fibres.

* *Barthez*, Nouv. élém. de la science de l'homme, tom. 1. p. 109. 2d edit. This axiom is deduced from the reflection that the insertion of any muscle whatever is always nearer to the centre of movement than the resistance or the weight that it moves round this same centre is.

225. To hold the body in a vertical attitude, there is always a need of a certain muscular force.

226. The mobility of the necks of birds is in ratio to the immoveableness of their back.

227. The position of the head on the neck, and on the vertebral column, always determines the erection of the body in all animals.

228. In man and in quadrupeds, standing is entirely produced by the continued action of the extensor muscles of the articulations.

LIX. Standing is preserved by the regulated action of extensor and flexor muscles being opposed to each other, which is acquired by experience.

229. It belongs to man to stand conveniently on two feet, and in a vertical direction; it is peculiar to birds to stand on two feet, but the body not in a vertical position.

230. Very long standing is more laborious than moderate exercise, sustained for an equal length of time.

231. In order that an animal be able to hold itself in a vertical position, it is necessary that all its parts be disposed so as to be easily maintained in equilibrium; that the muscles have the force of correcting continually the movements of aberration; and that the line of gravity of the whole body fall on the plain occupied by its supports.

232. Those animals which move with marked steps or jumps, have muscles attached to hard parts, which serve them as levers.

233. No animal can lanch itself from the earth,

or generally from any object on which it supports itself, without producing rapidly a change of position in its members.

234. All the progressive movements that an animal makes to transport its body from one place to another, require a determined celerity to be impressed in a certain direction on the centre of gravity of its body. For this object likewise is required the distention of a given number of articulations more or less bent, whose disposition is such, that their distention may be found free on the side of the centre of gravity, and impeded on the opposite, so that the greatest part of the motion may take place in the first of these two senses.

235. In descending by an inclined plane, the leg thrust forwards is always lower than that which is behind, and vice versa in ascending.

236. The centre of gravity of our bodies in pacing moves between two parallels, in the interval of which the centre describes oblique lines, which go from one to the other, forming zig-zags.

237. The body of man in running, requires to be inclined forwards, in order that his centre of gravity may be in the necessary position to be thrust in the same direction from the posterior leg; the other leg requires to be brought quickly forwards, in order to prevent a fall; and the phalanges of the feet alone serve as points of support.

238. To constitute running, the body requires to be urged forward at every step, and that the hinder

foot be lifted from the ground before the anterior is put down.

239. Quadrupeds, in walking, first of all thrust the posterior foot of one side forwards, then the anterior of the same side; then the two feet of the opposite side, first the posterior and then the anterior; and every pace proceeds in similar manner. *

240. In the trot of quadrupeds the legs are raised from the earth by two at a time, and in a diagonal direction. In violent galloping the animal makes a succession of leaps forward.

241. The swiftness acquired in running is preserved and augmented at every spring by the new velocity added to it; from that it comes, that accelerated running cannot be suspended all at once.

242. Jumping in man cannot take place without a sudden distention of the inferior articulations previously bent.

243. The body of an animal, in jumping, must be considered as a projectile, which gradually loses the velocity acquired in rising.

244. The extent of the leap depends on the proportional length of the bones, and on the force of the muscles. Whence animals which leap best, are those which have the posterior extremities very long and large.

* This appears contrary to *Barthez*, and many other physiologists; but besides that *Borelli* and *Araldi* are in my favour, I am assisted by ocular observation, which has secured me from the danger and uncertainties that the rapidity of walking might occasion.

245. The duration of the leap is in ratio to the force of projection employed.

246. The space little animals pass over in a leap, is proportionably greater than that passed over by large animals; because when the forces are proportioned to the masses, they communicate to the last equal velocities, and the spaces passed over, depending entirely on the velocity, they must be nearly equal as well for little as for large animals.

247. The direction of the jump depends on the position of the centre of gravity, in relation to the limb that gives the impulse; for this reason man and birds only can leap vertically.

248. Quadrupeds and insects can only jump forwards.

249. To direct oneself, in swimming, more to one side than on the other, it is necessary to strike the water with greater force or with more quickness on the part opposed to the direction one wishes to take.

250. It is by means of the swimming bladder, that the greatest part of fishes move up and down in swimming.

LX. The air bladder renders the fish as specifically light as the line of water it inhabits, which enables it to preserve a certain depth in the water when it is at rest, preserving it from the jaws of a deeper inhabitant.

251. The fishes which swim quickest are those with a long and compressed body.

252. Natation in man and quadrupeds is produced, first from the impulse directed upwards and forwards, which the legs give in man, and the posterior legs in quadrupeds; secondly, from the reciprocal action of muscles that move downwards and backwards the arms of man, and the anterior legs in quadrupeds. This reciprocal action, which augments in ratio to the resistance that water opposes to these motions, makes an effort to move all the body round the superior part of the arm, or of the anterior leg of the same side; from these two angular movements combined, there results a middle movement that brings the body forwards and upwards.

LXI. In man the lungs are inflated before giving the propelling stroke in swimming, and the body rises from the water during that stroke, and sinks again when the stroke is completed, which is followed by expiration, and the recovery of the limbs to a fresh advance. Diving is performed in a similar way to swimming, excepting that the lungs are not inflated, the pressure of the water preventing the action of the inspiratory muscles.

253. Natation may be performed either in a horizontal plane, or in a more or less inclined direction.

254. The velocity that all the winged animals acquire in mounting is gradually diminished by the effect of weight, and there is an instant in which this velocity is null; if they give then a new stroke of the wings they acquire a new as-

cending velocity, which will make them pass over a space equal to the first, and continuing in like manner they will ascend uniformly. On the contrary, if the birds give a second stroke with their wings, before arriving at the point where the velocity acquired by the first ceases, then they add a new velocity to that which remains, and thus maintain an accelerated motion.

LXII. In order to ascend in the air, birds expand the air cavities pervading their bodies with air which becomes warm, and renders them as specifically light as the atmosphere they inhabit.

255. When birds do not flap the wings at the moment that their ascending velocity has ceased, they descend with an accelerated motion.

256. In order to descend, birds have only to suppress or to diminish the motion of their wings; in the first case they fall with the velocity of heavy bodies.

LXIII. Birds of prey that fall suddenly on their game expel the warm air from the air cavities, and fall with the velocity of solid bodies.

257. Birds cannot fly vertically, without disposing their wings in a direction horizontal to their perpendicular of gravity. Nor can they fly horizontally without describing a succession of curves from above downwards.

258. To fly to the right or left, it is necessary that the wing opposed to the direction of the flight move with greater force, or with more velocity.

259. The more rapid the flight, the less acute

the bendings, whence birds of quick flight only turn in large circles.

260. The lightness of the body of birds gives them a greater facility to raise themselves.

261. When a bird flies with both wings, the movements that the large and middle pectoral muscles communicate to the wings urge it upwards and forwards in a middle direction.

262. Flying creatures would turn round their centre of gravity, and their flight would change continually its direction, if the sum of the forces which move their wings and tail were not combined and modified so as to conduct them in a given direction.

263. The property that flying creatures have of directing easily to the centre of gravity of their bodies the power resulting from the force of the wings and tail, gives them the advantage of transporting themselves and flying in all directions.

264. In order that grubs, larvæ, worms, and the like, be able to creep, it is necessary that they fix on one point a part of their body, and that all the other parts which follow be successively approached to it; when that is done, the latter parts fix themselves, and the first are elongated forwards. Serpents, not being able to shorten themselves, creep, making zig-zags.

265. To hold and grasp an object conveniently, the fingers must be separated, free, and pliable.

266. The force of the fingers is in ratio to their shortness.

267. The extent and direction of the movements performed by the bones, are in ratio to the cavities and eminences of their articulated surfaces, and the number, length, and rigidity of their ligaments.

268. The number and direction of the muscles that are inserted on the bones determine the movements of which they are capable.

269. A bone that articulates with another by one of its extremities cannot ever be moved but by flexion or rotation.

270. The ribs are the only bones in the body whose motion begins with birth and ends with death.

271. The prominence of the processes of bones is in ratio to the force and vigour of the muscles and movements, consistency of bones being equal.*

272. All animals that have an articulated skeleton in their interior, and covered with muscles, are endowed with a vertebral column, a heart, and red blood.

273. Animals without vertebræ, either are totally deprived of hard parts, or have the body and membranes enveloped in scaly articulated parts, one over the other; or, lastly, they are enclosed in peculiar shells.

* See *Mojon*'s Mémoire sur les effets de la castration. Montp. 1806.

GENUS IV.

OF THE VOICE.

Of speech, sighing, yawning, sneezing, coughing, laughing, weeping, &c.

274. The principal organ of voice in quadrupeds and reptiles is the larynx.

275. The voice of birds is produced by the division of the trachea into two bronchiæ.

276. Voice is given to those animals only that have lungs; such as mammalia, birds and reptiles.*

277. Voice is constituted by the vibration communicated to the air expired from the vocal organ oscillating.

278. The force and intensity of the voice depend on the volume of air expired at one time, on the proportional size of the lungs and air cells, and on the more or less great vibratility of the canal which emits it.

279. In the deep voice, the larynx is depressed and the lips, a little contracted, project; in the shrill voice, the larynx is raised and the mouth

* An exception is made to this law: the cetacei having a larynx deprived of the glottis and the vocal cords.

is dilated a little. In the first case, the tongue is depressed and dilated; in the second it is elevated, it rests with the apex on the teeth, and occupies greater space.

280. Discourse or speech consists of an aggregation of sounds diversely modified and reflected against the fauces, nostrils, tongue, teeth, palate, and lips.

281. The facility of modulating song depends on the mobility of the muscles which act on the vocal organs.

282. In all four-footed animals, the voice of the male is stronger and deeper than that of the female, especially when past the age of puberty.

283. A slow, deep, and sonorous expiration, preceded by an equal inspiration, constitutes a sigh.

284. A yawn is made by a slow inspiration, with the mouth wide open, after which comes a full and equally slow expiration. A yawn is often accompanied by a powerful distension of the limbs: it is generally occasioned by listlessness, sleepiness, hunger, or by imitation.

285. A sneeze is constituted by a deep and full inspiration that takes in a great quantity of air into the lungs, and a violent and sonorous expiration that obliges it to issue rapidly, by which all the body is shaken.

286. Coughing is executed by making repeated rapid and alternate movements of inspiration and

expiration, accompanied by the action of the diaphragm and abdominal muscles.

287. Coughing is destined to expel the air with violence from the lungs, in order to throw out that which opposes free respiration.

288. A full inspiration, to which succeed repeated and intermitting sonorous expirations, constitutes laughing.

289. In weeping, the expirations are short, interrupted, and sonorous, and are preceded by a full inspiration, to which wailing and tears are united.

290. A groan consists in a great, quick, and sonorous inspiration, which is repeated often.

291. Sucking is a particular inspiration made by applying the lips to the nipple, or tube communicating with the liquor, so that it forms a vacuum that the liquid goes into and fills.

LXIV. Sucking is caused not by inspiration, but by drawing the tongue downwards and inwards towards the throat, constituting an exhausting action. Respiration goes on as before until the mouth is filled, when the tongue, thrown forward, rises to the roof of the mouth, urging the contents gradually from the apex of the tongue back to the œsophagus.

292. The different construction of the larynx, the opening of the glottis, the cavity of the mouth and nostrils, and the greater or less mobility of the tongue, the lips, and the cheeks, give the different manners various animals have of ex-

pressing themselves; that is to say, the howling, bellowing, barking, braying, neighing, mewing, roaring, grunting, whistling, hissing, &c.

293. The brutes endowed with pulmonary organs declare equally with man, by different modifications of their voices, their sundry wants and feelings of love, jealousy, anger, sorrow, hunger, pleasure, &c.

ORDER II.

OF THE FUNCTIONS THAT BELONG TO ORGANIC LIFE.

GENUS 1.

OF DIGESTION.

The necessity of digestion. Of aliments. Of hunger and thirst. Of mastication, salivation, deglutition, and alteration of the alimentary paste in the œsophagus, stomach, and intestines. The action and property of the gastric juice, bile, pancreatic juice, and intestinal mucus. The separation of the alimentary sustenance into nutritive and excrementitious parts. Of rumination. Of intestinal gases. Of excrement.

294. The existence of a central apparatus of digestion is one of the characters most essential to animality.

LXV. The reducing alimentary matter to conglomerated paste with the teeth and saliva; the absorption of the liquid part of that paste as it passes through the nutritive tubes and receptacles, and the regular expulsion of the residuum,

constitute the function of the alimentary canals called digestion.

295. Animals for their sustenance are obliged to introduce into the stomach, at given intervals, a material that serves them as aliment.

296. In order that a substance be fitted to nourish, it should be capable of undergoing an internal and spontaneous motion, by which its elements undergo changes of combination and relations ; wherefore, all that is not organized is excluded from the class of aliments.

297. In order that the animal sustenance may be digested, it is necessary that it be deprived of vitality.

298. Animals that nourish themselves on farinaceous food, or on other vegetable substances, are in general more fat than those that live exclusively on flesh.

299. All animals with hoofs or horns are herbivorous.

300. Hunger and thirst are two sensations which admonish us of the wants of our bodies to repair the continual loss that is produced by vital motion; and these two sensations will be more or less violent according to the greater or lesser necessity of repairing that loss.

301. Hunger and thirst are felt more imperiously in early youth than in old age; more in those who labour than in those who do not.

302. The intensity of thirst is in proportion to

the quantity of secretions, especially the serous and watery.

LXVI. The intensity of thirst is in proportion to the state of contraction of the stomach, which seems to be the cause of that sensation.

303. An animal in the state of nature is always led by its appetite to choose the alimentary substance that is most fit for its preservation.

304. Strong commotions of mind blunt the appetite, and the sight of disgusting objects, or the mere recalling them to mind, takes it entirely away.

305. The different forms of the teeth influence very much the nature of the substance which the animal can submit to mastication.

LXVII. The form of the teeth is adapted to the substance capable of preserving life in a particular state of existence or form of being.

LXVIII. If animal life can be preserved by the reduction and assimilation of animal food, or flesh and bones, in their natural state, to a pulp, we find a being adapted and suited to the means of subsistence, and provided with incisor teeth at the commencement of the alimentary tube, for the purpose of preparing the alimentary matter for the digestive process, as in all carnivorous animals.

LXIX. If life can be preserved by the reduction and assimilation of vegetable food or grasses, in their natural state, to a pulp, we find a being adapted and suited to the means of subsistence, and provided with incisor and grinding teeth at

the origin of the tube, for the purpose of preparing the alimentary matter for the digestive process, as in the graminivorous animals. If the alimentary matter be various, and derived from both states of vivacious being, we find both sets of teeth at the origin of the alimentary tube, as in man.

LXX. If the preservation of the being requires the additional aid of wings, for the instantaneous or sudden removal of the being from the earth, we find the function of mastication is performed in another manner, having a grinding apparatus or gizzard in another part of the digestive passage, immediately beyond the pouch or crop, which has not the operation of a stomach, but of a providing tube to the gizzard or masticating organ, as in birds.

LXXI. The digestion of insects is generally performed by a simple tube, some having a masticating process at its origin, and some not.

LXXII. The digestive process of other forms of life is generally carried on by simple pressure on the nutritive fluid.

306. The shape of the teeth, the length, folds, dilatation, and contractile force of the alimentary tube; the number, abundance, and the qualities of the dissolvents which are found in it, maintain a constant proportion among themselves, and with the nature and the degree of hardness and of solubility of the substance that the animal eats.

307. The aliments taken in at the mouth are

triturated by the teeth and pervaded by saliva; pass into the œsophagus, taking up its juice; thence they descend into the cavity of the stomach, where they are dissolved in the gastric juices, and are changed into a chymous paste, which, traversing the pylorus, having arrived in the duodenum, combines with the bile and the pancreatic and duodenal juices; it is then separated into chyle and excrementitious parts, and, passing along the intestinal tube, it deposits the chyle and appropriates to itself the intestinal humours; and the innutritious part alone, or that which exceeds the wants of nutrition, is finally evacuated.

308. During the time of digestion, the orifices of the stomach are restricted; it changes its shape, and its parietes are agitated by a continual motion of contraction and relaxation,* by which the contained alimentary paste becomes moved; the intestines are likewise endowed with equal peristaltic motion.

309. The action of the gastric juices on aliments varies very much in the different classes of animals; it depends particularly on the different natures of the abovenamed juices, which are provided, and by the qualities of the foods.

310. The dissolving property of the gastric juice is in inverse proportion to the sum of the other forces that can act on the elements to digest them.

* Relaxation would produce vomiting; therefore it does not take place in digestion.—*Trans.*

311. The more the aliments are divided and triturated, the more the gastric juice operates on them with rapidity and energy, and the action becomes yet more augmented by the temperature of the stomach.

312. The nature of the gastric juice of carnivorous animals is totally different from that of the gastric juice of herbivorous animals.

313. The gastric juice in the stomach of the living animal prevents the putrefaction of the substances swallowed, softens them, and dissolves them. It is a composition of much water, a little gelatino-mucous substance, muriate of ammonia, muriate of soda, and phosphate of lime. There are some animals whose gastric juice has an excess of soda, and in others it has an excess of free phosphoric acid.

LXXIII. Carbonic acid gas is taken in the aliments, and is necessary in the stomach, which, by its pressure, prevents the process of fermentation taking place; it is afterwards given off from the blood, by giving place to the union of oxygen with the blood, the cause of animal heat.

314. In animals that are torpid in winter, digestion is suspended all the time of their lethargy.

315. The aliments do not go out from the stomach by the pylorus in the same order that they entered into it, but as they are more or less easily digested.

LXXIV. The aliments pass promiscuously from

the stomach, except when a portion or body is too large to pass the pyloric orifice.

316. The gastric viscera, in the natural series of their functions, are never equally distended at the same time.

317. The bile in the duodenum mixes with the pancreatic juice, uniting intimately with the chymous paste; and they mutually decompose themselves: the most soluble fluid and nutritive part of the chyme unites with a portion of the alkaline substance, the salts, the animal substance, and the saccharine matter of the bile, with which principles it forms the chyle; whilst the other portion of bile, composed of coagulable albumen, concrete oil, coloured, black, and bitter, combines with the excrementitious part of the aliment, with which it is condensed along the intestinal tube, which expresses the chylous juice by its repeated contractions. It goes out finally from the body under the form of excrement.*

318. In ruminating animals, aliments swallowed for the first time, and little masticated, descend into the paunch, (*panse,*) and from that by degrees into the hood, (*bonnet,*) where they are softened a little, warmed, and reduced into a pellet; then they are reconducted to the mouth, better masticated, and a second time swallowed, descending by the canal which leads to the third stomach, (*feuillet*): there the aliments are submitted to new

* See *Werner.* Dissert. circ. mod. quo chymus in chylum convertitur. Tubing. *Fourcroy,* Systême des connais. chimiq. t. 10.

modifications, and thence pass to the fourth stomach, (*caillette,*) where they are really digested.*

319. The ruminating animals, as long as they are at the teat of the mother, do not ruminate.

320. The activity of digestion is in proportion to the wants of the animal to grow and repair itself.

321. The sensibility of the digestive passages decreases as they descend from the pylorus towards the rectum.

322. Animals of the same species have excrement of the same nature and form, although the substances with which they nourish themselves may be different; whilst animals of different species nourishing themselves with the same aliments, always evacuate fecal matter with a distinct character, and a form and nature peculiar to them.

323. The portion of azote in the intestinal air increases as it descends towards the rectinal intestine.

* The professors *Haller*, *Presciani*, *Jacopi*, *Azzoguidi*, and some other expert physiologists, think differently on rumination. The reasons that are adduced will not bear a comparison with those of *Buffon*, Hist. natur. artic. bœuf; of *Blumenbach*, Manuel d'hist. natur. t. 1; of *Millin*, Elém. d'hist. natur. 3d edit.; of *Cuvier*, Tableau élément d'hist. natur.; of *Richerand*, Nouv. élém. de physiol. t. 1, ed. 4; of *Gallini*, Nuovi élém. della fisica del corpo umano, t. 3, prima ediz.; of *Camper*, Leçons sur l'episootie, 3me Leçon.

GENUS II.

OF THE CIRCULATION OF THE BLOOD.

Of the heart, arteries, veins, and blood. Of the arterial, venous, and human fœtal circulation.

324. The heart, arteries, and veins, are the parts in which the circulation of the blood, properly called, operates.

325. All vertebrated animals are provided with a heart and sanguiferous vessels, and have a true circulation of fluids.

326. The volume of the heart, compared to that of other parts, is greater in the fœtus than in the recently born infant; greater in the small subject than that of a high stature.

327. The capacity and force of the heart is greater in proportion to the system of vessels, in the commencement of life than at any other successive period.

328. The heart is larger, stronger, and more robust in courageous animals than in feeble and timid: it has a greater energy in the carnivorous than in the herbivorous animals.

329. The heart in man, whatever is its volume or its force, is always in proportion to the lungs.

330. In circulating the blood, the heart changes its situation and form at every palpitation.

331. All vertebrated animals with warm blood have a heart with double cavities, and thence a duplex circulation. Vertebrated animals with cold blood, on the contrary, have a simple circulation; or if they have a duplex circulation, they have only one ventricle.

LXXV. The turtle has a heart with two ventricles and two auricles: the former communicate, but the latter do not, as in the fœtal heart.

332. The capacity of the ventricles in the heart of all warm blooded animals, or those with duplex circulation, is greater than that of the auricles; the contrary is the case in cold-blooded animals.

333. The particular diameter of the arteries diminishes as they are distant from the heart.

334. The total capacity of the arterial system augments as it is dispersed from the heart, because the sum of the diameters of all the arterial branches much surpasses the diameter of the common trunk.

335. The arterial tissue is condensed as the animal advances in age.

336. The force of the arterial parietes is proportionally greater in small than in large animals.

337. The excess of the arterial blood over the venous blood is greater at the beginning of life than at any subsequent period: that is, as long as the

superiority of the forces over resistance lasts, there is arterial plethora, and vice versa. Venous plethora begins when the rigidity of the solids prevails.

338. The capacity of the sanguineous vessels continually increases in greater proportion than that of the heart, until the body arrives at its maximum of increase.

339. The capacity of all the venous system is greater than that of the arterial.

340. The valves of the veins appear specially destined to oppose the effect of the gravitation and retrocession of the blood.

LXXVI. The valves of the veins prevent the retrocession of the blood, which is continually returning by the pressure of the medium surrounding the veins.

LXXVII. The force propelling the venous blood is the pressure of the dilated artery against the hard and bony parts, and the pressure of the surrounding medium of all animals without a shell; as the water on the surface of fishes, the atmosphere on the surface of terrestrial animals and birds; and the resistance of the shell to the dilated artery in all crustaceous animals.

LXXVIII. The venous circulation in man is effected by the pressure of the dilated arteries against the cranium in the head, the respiratory pressure in the thorax and abdomen, the pressure of the dilated arteries against the surrounding dense bodies, as the bones, muscles, cartilages, &c., and the atmosphere on the surface of the body.

341. The capacity of the veins is in inverse ratio to the velocity of the fluid that is conveyed in them.

342. The healthy state requires an equilibrium between the loss of arterial blood and the gain of the venous.

343. The proportion of the quantity of blood that is distributed to the different parts of the system, varies at different periods of life.

344. The vessels of the head receive more blood, in proportion to the rest of the body, in the first than at subsequent periods of life.

345. When the animal machine arrives at its full growth, the blood contained in the veins augments in proportion to that in the arteries.

346. In the fœtus of viviparous animals the blood is equal, at least in appearance, in both systems.

347. The blood in the human fœtus does not contain any phosphoric salt; and the fibrous substance is almost gelatinous: after birth it acquires phosphates, particularly of lime and iron; it takes a fine red colour, and a greater concretability. At the age of puberty the blood is more warm, higher coloured, and acquires a spermatic odour. At adult age it is more consistent, and contains a greater quantity of fibrine. In old age the blood is somewhat discoloured, and is much disposed to form various kinds of concretions.

348. The blood of birds is generally more red, more concretable and warmer than that of mam-

malia. That of amphibious animals and fishes has a slightly higher temperature than the air or water they inhabit; it is little concretable, and much disposed to become oily.

349. The arterial blood furnishes the materials of the secretions, except that of bile; it is warmer, redder, more oxygenated, and has less hydrogen and less carbon than venous blood.

350. The venous blood is specially destined to receive the materials fitted to repair the losses that the arterial blood is continually subject to.

351. The colour of the blood is various in the different classes of animals; more or less red in animals with an osseous skeleton; yellow or whitish in the greater part of the moluscæ and insects; aqueous and transparent in zoophites.

352. The systole and diastole movements of the heart and arterial system commence and cease with life.

353. In all warm blooded animals, the sanguiferous circulation is more rapid as they are less old; and, on the contrary, the older they grow, the beatings of the heart and arteries are the more slowly and unequally made.

354. In the mammalia and birds there is a simultaneous action between the right and left auricles of the heart, between the right and left ventricle, and between the aorta and pulmonic artery. Thence, whilst the auricles of the heart are dilated and full of blood, the ventricles are empty and contracted, and the arteries are

contemporaneously dilated and full, and vice versa.

355. In the circulation of the mammalia, the arterial blood passes from the capillary extremities of the pulmonic vein to the more conspicuous branches, which pour it into the left auricle of the heart; from this it goes into the corresponding ventricle, by which it is propelled into the aorta; from thence it is distributed to the rest of the arterial system, even to its most minute ramifications.

356. The venous circulation in the mammalia has its origin in the general capillary system; the blood passes from the venous branches to the greater veins, which convey it into the right auricle, from which it passes into the corresponding ventricle, which, lastly, sends it into the pulmonic artery, and to the most minute extremities.

357. In the arterial circulation the blood divests itself successively of the nutritive, albuminous, and fibrous matters; it loses a portion of aqueous humour and caloric; it is surcharged with hydrogen and carbon; and, finally, passes into the veins returned to the state of venous blood.

358. The venous blood in its circulation loses some principles constituting bile, and acquires chyle and all that the absorbing system brings to it.

LXXIX. The venous blood of the intestines alone yields the bile as it passes by the vena porta, through the liver to the heart; evidently showing that the presence of bile in the general circula-

tion would be detrimental to life, and constitute disease.

359. In fishes and reptiles, the heart being of one single ventricle, the blood is only carried there once in the entire circulation.

360. The impetus and velocity of the blood in any part of the sanguineous system are in proportion, first, to the distance found between that part and the heart; secondly, to the quality and quantity of blood; thirdly, to the capacity, the curvature and force of the action of the arterial ramifications of those parts. *

361. The blood in the human fœtus, that the

* See *Galen*, De usu pulsum; *Senac*; *Willis*; *Borelli*; *Vallisnieri*; *Albino*, Annot. acad.; *Morgagni*; *Winslow*; *Monro*, Medical essays and observations; *Barthez*, Nova doctrina de fonctionibus naturæ humanæ; *Lasonne*, Recher. sur la struct. des artèr.; *Hunter*, Treatise on the blood; *Whytt*, An inquiry into the causes which promote the circulation; *Gregory*, Conspectus med. theor, tom. 1; *Sabbatier*, Traité complet d'anatomie; *Cullen*; *Soemmering*; *Leber*; *Scarpa*; *Schmid*; *Vanlembos*; *Kraause*, *Werschuir*; *Platner*, Quest, physiol.; *Vrignaud*, Nouvelles recherches sur l'économie animale; *Caldani*; *Blumenbach*, Instit. physiol. § 123; *Bonnet*; *Rezia*; *Prcsciani*, Discor. d'anat. e fisiol. tom. 1; *Sottira*, Mémoire sur la circulation oscillatoire du sang; *Sementini*, Instit. physiol, tom. 1: *Kramp*, De vi vitali arteriarum diatribe; *Darwin*, Zoonomia; *Dumas*, Elém. de physiol.; *Richerand*, Nouv. élém. de physiol.; *Cuvier*, Leçons d'anat. comp. tom. 4; *Tommasini*, Quanto influisca il cuore nella circolazione del sangue; Lez. crit. di fisiol. e patol.; *Boyer*; *Portal*, Anatom. médical. tom. 3; *Virey*, Nouv. dict. d'hist. natur. art. artères; *Jacopi*, Elementi di fisiol. tom. 1, &c. &c. The experiments of the above authors, and many others, are sufficient to destroy the opinion of those who regard the arterial system as deprived entirely of a peculiar contractility, supposing that the heart is the sole mover of the blood in the animal machine.

inferior vena cava receives in the first months of its development, passes entirely into the left auricle of the heart, passing by the foramen ovale; by which auricle it is transmitted to the left ventricle, thence to the aorta, and all its branches. By the arterial system the blood passes into the different ramifications of the superior vena cava, and is carried to the right auricle, from thence into the corresponding ventricle, which throws it into the pulmonic artery. A little portion of blood is transmitted into the lungs, and the greater part to the descending aorta, by means of the ductus arteriosus. The superfluous blood traverses the umbilical arteries, and, finally, is lost in the placenta. *

362. The nearer the fœtus approaches the epoch of its birth, a greater quantity of blood is directed to the lungs, and less passes by the ductus arteriosus; whence it is that the quantity of blood is in direct proportion to the age, in the pulmonic artery, and in inverse ratio in the ductus arteriosus.

363. The blood, carried by the circulation into different parts of the body, is the principal source of their nutrition and respiration.

364. Motion, digestion, stimulants in general,

* See *Sabbatier*, Mémoire sur la circulation du sang dans le fœtus; *Bichat*, Anat. génér. tom. 2; *Esparon*, Essai sur les âges de l'homme; *Cuvier*, Tableau élément. de l'histoire naturelle; *Blumenbach*, Instit. physiol.; *Boyer*, Traité complet d'anat, tom. 4; *Lobstein* denies this method of circulation, but his reasons have not persuasive force, nor can they stand in opposition to anatomical facts.

strong and unexpected impressions of the mind accelerate the circulation of the blood.

LXXX. Stimulants in the stomach increase the action of the heart and arteries; vomiting and nausea depress their action; also accelerated respiration increases the rapidity of the pulse. The number of pulsations of the heart during respiration is generally six, three during inspiration, and three during expiration; thus if the respirations are twelve in a minute, we have a pulse of seventy beats in a minute, or nearly so.

GENUS III.

ON RESPIRATION.

Of inspiration and expiration; connexion of respiration with life; chemico-animal phenomena, that take place in respiration relative to atmospheric air, and to the blood, &c.

365. ALL animals with a heart, and therefore with a true circulation, respire by a particular organ.

366. The organs destined for respiration are always, considering the different animals as to their composition, in close and reciprocal relation with those of the circulation.

367. In moluscæ, red blooded worms, and crustaceous animals, respiration is made by means of circumscribed bronchia; in insects it takes place by means of the trachea, which branches all over their body: in true zoophites, medusæ, and in polypi, it appears that the whole body breathes, there being no particular organ destined for that purpose.

368. In cold blooded animals respiration is made by a double movement of inspiration and expiration.

369. All warm blooded animals keep the lungs

in a continual exercise the whole of their lives, by which the circulation in those viscera is facilitated.

370. The human fœtus does not respire as long as it is enveloped in its proper membranes within the uterus. Respiration does not begin in it till the moment of its birth.

371. The amphibious reptiles and the amphibious serpents, because of their particular structure, can suspend respiration arbitrarily without stopping the course of the blood.

LXXXI. Amphibious animals have a large sinus or termination to the vena cava inferior, which is filled with blood, and serves when diving as a feeding reservoir to the auricle, which it fills by the pressure of the abdominal muscles and viscera exercised on the course of the vein.

372. The cavity of the thorax is dilated and contracted by means of the action of the diaphragm, pectoral muscles, and also, in part, by the action of the abdominal muscles; the lungs, in consequence of these movements, inspire and expire atmospheric air.

373. In animals with a complete pulmonic circulation, the movements of inspiration and expiration succeed one another regularly; in reptiles these movements are much less frequent.

374. The lungs of warm blooded animals are purely passive in the movements of inspiration; they co-operate, however, by a force peculiar to them in the movement of expiration.

375. Running, and every accelerated muscular

movement, as also strong and unforeseen agitation of mind, render respiration more rapid.

376. In man, the respiratory movements differently modified, enter, in a great degree, into the formation of voice, ventriloquism, hiccough, weeping, laughing, singing, sneezing, &c.

377. At each inspiration of the adult, about 40 cubical inches of atmospheric air enter the lungs.

378. Four or five arterial pulsations accompany every respiration in the adult.*

379. A very marked harmony exists between the movements of respiration and the beating of the arteries.

380. The dilatations of the lungs in man, before and after inspiration, are about as 109 to 123. †

381. The venous blood conducted to the centre of respiration loses its excess of carbon and hydrogen, uniting with a portion of atmospheric oxygen, and to caloric, which is developed by the combustion, acquires a fine red colour, and becomes frothy, warmer, lighter, and more fluid. ‡

382. Respiration, by combining a portion of oxygen with the venous blood, renders it more

* See Law LXXX.

† *Goodwyn*, Connexion of life with respiration; *Menzies*, Dissertation upon respiration.

‡ *Priestley*, Philosop. transact.; *Hewson*, Ricerche speriment. sulle proprietà del sangue; *Crawford*, Experiments and observations on animal heat; *Lavoisier*, Mémoires de l'académie des sciences, an. 1780; *Chaptal*, Elém. de chymie; *Tommassini*, Dubbj su quanto influisca il cuore nella circolazione; *Goodwyn*, *Hassenfratz*, *Berthollet*, *Fourcroy*, *Dumas*, *Richerand*, *Cuvier*, *Alibert*, &c. &c.

coagulable, and fitter to effect the nutrition of the animal solids by deposition from the arterial extremities.

383. Animals, after a good and plentiful feed, consume a greater quantity of atmospheric oxygen by means of respiration, than with a fasting stomach; this consumption is in proportion to the want which the assimilation of the aliments and animal fluids has of it.*

384. The birds that ascend to where the air is little respirable have a peculiar structure, by which they preserve in their air vesicles a portion of respirable air to make use of on occasion.

385. Birds consume in a given time a much greater quantity of oxygen, in proportion to their volume, than quadrupeds.

386. Among the principal services that respiration effects in the animal machine, the most singular is that of reanimating the muscular force, by restoring the exhausted irritability to fibre; and, indeed, among the animals that respire free air, those with double circulation, birds and mammalia, move with more force and vivacity than the other red blooded animals; and their faculty of moving themselves, and their vital activity, precisely correspond to the quantity and intensity of their respiration.

387. The less respiration is fit to re-establish the irritability of fibre, the more difficultly this property of fibre will be exhausted; thence it

* See Law LXXIII.

comes that the irritability is so tenacious in reptiles, that their flesh palpitates and contracts long after death; whilst warm blooded animals lose that property in becoming cold.

388. Warm blooded animals, subject to become lethargic, are found in the condition of cold blooded animals, respecting the quantity of oxygen their respiration requires when they are in lethargy.

389. The capacity of the thorax in the fœtus is in a constant ratio to the absolute size of the organs contained in it.

LXXXII. Respiration in an adult is usually performed about twelve times in a minute, accompanied with a pulse of six to one.

GENUS IV.

OF ABSORPTION AND TRANSUDATION.

Of the use of the lymphatic vessels; of the different energy of the absorbing system in various parts of the animal machine; of the absorption of chyle, &c.; of the vessels destined for transudation; of the different natures of the humours of perspiration in various animals, and in different parts of the same animal; of pulmonic and cutaneous transpiration; of the mucous membrane, &c.

390. The absorption of humours of whatever sort in the human body, and in that of all the mammalia, is made by means of the lymphatics.*

391. Absorption is much more active in children and women than in men, and yet more during sleep, and in the morning, than in the rest of

* It does not appear to me that the reasons adduced by *Swammerdam*, by *Kaaw*, *Boerhaave*, *Haller*, *Lieberkuhn*, *Mekel*, *Fl. Caldani*, *Walter*, *Lupi*, *Magendie*, and many others, with which they endeavour to prove the venous absorption, can be compared with those of *John* and *William Hunter*, *Howson*, *Rezia*, *Sografi*, *Assalini*, *Des-Genettes*, *La Haave*, *Mascagni*, *Cruikshank*, *Monro*, *Gallini*, *Cuvier*, *Reiseisen*, *Soemmering*, *Prockaska*, *Jacopi*, &c. who do not admit any absorbing virtue in the veins, limiting it solely to the lymphatic vessels.

the day: it is ordinarily less energetic without the body than within.

392. The lymphatics of the external superficies of animals, comprising that of the cavity of the stomach, the intestines, lungs, urinary bladder, nostrils, &c., seldom reabsorb that which exudes from the said superficies; whereas the lymphatics of the superficies of all the other cavities, reabsorb those same fluids which exude from them; by which it comes, that in the internal cavities the absorbents correspond to analogous exhalations.

393. The absorbing system sucks from the internal cavities and from the cuticle as much as may serve for the wants of the animal machine, and repair the loss that the exercise of the body continually produces.

394. The absorption of chyle in animals is made by the intestinal lacteal vessels, which carry it to the mesenteric glands; from which it passes into the reservoir of Pecquet; thence it passes through the thoracic duct, and is ultimately emptied into the blood.

LXXXIII. The absorption of chyle from the stomach is performed by the pressure of that organ, in consequence of its contractile power, which is in proportion to the degree of irritability of the muscular power. The absorption of fluids from the intestines is performed by the pressure of the peristaltic contraction of those tubes, and takes place when they are excited by the presence of mat-

ter, and is in proportion to the non-excitement of the stomach, that is, to a passive state of its contraction.

395. In mammalia the chyle is white and opaque; in birds, reptiles, and fishes, it is transparent. The lymphatic vessels of these two last classes of animals do not form any conglobate gland, whilst they form very many in man, and many other mammalia.

396. Transudation is performed by the extremities of arteries, and by the porosities that are found in their parietes. *

LXXXIV. Transpiration or the vapour of the breath is a watery fluid secreted by the thyroid gland, and suspended in the respired air from its volatility caused by the presence of caloric.

397. The Perspiration of the skin is more or less abundant in different parts of the superficies of the body: it is not of the same nature in all animals, nor is it the same in all parts of the same individual.

LXXXV. Perspiration or the moisture of the skin is a secretion from glands, commonly called lymphatic glands; it is in greatest abundance immediately in their vicinity and state of activity.

398. The transpiration or vapour of the lungs is greater in proportion to the superficies of

* My declaration of this opinion is supported by different experiments of mine, and reasons adduced by *Mascagni*, *Dumas*, *Azzoguidi*, *Prockaska*, &c.; nor can I admit a particular order of exhaling vessels, as *Hewson*, *Cruikshank*, and *Bichat* do, when anatomy does not demonstrate it.

the lungs, than the cutaneous transudation is to the superficies of the skin.

399. When the quantity of perspirable humour carried to the skin is greater than the dissolving capacity of the atmosphere, sweat is then manifested.

400. Cutaneous exudation is greater in summer than in winter; greater in youth than in old age, in waking than in sleeping.

401. The hour of the day at which perspiration is most abundant is the fourth or fifth hour after dinner; beverages increase it much more than solid aliments.

402. Cutaneous exudation is in compound ratio to the circulating force of the blood, the vital energy of the cutaneous organ, and the dissolving quality of the air.

403. The secretion of the mucous membranes always follows the inverse ratio of the cutaneous transudation.

404. Besides the humour of perspiration, the cuticle of the human body continually exhales carbonic acid gas, and a particular vapour, which varies through many circumstances; therefore transudation is fitted to decarbonize the blood like respiration.

405. The humour of perspiration softens the skin, throws out from the body various principles which would be noxious, and maintains a given equilibrium in animal heat, diminishing the excess of it.

GENUS V.

OF SECRETIONS.

Of the secreting organs; of the variety of animal humours; of the separation of bile, milk, urine, semen, fat, &c.

406. The primary organs of secretion in vertebrated animals, and many others, are glands.

407. Every gland is furnished with a peculiar sensibility, that it may be able to perceive, select, and combine the particles composing the fluid from which it secretes.*

408. When a gland enters into action it becomes a centre of afflux, to which the blood comes from all parts; then it swells, hardens, and passes to a state of orgasm, or, as it were, of erection.

LXXXVI. Secretion is in opposite proportion to the activity of the circulation; excited circulation arresting the secerning power of a gland. Secretion is in ratio to the secerning sensibility of a gland, which requires the moderate sensibility of mental organs.†

409. Although the secretions depend on the peculiar and inherent force in every gland, as well

* See Law XII. † See Law VIII.

as on the quantity of blood which comes to it, they are also assisted by the repeated shocks they receive from the surrounding parts being put in motion.

410. The excreting ducts of the glands, when secretion of any humour is performed, participate in the augmented excitement of the gland, and are disposed, by erecting themselves, to receive the humour secreted, in order to transmit it elsewhere.

411. Every gland is exclusively in relation with the principles composing the humour it separates; thus we see the salivary glands always separate saliva, the liver bile, the kidneys urine, the testicles sperm, &c.

412. All glands have their particular mode of sympathy; it is evident that the testicles sympathise with the pectoral and vocal organs, the liver with the brain, the kidneys with the stomach, the breasts with the womb, &c.

413. Very lively passions remarkably alter the secretions, augmenting some, abating or suppressing others.

414. The separation of animal humours takes place every time the secerning vessels of any organ take away from the blood a given part of the elements that compose it, sucking up the materials that are required for the formation of a given liquid.

415. The differences of the separated liquids are in proportion with those existing in the organic apparatus employed for their elaboration.

416. The various secretions have a reciprocal influence and action, whence it is that one being augmented, the other diminishes, and vice versa.

417. The lachrymal gland separates a humour analogous to snot; but, however, more fluid, and not so easily inspissated. *

418. The mucus that moistens the nasal membrane is clear, somewhat viscid, inodorous, of an acrid saline taste, containing carbonate and hydrochlorate of soda, phosphate of soda and lime, and animal mucus; it preserves the membrane soft, by which it is secreted; moderates and regulates the sensibility, and retains the odorous molecules.

419. The saliva is a viscid, saline, inodorous, transparent, frothy liquid, separated by the salivary glands; it is greedy of oxygen, and is composed of water, coagulable albumen, mucus, hydrochlorate of potash and soda, and lactate of soda.†

420. Bile is separated by the liver; the gall bladder is destined to contain, to perfect, and render it more dense, more coloured and bitter; finally, to pour it into the duodenal intestine when it is required.

421. In all animals having a gall cyst, two kinds of bile are found, *hepatic* and *cystic;* the first is of a light yellowish green, and slightly bitter, slightly liquid, coloured, and unctuous; the second is thick, viscid, of a deep yellow-green, very bitter, and more or less soluble in water.

* See Law 90. † See Laws 312, 313.

422. The cystic bile of herbivorous animals is viscid, dark yellow, very bitter, of disagreeable odour, and is soluble in water; that of carnivorous animals, amphibia, and fishes, is of a light green colour, and little soluble in water, but very soluble in alcohol; that of the crotalus horridus is blue. The bile of gallinaceous birds is commonly yellow, of an oily consistency, and is soluble in water. Human bile is more dense than that of herbivorous animals; it contains a waxy oil, soda, yellow matter, phosphate of soda, oxyde of iron, hydrochlorate of soda, and resin.

423. Man, the cetacei, and viviporous quadrupeds, are the only animals furnished with teats; these, in females, are destined for the separation of milk; sucking their teats, very much accelerates the secretion, and increases its quantity.

424. Milk is a white humour, opaque, unctuous, of a sweetish taste, of a grateful odour, composed of an oily substance, suspended in a muco-saline liquor, by means of the cheesy part: these different principles composing milk vary in different proportions in different mammalia, at different epochs of lactation; and also according to the nature of the aliments.

425. The milk, or *colostrum*, that is separated in the first days after parturition, is very fluid, has an opal colour, is insipid, not coagulable with rennet, slightly butiraceous, at the same time a little sanguinolent.*

* See Class II., Ord. III., Gen. II., Laws 563, 564.

426. The kidneys are the organs destined for the secretion of urine. When it is separated by them, it traverses the ureters, enters the urinary bladder, which retains it for a greater or less time, and thence it is evacuated by the urethra.

427. All vertebrated animals have two kidneys.

428. The sojourn of the urine in the urinary bladder is in proportion to the amplitude and dilatability of the bladder, and in inverse proportion to its irritability and sensibility, as well as to the irritating quality of the urine.

429. The quantity of the urine is in inverse proportion to that of the humours of transudation; and in direct proportion to the drink and cutaneous absorption.

430. The impetus with which the urine is sent forth from the urethra, is in proportion to the content of the bladder, the energy of its muscular coat, and the narrowness of the urethra.

LXXXVII. The impetus with which the urine is sent forth from the urethra, is in proportion to the voluntary contraction of the diaphragm, abdominal muscles, and the muscles of the anus and their connexions.

431. The nature of the urine varies in different animals, at different ages of the same animal, under the use of different aliments, and even in the same individual at different hours of the day. It may thence be asserted, that of all the animal fluids, the urine is that which presents the greatest number of elements, and the most varied qualities.

432. The urine of a human adult is transparent, of a citrine colour, more or less pale, a particular smell, a slightly acrid taste, is pungent, salt, and nauseous. It contains, in different proportions, uria, uric acid, hydrochlorate of soda and ammonia, phosphates of soda, ammoniacal magnesia, acid phosphate of lime, benzoic acid, and free lactic acid; the whole dissolved in a great quantity of water, and combined with an albumino-mucous substance.

433. The urine of the human fœtus is without colour, or odour, and slightly mucous. That of infants contains a very little uria, abundance of benzoic acid, and is without earthy phosphates. Salts, uric acid, and uria, abound in the urine of adults and old people.

434. Urine is the most putrescible of the animal humours, and then acquires an ammoniacal odour.

435. The testicles are destined for the separation of semen; and the seminal vesicles to contain it, and perhaps also to perfect it.

436. The more the object that produces the emission of sperm is pleasing to the mind, the greater quantity of this fluid will be ejected in a given time; and so much the greater will be the sensation of pleasure that accompanies such emission.

437. There is a constant relation between the secretion of semen and the wasting of fat, and it appears that these two fluids are in inverse proportion one to the other; so that many animals

become thin when they are rutting, and fatten when castrated.

438. Semen varies sensibly in character in different species of animals, and the different stages of their lives.

439. Human semen fresh is white, more or less gelatinous, of a particular odour, sometimes insipid, and sometimes salt; in its natural state it is insoluble in water, in contact with atmospheric air it congeals, and afterwards liquifies; it holds in solution an animal mucilage of soda and phosphate of lime.*

440. The secretion of fat appears to be performed by the secerning extremities of arteries, which pour it into the cellular tissue.

441. Fat is an oily substance, unctuous to the touch, of a sweet insipid taste, a particular smell, different in different species of animals, more or less white, opaque, and consistent.

442. Little fat is found in the fœtus, and is almost liquid, but much is found in the infant; in the fortieth year it is in its maximum; it afterwards diminishes and grows yellow in old age.

443. Fat is commonly more solid in herbivorous animals than in carnivorous; in birds it is soft, unctuous, and very fusible; it is more liquid and oily in fishes; and in some of these, as the cetacei, it is much oxygenated, spermaceti.

444. Fat keeps the limbs pliant and soft, and determines the form and roundness of them;

* See Class II., Gen. II., Law 504, on this operation.

when it is not in excess it facilitates muscular motion, maintains an equilibrium of animal heat, defends the nervous papillæ from irritation by external bodies; and, lastly, serves in case of need to nourish the body.

GENUS VI.

OF NUTRITION.

Manner in which it is performed; its principal object, and necessity of it; of the blood, considered as the agent in this function; of assimilation, and of the growth of the animal machine; of ossification; of the use of bones, their structure, &c.; of natural death.

445. NUTRITION is essentially necessary to all living beings; it is but the transformation of aliment into living matter.

LXXXVIII. Nutrition is performed by pressure which propels the chyle, or nutritive fluid, into the small tubes adapted to carry it into the blood, or circulating nutritive fluid.

LXXXIX. In animals with a stomach, the chyle ascends in the thoracic duct by the propelling pressure of its muscular coat.

XC. The absorption of chyle from the intestinal tube, is performed by the peristaltic pressure of the intestines.

XCI. Nutrition in vegetables is performed by the pressure of the surrounding medium on their nutritive fluid.

446. The property of nourishing and growing

by a power of sucking, intus-susceptio, is peculiar to organized living bodies.

447. In order that any part be fitted to nourish itself, it is necessary for it to have sensibility and motion.

448. Living beings attract continually, by a force peculiar to them, new molecules, which are placed in the intervals of those already existing.

449. The principal object of nutrition is to repair the losses organized bodies experience at every instant, and to augment their volume until their total growth.

450. Therefore the quantity of nutrition is always proportionate to the reparation and growth of the individual, as well as to the rapidity with which these two functions are performed.

451. The most active animals are those which require most nutrition, because they make the greater losses; and vice versa, the most indolent demand least, the subtractions to which they are subject being less.

452. Living bodies cannot grow indefinitely; nature assigns their limits, which cannot be exceeded.

453. The nutrition of the different parts of the animal machine is performed by the blood traversing all the most minute extremities of the arteries.

454. From the instant the animal receives vital movement, it continues to exist only by the successive addition of substances foreign to its body,

which, received into particular cavities, are assimilated to its own substance, become integrant parts of its organs, augmenting their weight and volume.

455. Living bodies, are only nourished by bodies that have already lived; from thence it results, that organic substances only are capable of nourishing animated bodies.

456. As animals grow, nature teaches them to make use of new organs, the exercise of which contributes to develop them.

457. All the solids and fluids of animals are formed by substances drawn from aliments under a fluid form.

458. Chyle changes into blood, by means of the circulation and respiration; it is carried round in the different parts of the animal machine, where it is divested of various principles, part of which are destined to repair losses, and part to be evacuated.

459. In the growth of animals, as long as superiority of the circulating force continues over the resistances, the quantity of blood of the arterial system prevails over that of the venous; but when the action of life begins to be balanced with the rigidity of the solid parts, then there is more blood in the veins than in the arteries.

460. The activity of the assimilating force is in proportion to the affinity that the assimilating substances have with the animal, at equal states of vital energy.

461. The extraordinary development of an organ is often made at the expense of the neighbouring parts, of which it appropriates the juices to itself.

462. In the first epochs of life, appetite is greater, the digestive forces are more energetic, and nutrition is much more active than in the later periods.

463. Assimilation is made better and with more activity during sleep, than in waking; when all the functions of internal life are made in a uniform manner in all parts of the body, and when those of animal or external life are at rest.*

464. Cold retards the growth of organized bodies; thence it is, that in northern climates living beings grow slowly.

465. From birth, until the epoch of our perfect growth, there is a constant diminution in the proportions of the head relatively to the remainder of the body.

466. When the body has acquired its due growth in length and height, by means of the entire development of all its parts, it augments in size; and when this ceases, then the solids of the body continue to increase in firmness.

467. All cold blooded animals grow slower, and always have their parts more soft, than warm blooded animals; they increase during almost the whole of their lives.

* *Adair's* Medical cautions, p. 418; *Darwin*, Zoonomia, vol. i. p. 199; The code of health and longevity, by *Sinclair*.

468. The bones of animals begin by being membranous and gelatinous, afterwards becoming cartilaginous, and ultimately hardened. Those that are flat, ossify from the centre to the circumference in diverging rays, and long ones in three different points, in their middle and extremities.

469. When the osseous fibres of a centre of ossification are joined in all parts with those of the neighbouring centres, the bones are only separated by sutures, which are sooner or later obliterated.

470. The time that bones take to acquire their final degree of consistency, is in proportion to the time necessary for the entire growth of the animal machine.

471. Bones begin to harden in those parts in which they are to exercise the greatest force.

472. The osseous system serves to support and attach many parts of the body; encloses and defends some viscera, and gives form, firmness, and support to the entire machine.

473. The structure of the osseous system, and particularly that of the cranium, is more solid in man than in women; the other parts of whose body are also less solid.

474. The texture and density of bones not only vary in different animals, but also vary in different bones of each animal.

475. The bones of insects only become completely hardened when they acquire their ultimate form.

476. There are some animals whose skeleton always remains cartilaginous.

477. The quantity of calcareous phosphate deposited in the texture of the bones, is in direct proportion to the age; whilst their flexibility and elasticity, as well as the energy of their vital faculties, are in inverse proportion to it.

478. In man, when he advances to old age, the membranes begin to become cartilaginous, cartilages ossify, the bones become more solid, their texture more compact, and their sutures disappear; the skin dries and corrugates, perspiration diminishes, muscular force is lost by degrees, and movements become slow and difficult; the fluids form particular concretions; the venous blood is in greater quantity than the arterial; the circulation of fluids is slowly performed; the digestion of aliments becomes slow and laborious; the principal organs of generation are inactive; the senses more obtuse; memory is lost; the hair becomes white and falls off; then the teeth drop out; the face is deformed; the body curved; the age of decrepitude comes on; after which follows death, as a necessary termination of life.

XCII. The falling of the teeth indicates the excess of solids over fluids, and, by rendering mastication less perfect, prevents the too great absorption of nutriment in consequence of the alimentary paste not being so soluble as when the function of mastication is complete.

479. Death consists in an irrevocable cessation

of sensibility and all movements of our organs; it ought to be considered physically as the beginning of the metamorphose of one being into another.

480. Each living being has a particular manner of dying, as it has of living.

481. In slow death the extremities die sensibly before the trunk; the circulation finishes in the parts farthest from the heart, before the last beats of this organ.

482. When a woman has already passed a certain age, she generally lives a longer time than the contemporary man.

483. From the moment an animal has ceased to live, its components undergo a spontaneous alteration that follows the laws of chemical affinity; and the sum of the powers tending to reunite the azote to the hydrogen, the oxygen to the hydrogen, the carbon to the oxygen, and the hydrogen to the carbon, to the sulphur, and to the phosphorus, is greater than the sum of those forces which hold these substances united in quaternary combinations.

GENUS VII.

OF CALORIFICATION.

Of animal heat in general; of the degree of heat in man, birds, and cold blooded animals; of the heat of the blood, &c.

484. Every organized being has a particular temperature, which is preserved equally in warm and in cold weather, and which is distinct from the temperature of the medium it lives in.*

485. Animal heat begins with the foundation of the germ, and ends with the cessation of life.

486. Animal heat is in compound proportion to the capacity and structure of the respiring organ, and of its relations with the vascular system, as well as to the pureness and quantity of the air inspired; it increases in proportion to the frequency and extension of the respiratory movements.

xciii. Animal heat is the result of chemical action; namely, the development and propensity of carbonic acid gas, to give place to the union of oxygen with its vehicle, the chylous and venous blood.

487. Animal heat is not produced solely by the pulmonary and circulating combinations; it is

* *Blagden, Fordyce, Crawford, Duhamel, Tillet, Cuvier, Delaroche* and *Borgor, Araldi, &c.*

also owing to phenomena which take place in the different viscera; such as digestion, the passing of fluid and gaseous substances into solids, the decomposition of the atmosphere on the superficies of the skin, the assimilating power, and also the force of the cerebral activity.

488. In the adult man, animal heat is habitually from 23 to 34 degrees of Reaumur's thermometer.*

489. The ordinary temperature of the body of birds is from 8 to 10 degrees above that of mammalia †

490. In fishes, insects, and reptiles, animal heat is from 1 to 12 degrees above zero of Reaumur's thermometer. ‡

491. The heat of arterial blood is nearly uniform in all parts of the animal, as well near to the lungs, as at a distance from them.

492. The capacity of the arterial blood for caloric, is to that of venous blood, in the proportion of 11.5 to 10. §

493. The animal machine maintains the same degree of heat in all its parts, in consequence of the circulation of the blood, and of the changes

* According to Fahrenheit's thermometer, it is at 104 to 110. According to Skene's thermometer, it is at 1+0 to 1.08+0.

† From 18 to 24 degrees of Fahrenheit's thermometer, and ,25 to ,31 of Skene's thermometer.

‡ From 32 to 59 above zero of Fahrenheit's thermometer; and from ,03+0 to ,37+0 of Skene's thermometer.

§ *Crawford*, On animal heat; *Hunter*, Treatise on blood; *Goodwyn*, Connexion of life with respiration; *Fourcroy*, Systême des connais. chim., t. 10; *Dandolo*, Della scienza chim., t. 2.

that take place in the latter during its circulation.

494. Sleep, and all debilitating causes, such as hunger, inaction, the secretions, evacuations, ligature, compression of a nerve in any part, &c. diminish animal heat; and it augments by means of fecundation, and all that is capable of exciting sensibility and mobility.

CLASS II.

OF THE FUNCTIONS OF GENERATION AND THOSE RELATIVE TO THE SPECIES.

ORDER I.

OF THE FUNCTIONS PECULIAR TO THE MALE SEX.

GENUS. I.

PHENOMENA OF PUBERTY IN MAN AND MALE ANIMALS.

Of the organic changes that take place at the age of puberty in man and animals.

495. At the age of puberty the arterial system is balanced in its parts, and predominates in its totality over the venous system. At this age all parts in a youth begin to take a manly form: the beard shoots forth, the skin of the pelvis is shaded with hair, the voice acquires a deeper tone, and the genital parts experience a new prurient sensation, which is communicated to the whole system.

496. The testicles, the prostate gland, and the spermatic vesicles are developed at the epoch of puberty nearly at the same instant. At this epoch the muscles belonging to the functions of animal life become more compact, more red, cease to

increase in length, but continue to thicken, and their forms are more decidedly pronounced; their action is less ready, yet more energetic.

497. The changes that take place in the *moral* of individuals at the time of puberty, are the result of those of their physical constitution.

498. The greater part of slightly prolific animals take nearly all their growth, and often they acquire it entirely, before being capable of generating; whilst the greater number of those animals which generate many fœtuses, are fit to procreate before their bodies have acquired the half of their due growth.

499. The male stag, when it becomes fit to copulate, puts forth horns, that are renewed every year.

500. At the age of puberty the male animal becomes fitted to reproduce; because it is at this epoch that the testicles properly begin to enter into action, and to separate sperm in all its perfection.

GENUS II.

OF THE USE OF THE GENITAL PARTS.

Of the erection of the penis; of the production and emission of semen.

501. The use of the genital parts in man, and animals with testicles and a penis, is to prepare sperm, and to carry it into those parts of the female destined to receive it.

502. The blood is carried in abundance into the cavernous bodies of the penis; it gives to the penis of the mammalia the rigidity necessary to introduce it into the sexual parts of the female; this erection facilitates the emission of sperm, and opposes the flowing of urine.

503. The imagination has a great share in producing the erection of the penis; but it is, however, independent of the will.

504. The semen separated by the testicles traverses the different canals, and is gathered in the seminal vesicles, in those animals endowed with them, remaining there until ejection expels it.

XCIV. The emission of semen is produced by the involuntary contraction of the diaphragm, abdominal, elevator and sphincter ani, erector penis,

accelerator urinæ, transversus perinei muscles, and the erection of the penis by the filling of the corpus spongiosum, and corpora cavernosa penis, with blood, and accompanied by an exquisitely pleasing sensation of tickling in those parts.

505. The accumulation of sperm in the seminal reservoirs excites venereal appetite. In order to satisfy this properly, the prolific fluid must enter into the cavity of the urethra, and advancing along it by means of the actions of those muscles which dilate and contract it alternately, must be ejected into the female receptacle.

506. As soon as the act restorative of the species is completed, the penis, in mammalia, loses the volume it had acquired by erection, and recedes into its former state.

507. Those animals which have only one marked epoch of lust, have true sperm only at that period, and on its approaching, the testicles are considerably swelled and enlarged, in viviparous animals as well as in birds.

508. The moderate evacuation of sperm excites appetite; whence it may be deduced that the most active mortification against lust is abstinence and fasting.*

* See Order II., Gen. V., Laws 435 to 439 inclusive.

GENUS III.

OF THE EFFECT OF CASTRATION.

509. When the testicles of man are taken away before the age of puberty, he does not acquire the fine manly forms that he might have had; his voice remains sharp and acute, the beard is not developed, his cranium remains small in proportion to the other parts, the thorax is large, and the processes of the bones little marked.*

510. The cellular tissue of those castrated is much developed, and contains much fat; their muscular fibres have not the usual strength and tenacity of the complete man; their cuticle continues smooth and fine like children's; their glandular system of lymphatic vessels is commonly gorged with humour, and almost inactive; and, lastly, their articulating capsules are somewhat swelled by the excessive quantity of synovial fluid.

511. All animals entirely castrated are absolutely incapable of generating.

512. A stag castrated before the time of puberty remains for ever deprived of its horns; if castra-

* I believe I have sufficiently developed, in my Mémoires sur les effets de la castration, in 8vo., Montp., all the phenomena that take place in the organization of a castrated being, to dispense with my adding new details.

tion is performed after they are pushed forth, they neither fall nor are they renewed.

513. Castration renders all animals more pusillanimous, tame, and tranquil; so that the *physique* and the *moral* are equally deteriorated.

ORDER II.

OF THE FUNCTIONS PECULIAR TO THE FEMALE SEX.

GENUS I.

PHENOMENA OF PUBERTY IN WOMEN AND FEMALE ANIMALS.

Of the changes that take place in a woman at the epoch of puberty; of menstruation; of the excitement to coition.

514. The epoch of puberty in women is marked by a sanguineous discharge coming from the uterine vessels, which becomes monthly periodical; by a sensible augmentation of the breasts; by the covering of the pubes with hair; and, finally, by a particular and new sensation, which they refer particularly to the genital parts.

515. In the human species the female arrives sooner at the age of puberty than the male; this epoch, however, is different in different nations; it seems to depend, in part, on climate, on quality and quantity of aliments, on particular education and development of the moral faculties, on peculiar constitution, &c.

516. The menstrual discharge in women is one of the principal signs of the disposition to fecundity.

751. In the common course of nature women are not in a state to conceive unless after the first appearance of menstruation ; and its cessation at a certain age renders them sterile for the remainder of their lives.

518. The superabundance of nutriment and blood is the principal reason of menstruation ; in fact the symptoms that precede it are so many signs of fulness.

519. The quality and quantity of blood that is evacuated at every menstrual recurrence depend on the nature and abundance of food, on age, temperament, climate, the other evacuations, predispositions, the state of the uterus, &c.

520. The duration of the menstrual discharge is generally from three to five days.

521. Commonly the menstrual flux is suppressed in pregnancy, and in the first months of suckling.

522. The principal object that the menstrual blood appears to be destined for, is that of furnishing material to the fœtus for its enlargement and development.

523. The menstrual discharge commonly terminates at about thirty years from its beginning.

524. The blood peculiar to the menstrual discharge of women is not coagulable.*

* See *Hunter's* Treatise on the blood, page 26 ; *Hamilton*, Traité des maladies des femmes ; *Jacopi*, Elem. di. fisiol., t. 2 ; *Lavagna*, Mem. sul sangue menstruo.

525. During menstruation, and the first months of pregnancy, the general sensibility in women is exalted, and more particularly that of the genital and (*educatori*) rearing organs.

XCV. The menstrual discharge is almost always suspended during pregnancy, and returns generally in five or six months after parturition if the female suckles the infant, earlier if not.

526. The particular odour of the genital parts of the female of many animals, especially when they are in lust, strongly excites the male to copulation.

527. In females of the viviparous animals at the epoch that they are in lust, the womb and vagina are swelled, and transude a white, bloody, smelling humour.

ORDER III.

OF THE FUNCTIONS RELATIVE TO THE UNION OF THE TWO SEXES, AND OF THE PRODUCT THAT RESULTS.

GENUS I.

OF GENERATION IN GENERAL.

Of copulation; of hermaphrodite animals; of oviparous and of viviparous generation.

528. All organized bodies are derived from bodies similar to them.

529. There is no animal that has not participated in the life of another body, before exercising by itself vital movement.

530. Generation is the process by which new organized beings are formed; it is effected by means of the conception of one or more mature eggs fecundated. Some animals however multiply by germs or buds.

531. Generation, in perpetuating organic beings, transmits a similarity of form, structure, and properties, that determines the species of individuals coming from the same stock.

xcvi. For generation to take place, the exist-

ence of male and female organs of copulation is required.

XCVII. The female organs provide the ovum, or egg, which, in mammalia, is formed in the ovaria, and propelled in the moment of overpowering pleasure by the Fallopian tubes into the uterus, where it is fecundated by the semen of the male.*

XCVIII. The male organs furnish the semen or fecundating fluid, which gives sensibility to the ovum in the uterus.

XCIX. The act of copulation in human beings is principally performed by the action of the external and internal dorsal muscles, and the small rotatory muscles of the femur, whose action ceases at the time of emission.

532. If a female is fecundated by a male of a different species, bastards or mules are produced, whose formation partakes of that of the father and mother.

533. By the copulation of a white man with a negress, or vice versa, mulattoes or mongrels are produced.

534. The animals that have but one sex, multiply only by means of the coupling of the male with the female; except some oviparous fishes, and cephalopodous moluscæ.

535. All vertebrated animals, and all insects,

* When the ovaria are removed from the female of many animals, as the sow, the same phenomena are observed that take place in the castrated hog.—*Trans.*

have separate sexes; the moluscæ and zoophites have them united in the same individual.

536. The greater part of insects only copulate once in the course of their lives. Death is so inevitably the consequence of their first pleasures, that their existence may even be prolonged some time by retarding their copulation.

537. The copulation of those animals whose bodies waste when they are in lust, only takes place at long intervals; the pining of their bodies is so much the more marked as the time between one copulation and another is greater.

538. For coition, the female of all animals prefers the male that is most courageous and strong to the timid and sickly, as if the weakness of the one aspired to the strength of the other.

539. An animal at heat becomes uneasy, agitated, loses repose, an unusual heat torments it, sending forth sighs and cries of pain.

540. The moment of venereal orgasm is accompanied by a general trembling of the body, and by a species of convulsion, in which all seems dead except the pleasure.

541. From fruitful coition conception results; and it is immediately followed by pregnancy in mammalia.

542. The gasteropodous moluscæ, although each one has in itself both sexes, cannot fecundate themselves; they require their reciprocal copulation. The acephalous moluscæ, on the

contrary, do not want reciprocal copulation to generate.

543. Almost all animals have every year one or more periods destined for being in lust and for generating: birds have it in spring; carp and many other species of fish enter into lust in the warmest time of summer; other fishes enter in April and May; cats go into lust in the months of January, May, and September; goats in the month of December; horses in summer; foxes and wolves in January; almost all insects in Autumn; stags in the months of September and October, &c.

544. All the mammalia are viviparous, and nourish their offspring with the milk of their teats; in all the act of fecundation is performed by means of introducing the penis into the natural parts of the female; and all these have a clitoris, the principal organ of voluptuousness.

545. Viviparous animals are ordinarily larger than the oviparous; but these, however, are much more prolific than the former.

546. In general, large animals are less prolific than small; the elephant, rhinoceros, bull, horse, man, whale, dolphin, marwall, &c., commonly generate but one young, and seldom two at a time; whilst little animals, as the cat, rabbit, rat, &c. produce oftener, and more young at the same time.

547. Birds are viviparous, and their eggs come out from the aperture common to the excrement.

548. The eggs cannot develop themselves unless fecundated.

549. The eggs of oviparous animals at first adhere to the ovaria, and gradually increasing, detach themselves, so as to be invested in the ovary duct, with albumen, some membranes, and a shell.

550. In the cephalopodous moluscæ, and various species of fish, the fecundating fluid is sprinkled on the egg previously deposited, without the action of coition taking place.

GENUS II.

OF PREGNANCY AND THE FŒTUS.

Of the relations of the fœtus to the mother; of the duration of pregnancy; of the phenomena relative to the state of the uterus and breasts in pregnancy; of child-birth, and its mechanism; of the difference of organization between the fœtus and adult.

551. PREGNANCY takes place only in viviparous generation.

552. The womb is peculiar to viviparous animals; and is destined to serve as a cell for one or more fœtuses; also to furnish them during gestation with the nutritive fluid which they want. In oviparous animals, one or two ovary ducts are found, in which the eggs remain more or less time, according to the different species of animals.

553. The womb, when in action, extends its influence over all the animal economy; agitates it forcibly, and seems to be the principal mover in it.

554. In pregnancy, the uterus of woman and of female mammalia gradually augments in volume, changes in form, and finally becomes almost round or oblong; there is a greater quantity of

blood carried to it at this period; its tissues are rendered more visible, and its orifice is restricted.

555. The fœtus of mammalia communicates with the mother, and is united to her by means of the placenta and umbilical cord, by which it receives that which is necessary for its nutrition and development, and returns to the mother what is superfluous.

556. The fœtus in the uterus, while yet contained in its proper membranes, has no communication with the external air.

557. The quantity of the amnios fluid, after the fourth month of pregnancy, is in inverse proportion to the development of the fœtus.

558. The growth of the fœtus is so much the more rapid as it approaches the time of its birth.

559. The human fœtus can be born and live when it has passed an interval of seven or eight months from the instant of its conception; but the epoch to which the critical term of childbirth in woman corresponds, is towards the end of the tenth lunar month, or two hundred and eighty days after the fecundation of the germ.

560. In viviparous quadrupeds, the duration of pregnancy varies according to the different species: the mare and ass continue pregnant about eleven months and a half; the cow, and many species of monkeys, nine months; the elephant and cetacei, ten months; the bitch, sixty-three days; the cat, fifty-six; the sow, four months; the hare and rabbit, thirty days; &c. &c.

561. The expulsion of the fœtus from the uterus is principally produced by the contraction of the womb, assisted by that of the diaphragm and abdominal muscles.

562. At the moment of birth, no want is more imperiously felt than that of expelling the fœtus.

563. The teats augment in volume during pregnancy, and yet more after birth: that depends upon the milk that is separated and accumulated in them. This liquor is destined to serve as the first aliment to all new-born viviparous animals.

564. The more woman advances to the epoch of her parturition, the more the serosity of her milk is found charged with calcareous phosphate; and in advancing from it, the milk loses, in proportion, that substance, whilst the other nutritive parts of which it is composed augment in inverse proportion.*

565. The organization and the proportions of the different parts of the human fœtus, when still enclosed in the maternal uterus, are not the same as those of the adult. The head, in proportion to the remainder of the body, is larger, chiefly in the first months. The liver and the renal capsular glands are larger; the thymus gland is very much developed; the inferior limbs are smaller in comparison to the superior. The genital parts are scarcely visible; the testicles before the seventh month are usually contained within the abdominal cavity. The pupil is covered by a fine peculiar membrane,

* See Ord. II., Gen. V., Laws 423, 424, 425.

(*velum pupillæ.*) The stomach has an almost perpendicular direction, and the large intestines differ very little from the small; no true digestion is made in the fœtus; the lungs are little developed, and there is no respiration. The blood is apparently equal in the arteries and veins. The circulation of the blood is not performed in the fœtus as in the adult; and that from the particular organization of the parts destined to perform it. Ordinarily the teeth are not cut, and the hair has scarcely begun to shoot forth. The osseous and cartilaginous systems are still confused, and as the former is developed the latter is reduced; all the apophyses are epiphyses; the bones of the cranium, not being yet well developed and united, leave particular spaces between them (*fontanelle*); and lastly, the life and nourishment of the fœtus depend on those of the mother, to whom it is united by the umbilical cord.

APPENDIX.

OF NERVES.

Of impressing nerves; of expressing and secerning nerves; of the brain.

C. All organs are composed of nervous matter, under different appearances or states of being, as the brain, organs of sense, glands, muscles, membranes, bones, &c., and are connected together by nerves of one general appearance.

CI. Nerves are composed of matter similar to the brain, and spinal marrow, but of a more hard, dense, and fibrous texture, and are supplied with sanguiferous vessels; they are of two classes,—*impressing*, and *expressing*, and have a single or a bifurcating origin, the latter consisting of a ganglionic and simple nervous connexion.*

CII. Nerves form the sympathic communication between organs and the brain, to which they are all connected, so that an effect on one organ produces a sympathetic effect in another, although not always similar.

CIII. The two olfactory nerves form the sympathic connexion between the brain, and the organs of smell and taste, or those organs which impress the being with the airiform and soluble qualities of bodies.

* See *C. Bell*, Exposition of the nervous system; *Magendie*, Précis élémentaire de physiologie; *Mayo*, Outlines of human physiology.

CIV. The two optic nerves form the sympathic connexion between the brain, and the organs of vision, or those organs which impress the being with the luminous quality of bodies.

CV. The two *portio mollis* nerves form the sympathic connexion between the brain, and the organs of hearing, or those organs which impress the being with the vibrating quality of bodies.

CVI. The ganglionic or posterior origin of the two fifth and the spinal nerves form the sympathic connexion between the brain, and the organs of touch, or those organs which impress the being with the resisting quality of bodies.

CVII. The two *motor oculi* nerves form the sympathic connexion between the brain, and three pairs of recti muscles, or those organs expressing the attention and passions of the being.

CVIII. The two trochlear nerves form the sympathic connexion between the brain, and the two trochlear muscles, or those organs expressing the sensations, surprise, terror, joy, &c., by pressing the ball forward, and slightly downward and inward.

CIX. The two *abducens* nerves form the sympathic connexion between the brain, and the two abducens muscles, or those organs expressing the attention and the sensations of suspicion, of anger, jealousy, envy, &c., by acting as antagonists, or in junction with the recti muscles, turning the eyeball outwards or retracting it into the orbit.

CX. The two *portio dura* nerves form the sympathic connexion between the lesser brain, and the mucles of the face, or those organs expressing the passions, &c.

CXI. The two glosso-pharyngeal nerves form the sympathic connexion between the spinal marrow, and the involuntary contracting muscles of deglutition in the tongue and pharynx, or those organs expressing the effect of the presence of bodies within those parts.

CXII. The two *par vagum* nerves form the sympathic connexion between the spinal marrow, and the muscles of unconscious and involuntary contraction in the glottis, œsophagus, heart, stomach, &c., or those organs expressing the effect of the presence of bodies in those parts, and of distention.

CXIII. The two *motor lingualis*, or principal articulating nerves, form the sympathic connexion between the spinal marrow, and the muscles of voluntary contraction in the tongue and pharynx, or those co-operating organs expressing ideal sensations by speech, vibrations of air which they produce.

CXIV. The two superior articulating or spinal accessory nerves form the sympathic connexion between the spinal marrow, and the muscles of voluntary contraction in the neck and shoulder, or those co-operating organs expressing ideal sensations by loud speech, forcible vibrations of air which they assist to produce.

CXV. The two inferior articulating nerves form the sympathic connexion between the spinal marrow, and the muscles of voluntary contraction in the sides of the thorax, or those co-operating organs expressing ideal sensations by loud speech, forcible vibrations of air which they assist to produce.

CXVI. The two phrenic nerves form the sympathic connexion between the spinal marrow, the expressing *portio dura*, the articulating nerves, and *motor lingualis*, and the muscle of unconscious and involuntary contraction, or that organ expressing the effect of involuntary extension and the pressure of bodies on its inferior surface, which produces inspiration, and assists in vomiting and alvine and urinary expulsion.

CXVII. The intercostal and intervertebral nerves form the sympathic connexion between the spinal marrow, and the other muscles of unconscious and involuntary contraction, or those organs expressing the effect of involuntary extension, and of the pressure of bodies against their surfaces, which produce expiration, and assist in inspiration, vomiting, and alvine and urinary expulsion.

CXVIII. The anterior or simple origin of the spinal and two fifth nerves, forms the sympathic connexion between the brain and spinal marrow, and the muscles of conscious and voluntary contraction, or those organs expressing the will or volition.

CXIX. The two sympathetic and the ganglionic nerves form the sympathic connexion between

the fifth, the spinal, and trochlear nerves, and the secerning glands, which yield the different secretions, or those organs expressing by their minute contraction and dilatation the effect of the presence of secernable fluids.

cxx. All the expressing nerves are subservient in expressing the three varieties of pleasing, congenial, and painful sensation, experienced by the vivacious being.

cxxi. The brain is the organ of consciousness, sympathizing with the sensitive organs, and is the pathic organ of the third class, or ideal sensations; memory, association, attention, imagination, and reason: the lesser brain is the organ of consciousness, sympathizing with the expressing organs, and is the pathic organ of the second class, or expressing sensations.

Their kinds, composition, and function.

CXXII. FLESHY organs that contract and dilate, thereby increasing and diminishing the extent of distance between parts, are called muscles.

CXXIII. Muscles are composed of fleshy fibres, expressing the sensations of the being, or their own sensibility, by contracting and dilating.

CXXIV. The fibre of muscles runs in three directions, vertically, diagonally, and circularly, producing by contraction the determination of the extremities of a muscle to a centre, and by relaxation the removing of the extremities from a centre.

CXXV. Vertical and diagonal fibres of muscles are all capable of voluntary contraction and relaxation, whereas circular fibres of muscles without a fixed point of attachment, are all incapable of voluntary contraction and dilatation, as the arteries, &c.; those circular fibres of muscles that have a fixed point of attachment are more or less voluntary in their greatest contraction, and in their relaxation, but are involuntary in their usual state of contraction and relaxation, as the sphincter muscles.

CXXVI. The motion and volition of parts are performed by the vertical and diagonal fibres, and the secerning and propulsion of fluids by the cir-

cular fibres, with a few exceptions, where the expulsion of bodies requires the assistance of all the three kinds of fibres.

CXXVII. Muscles often terminate, at their extremities, in tendons, which are continuations of their component fibres, but are, in consequence of the absence of flesh, inelastic and dense.

CXXVIII. Tendons form the uniting connexion between their muscles and the processes of bone in which they are inserted.

CXXIX. The length of tendons allows the contracting organ to be placed far from the points to be approximated.

CXXX. For animal beings to have the power of locomotion, or even life, it is necessary that they should be formed with muscular fibres.

THE END.

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Shortly will be published, by the same Author,

An ESSAY on the MEDICAL PROPERTIES of PLANTS; translated from the French of M. A. P. de CANDOLLE, Honorary Professor to the Academy of Geneva, &c. &c. To which will be added, the Natural Arrangements of Plants of Linneus, De Jussieu, and De Candolle. Also, with the permission of Professor A. Duncan, jun., of the University of Edinburgh, &c. his Catalogue of Medical Plants, arranged after the manner of M. De Candolle.