The grouping of the cranial nerves ; Current nerve anatomy and physiology ; Gegenbaur on the metamerism of the head and the vertebrate theory of the skull / by Alex. Hill.

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Current Nerve Anatomy and Physiology; Gegenbaur on the Metamerism of the Head and the Vertebrate Theory of the Skull.

BY

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FELLOW AND LECTURER OF DOWNING COLLEGE; DEMONSTRATOR OF ANATOMY IN THE UNIVERSITY OF CAMBRIDGE.

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THE GROUPING OF THE CRANIAL NERVES.

BY ALEX. HILL, M.A., M.D.

Fellow of Downing College, Cambridge.

THE key to the arrangement of the nuclei of the nerves of the spinal cord is to be found in their segmental succession. I believe that the recognition of this anatomical fact is due to the late Professor Aeby. It has long been a favourite physiological axiom of Ludwig's, under whose direction various researches into the segmentation of the spinal cord have been carried out.

In my lectures as Hunterian Professor in 1885, I attempted to apply this principle to the brain, and to check the observations hitherto made as to the position in the cerebral axis of the nuclei of the several cranial nerves by a consideration of the distribution of these nerves in the segments of which the head is composed. It appears to me that this matter is of the greatest importance to neurologists, for a proper understanding of the constitution of the lower parts of the brain is impossible without a knowledge of the plan of segmentation of the head. On the other hand, the determination, by those who make a special study of the brain, of the position in it of the nerve nuclei, ought to throw light upon the difficult morphological problem of the segmentation of the head.

In all attempts at determining the lines of division between the segments of the head the cranial nerves have played a prominent part, and rightly, for no other constituents of the body so long retain traces of their origin. Nerves are the aristocrats among the organs, adhering with greater pertinacity than the rest to their traditional course and constitution. To a certain extent, no doubt, this is due to the fact that the nervous system is the first part of the body to be

developed, and obtains ontogenetically as phylogenetically to a certain degree of structural differentiation, before the modified organs for the control of which it exists, put in an appearance. A muscle is altered in form to meet the requirements of a change in occupation. The blood-vessels which supply the muscles adopt the course most suitable for providing for the nutrition of the muscle in the altered position in which they find it at the time of their development. The nerve, however, is formed before the muscles, and strikes out consequently for their original situation for generations after this has been changed. Hence it comes about, that while muscles and the bones which support them lose their metameric significance, the nerves preserve the records of the animal's ancestry.

It occurred to me some ten years ago that, since the nerves are outgrowths of a central system, their nuclei of origin within this system ought to exhibit a metamerism more marked than even that of the nerve trunks. I failed to classify them, however, because, following in the footsteps of all the morphologists who had up to that time dealt with this question, I expected to find a division of nerve roots into two series (sensory and motor, or dorsal and ventral) only, of which of course in the case of the cranial nerves, one series might be incomplete. Trying, however, to account for the apparently eccentric origin and distribution of the *spinal accessory* nerve, I realised that all the way down the cord, the columns of cells which belong to the anterior and lateral horns are so distinct as to belong evidently to nerve fibres supplying different groups of muscles.

The distinction between anterior and lateral horns is more obvious in the fœtus than it is in the adult. What may be the morphological division of the muscles into two groups with which this is correlated it is at present difficult to say. In the course of their growth the muscles exhibit an arrangement into somatic and splanchnic, as well as into dorso-lateral and ventro-lateral groups. It is better perhaps, in the present paper, not to attempt to decide to which of these systematic arrangements the division of the motor cells in the cord into anterior and lateral horns belongs. It suffices that the dis-

tinction is all the way down the cord (except perhaps in the lumbar and cervical enlargements, where the number of cells in each horn being great, the two regions become confluent), so clear that it is impossible to doubt, that the anterior nerve roots as they leave the cord contain two sets of fibres of different origin and destination.

In the cervical region the fibres from the lateral horn constitute a separate nerve, the spinal accessory. In other words, the cervical cord gives exit to anterior and lateral root-fibres, as well as entrance to the fibres of posterior roots.

This greatly simplifies the problem of metamerism. Up to this time morphologists looked upon all motor nerve-roots as of equal importance. Each cranial motor nerve was regarded as the homologue of a spinal ventral or motor root. A consideration of the arrangement initiated by the spinal accessory nerve teaches us, that it takes two motor cranial roots to equal one spinal ventral root, for in their exit from the spinal cord, except its cervical region, the fibres derived from the anterior and lateral horns run together. Not so the nerves which issue from the axis of the brain. In this part the separation between the anterior horn and its nerves, viz. the hypoglossal, abducens and motor-oculi, and the lateral horn and its nerves, the spinal accessory, facial and motor division of the fifth is distinct and easy to recognise.

At the time when I came to this conclusion, I was not acquainted with Van Wijhe's paper,[1] in which he puts the matter upon an infinitely better footing than any observations in adult anatomy could do, by tracing the origin of the muscles of the head to two distinct mesodermic sources, the "somites" and the "lateral plates," for which different groups of nerves are destined. My argument amounted to nothing more than bringing the known facts of adult anatomy to bear upon the question of cephalic segmentation. Van Wijhe's researches are referred to in the paper of Gegenbaur, which forms the excuse for this article. It will be noticed that Gegenbaur finds difficulties in the way of accepting the

[1] "Ueber die Mesodermsegmenter und die Entwicklung der Nerven des Selachierkopfes." (*Natuurk. Verhandelingen Koninkl. Academie, Amsterdam.* Deel xxii., 1882, Sep.)

complete homology of the third, fourth, and sixth nerves, which according to Van Wijhe belong to the first three somites respectively.

Secondly.—Gaskell's researches have shown that throughout the cerebro-spinal system we have also to reckon with a visceral root, which, as a rule, accompanies the anterior motor root, but in the case of the vagus and pars intermedia constitutes an almost pure nerve, leaving the system in company with the lateral motor and sensory roots.

Adding to the sensory root the three motor ones thus determined, we find that when we attempt to homologise cranial and spinal nerves, we must take four of the former to equal

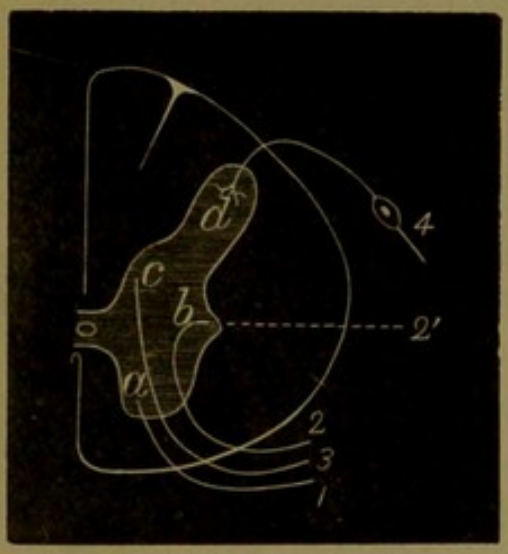

FIG. 1.—GROUPING OF NERVE ROOTS IN THE CORD.

1. anterior; 2. lateral; 3. visceral; 4. dorsal; *a*. anterior horny; *b*. lateral horny; *c*. Clarke's column; *d*. subs. gelatinosa Rolandi.

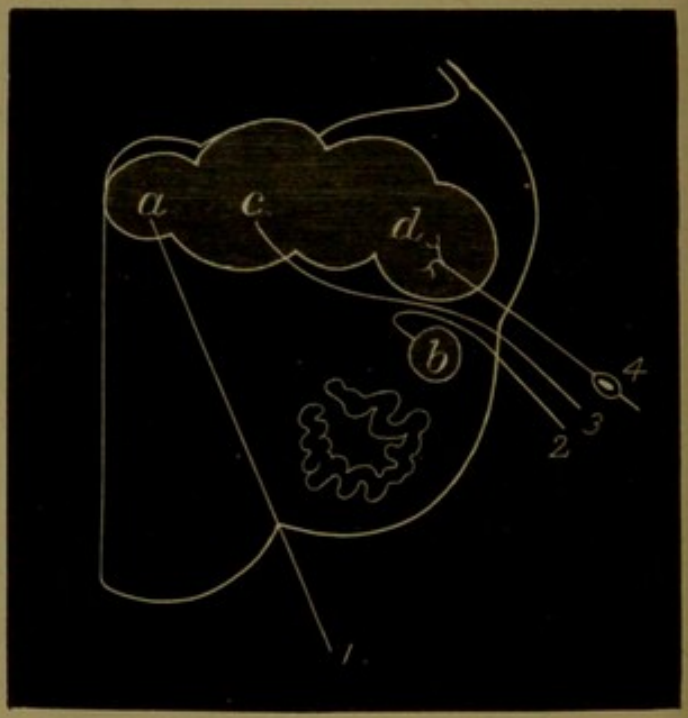

FIG. 2.—GROUPING OF NERVE ROOTS IN THE MEDULLA.

References as in Fig. 1 (*c*. Clarke's column is now swollen out into vagus nucleus).

one of the latter, since in the head the union of sensory and motor fibres does not take place just outside the central nervous system as it does in the spinal cord.

Charles Bell classified nerve roots in two divisions—dorsal or sensory, and ventral or motor.[1] I might speak of my

[1] Bell also observed that, while certain cranial nerves, namely the hypoglossal, abducens and motor oculi, follow the same line of origin as the motor roots of the spinal nerves, the *regular nerves*, as he termed them, the rest of the cranial nerves

classification as based upon the FOUR-ROOT THEORY, for I believe that each spinal nerve contains four sets of fibres, which in the case of the cranial nerves are more or less discrete.

Thirdly.—It is curious to notice the way in which the roots of the spinal accessory nerve, which has already divorced itself from the anterior motor nerve, the usual companion of a lateral motor root, gradually incline across the lateral column to join at the upper part of the medulla with the vagus and the glossopharyngeal. The nucleus of the vagus was recognised by Ross as the upper end of Clarke's column. The nerve arising from it no longer takes its exit in company with the anterior motor root, but with the posterior and the lateral motor. The change in grouping is shown at a glance in the accom-

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are *irregular* in their situation on the brain. The fifth nerve he rightly regarded as the sensory nerve of the head, but the remaining nerves, fourth, seventh glossopharyngeal, par vagum and spinal accessory, he considered as forming, with the "external respiratory" and phrenic, a group superadded to the regular nerves on account of their having a common function—namely, respiration. Dr. Gaskell, in a paper published some nine months after mine ('Journal of Physiology,' 1886, vol. vii. p. 1), gives to Bell the credit of not only discovering the division of nerve roots into sensory and motor, but also of recognizing the third great division of cranial nerves. This is very patriotic of Dr. Gaskell, and at the same time to a certain extent, from his point of view, justifiable; for Gaskell not only recognises the division of the cranial nerves (as given in my paper) into somatic motor (going to the muscles of the somites) and sensory; lateral motor (going to the muscles derived from the lateral plates) and *visceral;* but further subdivides the latter into efferent nerves going to visceral muscles, &c., and afferent nerves from hypoblastic surfaces (the glossopharyngeal and part of vagus). If the fourth and phrenic are taken out of Bell's list and the motor part of the fifth added to it, his respiratory group of nerves agrees with Gaskell's "splanchnic" group. In other words, the nerves which Bell observed to arise regularly from the base of the brain belong to the dorsal sections of the cephalic segments, the nerves which he classed as irregular to the ventral sections. Instead, however, of nerves of respiration, Gaskell would call them the nerves supplying motion and sensation to the viscera and to the arches by which the viscera are supported.

No one can read Charles Bell's writings on the subject ('Anatomy of the Human Body,' vol. ii. p. 373) without seeing that, far from having any such morphological classification in his mind, he was attempting to obtain anatomical data for a most untenable theory as to the functions of the body. Gaskell's scheme includes all that is contained in mine, and at the same time goes beyond it in what has a most plausible appearance of being the right direction. Until further morphological data are obtained, however, it seems hardly desirable to discuss its probability.

panying woodcuts. In Fig. 1 these nerves are seen to leave the spinal cord between its anterior and lateral column, although the dotted line indicates that in the cervical region the spinal accessory runs out alone through the lateral column. Fig. 2 shows one nerve only, the hypoglossal, leaving the medulla between its anterior pyramids and lateral column (olive), while three nerves come out between the olive and restiform body.

In reading the accompanying abstract of Gegenbaur's paper, it will be observed that the nerves of the organs of special sense receive a very varied treatment at the hands of anatomists. The olfactory optic and auditory nerves are regarded as either segmental nerves, or branches of segmental nerves, or nerves *sui generis*, and therefore out of the discussion.

The organs of special sense are looked upon as either independent gill clefts, or formed in connection with gill clefts, or even formed out of gill clefts. Or again, of the three organs one is regarded as having a different origin, and its nerve therefore a different homological value from the others. To the writer of this paper it has always seemed necessary that the nose, the eye, and the ear, should be treated alike. It seems highly probable that these organs are the only three left out of a complete series of segmental sense-organs which at one time existed, and that the relation of each of them to the central nervous system depends upon the period at which it specialised and became consolidated into its permanent form.

The uncertainty of morphologists as to the light in which the organs of special sense are to be viewed is due, as it seems to me, to a complete misapprehension as to their relation to the central nervous system.

It can be most easily proved, although the quoting of examples and references would make this paper too long, that the central nervous system was in the first instance deposited in the neighbourhood of the sense organs, and subsequently withdrawn to a common central ground for safety and convenience of exchange of impulses. In the first instance, the central nervous system consisted of detached clumps of ganglionic matter at the bases of the sense organs. Then the

clumps were connected together by commissures. Finally, clumps and commissures were withdrawn to a central situation. In the case of the first two sense organs, specialisation had advanced so far at the time when centralisation of the nervous system set in, that elements which in all the posterior segments are withdrawn into the central nervous system, retain their original position at the base of the nose and eye.

It is very likely, however, that the spinal ganglia mark the position of vanished sense organs, and that the fundamentally bipolar cells of which they are composed are portions of the ganglionic matter which at one time lay beneath the sense organs.

In the retina we find three kinds of nervous element, minute bipolar cells (nuclear layer), plexus (inner molecular layer), and multipolar cells. The olfactory bulb consists, as I have elsewhere shown,[1] of the same three sets of elements. I am of opinion that the cells of the spinal ganglia are the direct homologues of the bipolar cells of the retina and olfactory bulb, while the other layers of these two organs are in the case of posterior segments withdrawn into the cerebro-spinal axis.

Undoubtedly the nerves of special sense are of segmental value inasmuch as it is unlikely that any single metamer contained more than one sense organ, although, as Gegenbaur most forcibly shows, this had no necessary connection with a visceral cleft; but whether it was a branch of the general cutaneous sensory nerve, or, as is more likely, the sensory nerve, a branch of it, we have no evidence to show.

It is possible that the part of the head in which the nose and eye are situated obtained its form at a period prior to the existence of any such metamerism as the visceral clefts and arches indicate.

[1] 'Plan of Central Nervous System.' Cambridge: Deighton & Bell, 1885.

Current Nerve Anatomy and Physiology.—Titles and Indication of Contents of Papers which have appeared during the Quarter (Midsummer to Michaelmas, 1887). By Alex. Hill, M.D., Downing College, Cambridge.

Human Brain.

1. Observations on the Brain of Man. Michel von Lenhossék (*Anat. Anzeiger*, 1887, No. 14, June 15).

Three papers. 1. Description of a delicate white bundle on the outer side of each corpus albicans, already mentioned but not described by Von Gudden, for which the author proposes the name Stria alba tuberis. It is derived from the descending pillar of the fornix. 2. A description of the structure of the corpora albicantia as studied in section by Weigert's method. Distinction of nuclei. 3. A new bundle on surface of the pons; Fasciculus rectus pontis.

2. The Brains of Criminals (Parieto-temporo-occipital surface). Second memoir. Lor. Tenchini (*Luigi Battei, Parma*, 1887, 14 *plates*).

Comparative Anatomy.

3. Researches into the Structure of the Brain of Mysis Flexuosa, *Müll.* M. Koehler (*Ann. des Sciences Naturelles, Zool.* t. ii. pts. 3 and 4).

Examined by means of sections in various planes.

4. The Nervous System of the Opheliaciae. Dr. Willy Kükenthal (*Jenaische Zeitschrift*, vol. xx. hft. 4, p. 511).

5. Comparative Anatomy of the Nervous System of the Isopoda. E. Brandt (*Horæ Soc. Entom. Russicæ*, t. xx. p. 245. *Russian*).

6. The Dipnoan Brain. Burt G. Wilder (*American Naturalist*, 1887, p. 544, *June*).

Morphology.

7. The Ontogeny and Phylogeny of the Torus Longitudinalis of the Mid-brain of Bony Fishes. Rabl-Rückhard (*Anat. Anzeiger*, 1887, No. 17, p. 549, *August* 1).

The structure belonging to the mid-brain of bony fishes, and known as the Torus longitudinalis, is not homologous with the fornix or other constituent of higher brains, but is present in the brains of most vertebrates in a rudimentary form as an ependyma development.

8. The Homologies of the Chorda Tympani in Lower Animals. Froriep (*Anat. Anzeiger*, 1887. No. 15, p. 486, *July* 1).

9. On the fate of the Muscle Plate and the Development of the Spinal Nerves and Limb plexus, in Birds and Mammals. Dr. A. M. Paterson (*Quart. Journ. Micro. Sci.*, vol. xxviii. pt. 1, p. 109, *Aug.* 1887, pl. vii. and viii.).

10. Note on the Ciliated Pit of Ascidians and its relation to the Nerve Ganglion and so-called Hypophysial Gland, and an account of the Anatomy of Cynthia rustica (?). Lilian Sheldon (*Quart. Journ. Micro. Sci.*, vol. xxviii. pt. 1, p. 131, *Aug.* 1887, pl. ix. and x.).

The function of the ciliated pit is considered to be aëration of the brain, and, secondarily, it serves as a duct for the so-called hypophysial gland. The ciliated pit itself, however, is regarded as probably homologous with the hypophysis of vertebrates, which, according to this view, is an atrophied organ the function of which is lost.

11. Morphological Value of the Lateral Nerve of Petromyzon. Ch. Julin (*Bull. de l'Acad. Roy. des Sciences de Belgique*, t. xiii., No. 3).

Conclusion, that it is the remains of neural ridge (crête neural), which explains its relation with the vagus roots and the dorsal branches of the spinal nerves.

12. The Neurenteric Canal of Vertebrates. KUPFFER (*Sitz. d. Gesellsch. f. Morph. u. Phys. Munich*, 1887. III.).

Critical summary of recent observations on development of fishes and amphibia. Conclusion, that the blastopore is the original anus of vertebrates, and that this relation is changed by the caudal extension of the central nervous system, leading to the formation of the neurenteric canal and secondary anus. Probability that a stage existed in which the gut and the neural-canal had a common opening.

13. The Morphological Significance of the Epiphysis (Pineal Gland) in Vertebrata. CH. JULIN, Lille, 1887 (*Rep. Bull. Scient. de Lille*).

PHYSIOLOGY—GENERAL.

14. The effects of Total Anæmia on the Brain and its Diverse parts, studied with the aid of Decapitation followed by transfusions of Blood. HAYEM AND BARBIER (*Arch. de Physiologie norm. et path.*, vol. x. pt. 5, p. 1, *July*, 1887).

A series of experiments in which the carotids of a dog were put into communication with a supply of blood, usually from a living horse, and decapitation of the animal then effected. The transfused blood allowed to circulate either at the moment of decapitation or at varying intervals thereafter. Record of reflex and voluntary movements exhibited by the decapitated head. Their relation to the interval before transfusion commenced, &c.

15. Physiology of the Frog's Brain (*continued*). DR. MAX E. J. SCHRADER (*Pflüger's Archiv, July* 26, 1887).

Series of 42 critical experiments testing statements of Goltz and Steiner with regard to the physiology of the frog's brain, and necessitating certain emendations in their views. For example, circumstances are enumerated under which the frog deprived of its cerebral hemispheres behaves like an intact frog, not exhibiting the total want of spontaneity and Will ordinarily ascribed to it. Author comes to general conclusion, that the nervous system shows a physiological segmentation corresponding to its morphological disposition, each segment having certain functions peculiar to itself to perform.

16. Structure and Functions of the Brain. T. V. Rohon. (*C. Winter, Heidelberg*, 1887. 8vo. 39 pp.)

Sensation.

17. Influence of Trigeminus Stimulation on the Touch and Temperature Sense of the Face. Victor Urbantschitsch (*Pflüger's Archiv f. Physiologie, July* 26, 1887).

Having found that in cases of disease of the middle ear the neighbouring regions of the head are less sensitive on the diseased than they are on the sound side (for instance, the Eustachian tube is less sensitive to the passage of a sound), the author proceeds to investigate the extent of these variations in sensibility, duration of after-sensation, &c.

18. The Perception of the Direction of Sound by means of the Semicircular Canals. W. Preyer (*Pflüger's Archiv, July* 15, 1878).

Impossible to give an outline of this paper within the limits of this index.

19. The Sense of Smell in the Dog. G. J. Romanes (*Revue Scientifique*, 1887, *August* 13).

Experiments to determine the extent of the power in the dog of recognising his master's footsteps from amongst those of other people; odour belonging to the boot rather than to the person; insulation of boot from the ground by brown paper sufficient to mask the scent; anointing boot with oil of anise not sufficient, and so forth.

20. Note on the Specific Energy of the Nerves of Taste. W. H. Howell, Ph.D., and J. H. Kastle, S.B. (*Studies Johns Hopkins' Biol. Lab.*, 1887, *June*, p. 13).

The authors have made use of a substance, para-brom-benzoic sulphinide, which gives on the back of the tongue a pure bitter, and on the front of the tongue a sweet taste. At the tip of the tongue a slight bitter usually precedes the sweet taste. The stimulation of different sensations in the two regions of the tongue, regarded as a proof of the existence of separate nerves for specific tastes.

Physiological Psychology.

21. Sensation and Movement, Experimental Studies in Psychomechanics. Charles Féré (*Alcan, Paris*, 1887).

Introduction of measurement into domain of psychology. Study by means of dynamograph and plethysmograph of the influence of sensations upon the static force of the individual. Influence of position, gesture, &c., in suggesting ideas. Relation between the idea of movement and movement. On account of their hyper-sensitiveness, hysterical persons are largely made use of in these experiments. Pessimism a result of *dégénérescence* and other philosophical applications, &c.

Reaction Time.

22. Reaction Time for Action and Inhibition, gathered from Observations of Dr. Orschansky, Physiological Society in Berlin (*Archiv f. Anat. u. Phys.; Phys. Abth.*, 1887, p. 363).

Hypnotism.

23. Auto-suggestion in Hypnotized Subjects. N. Cybulski (*Phys. Centralbl.*, 1887, *Sept.* 3).

Cortex.

24. The meaning of Brain-fissuring. T. Seitz (*Toeplitz und Deuticke, Vienna*, 1887. 8vo. 67 pp.).

25. Contribution to the Morphology of the Island of Reil. G. A. Gullberg. (*Christiania*, 1887. *Danish.*)

Localisation.

26. The Localization of Brain Disease. Nothnagel (*Biol. Centralbl.*, Bd. vii. *No.* 13, *Sept.* 1).

Historical and critical essay read at the Medical Congress at Wiesbaden. Treats especially of the localisation of visual perceptions, and discusses the possibility of localising the cortical lesions in different portions of the visual area, leading to various forms of disturbance.

27. Eye-movements after Injury to the Nervous System. K. Szigethy (*Orvosi Hetilap*, 1887, *No.* 4, *in Hungarian. Abs. in Phys. Centralbl.* 1887, *Sept.* 3).

A series of experiments upon the movements of the eyes which follow mechanical injury to various parts of the brain in rabbits—particularly the medulla oblongata, mid-brain and cerebellum. Shows that compensatory movements of the eyes when the head is displaced still take place after destruction of the vermis.

Corpus Striatum.

28. On the Functions of the Corpus Striatum, and concerning a Basal Optic Nerve-root. L. Edinger (*Münchener Med. Wochenschr.*, vol. 34, No. 26).

Pituitary Body.

29. A case of Persistence of the Hypophysial Canal (*Anat. Anzeiger, No.* 16, *July* 15, 1887.)

Found p. m. in a girl æt. 14. The canal opened 2 mm. above the upper end of the pharyngeal tonsil (not into the bursa pharyngea). It contained a cord of substance resembling the pituitary body in constitution.

Mid-Brain.

30. The Mutual Relation between the Central Origins of the Eye-muscle Nerves. Nussbaum (*Medizinische Jahrbücher*, 1887).

Correction of Duval's and Laborde's results. Sections of brains of young cats stained by Weigert's method in carmine. Abducens nucleus of each side sends a diffuse bundle of fibres to posterior longitudinal bundle, crossed relation of post. long. bundle with the root fibres of the trochlearis. No crossed relation with the oculo-motorius visible.

Medulla Oblongata.

31. Studies in the Innervation of Respiration (seventh communication). O. Langendorff (*Archiv f. Anat. u. Phys.; Phys. Abth.* 1887, p. 237).

Author formerly showed the existence of spinal reflex centres, and concluded that a single respiratory centre in the sense of Flourens' *nœud vital* does not exist. Contends that the complex

of centres has no anatomical but only a physiological individuality. The article contains a critical *résumé* of recently published experiments and views, and shows how they harmonise with this theory.

32. Facts showing that it is because the Medulla Oblongata is the principal seat of Inhibition of Respiration that it appears to be the principal centre of Respiratory Movement. Brown-Séquard (*Comptes Rendus Soc. de Biol., Paris*, 1887, *May*).

Contention that there is no such thing in the medulla oblongata as a *nœud vital*, in the sense of a centre liberating respiratory movements. The cessation of respiration which follows injury to the medulla oblongata depends upon irritation of the inhibitory mechanism. Same standstill may be brought about by stimulating the trigeminus, &c., without injuring the medulla. In young animals section of the cervical cord does not prevent thoracic respiration. In some cases inhibition of respiratory movements does not follow injury to the region of the "nœud vital."

33. Where is the Swallowing Reflex released? N. Wassilieff (*Zeitsch. f. Biol. München u. Leipzig*, 1887, p. 29, *Sept.*).

Confirmation of the observation, that stimulation of supr. laryngeal nerve induces act of swallowing, while section of the same nerve is without effect. That stimulation of the glosso-pharyngeal nerve has inhibitory effect. Determination of a definite area, in the roof of the rabbit's mouth, touching of which is invariably followed by swallowing. This area loses its irritability when the trigeminus nerve is cut.

34. Origin and Connections in the Medulla Oblongata of the Hypoglossal Nerve. P. D. Koch (*Copenhagen*, 1887).

Cranial Nerves.

35. On the Functions of the Fourth Pair of Nerves. Henry Lee (*Lancet*, 1887, vol. ii. p. 9).

Spinal Cord.

36. The Posterior Nerve-roots, their Connections in the Cord and Central Prolongation. W. Bechterew (*Archiv f. Anat. u. Phys.; Anat. Abth.* 1887, p. 126).

Observations by Weigert's and gold chloride methods of cords

of fœtuses and new-born children. Posterior root contains two kinds of fibres acquiring myelin sheaths at different times. Those which develop first are also the larger fibres. Most of them go into the ground region of Burdach's column; a smaller number into the substantia gelatinosa. Of the smaller later-developed fibres the greater number go into the posterior part of the lateral column, a few into subs. gel. Further course throughout the spinal cord followed. Larger fibres pass amongst the cells of Clarke's column. Flechsig's observation, that the fibres from Clarke's column go into lateral cerebellar tract confirmed.

37. Sensory Nerves and Reflex Apparatus of the Spinal Cord (*continued*). K. Hällstén (*Archiv f. Anat. u. Phys.; Phys. Abth.*, 1887, p. 306).

Determination of the conditions under which reflex action can be obtained through the spinal cord of the frog. (1) By stimulation of the skin. Attempt at drawing up a scale of stimuli. (2) Secondary stimulation of the cut sciatic by means of a contracting muscle. Reflex cannot be obtained by rheoscopic stimulation with a nerve. (3) Double muscle reflex and reflex routes in cord. Attempt to prove that the impulse has the choice of a higher and a lower path across the cord. Upon the path selected depends the latent period and height of contraction.

Spinal Ganglia.

38. The Physiology of the Spinal Ganglia. Max Joseph (*Archiv f. Anat. u. Phys.; Phys. Abth.*, 1887, p. 296).

Experiments after the Wallerian method already recorded in Virchow's *Archiv* (cf. 'Brain' for July, this index). The notable result of these experiments is the discovery, that there is a partial degeneration of the portion of nerve attached to the spinal when the root is cut either proximally or distally to the ganglion. Also that when the root is cut proximally to the ganglion a portion of the root stump remains intact. Conclusion, that a certain number of fibres between the periphery and the cord pass through the root ganglion without union with its cells. Criticism of current views as to the constitution of the ganglion.

Spinal Roots.

39. Anatomical Investigation into the Spinal-roots of Man. Dr. Ernst Slemerling (*Hirschwald, Berlin*, 1887. 8vo. pp. 32, 2 *large plates*).

A purely anatomical study of the constitution of the nerve-roots, especially with regard to the character of the fibres of which

they are composed. The relative numbers of small and large fibres in both roots of each nerve. Their grouping and mode of development of the broad fibres, the largest are found to be those which have the longest extra-spinal course.

Sympathetic System.

40. The Ciliary or Motor-oculi Ganglion and the Ganglion of the Ophthalmicus Profundus in Sharks. J. Beard (*Anat. Anzeiger*, 1887, No. 18, *August 15th*).

The ciliary ganglion is by some regarded as belonging to the sympathetic system, by others it is looked upon as a posterior root ganglion. The object of the present paper is to clear up this uncertainty, which is due to the fact that, during the development of lower vertebrates, the ganglion on the ophthalmicus profundus branch of the fifth is conspicuous, and therefore mistaken for the ciliary, whereas in mammals it is fused with the Gasserian. The ophth. prof. ganglion belongs to the root ganglion series, while the ciliary is a portion of the sympathetic system.

41. Anatomy of Ciliary Ganglion and Vagus Nerve in Selachians. Onodi (*Physiological Society in Berlin*) [*Arch. f. Anat. u. Phys.; Phys. Abth.* 1887, p. 357].

42. Processes of Nerve-cells in Heart-ganglia. Nikita Ladowsky. *Communicated by* Prof. C. Arnstein (*Archiv f. Mikro. Anat.*, 1887, p. 609, pl. xxxviii.).

Gold chloride and formic acid 10%. Frogs and rabbits. Relation of nerve-cells to nerve-fibres on the one side, and muscle-bundle on the other described and figured. Various forms of uni-, bi-, and multipolar-cells, or of the former with spiral fibre. Definite observation of the connection of cell processes with the musculature of the auricle.

43. The Nervous System and Animal Heat. Ch. Richet (*Revue Scientifique*, 1887, *Sept. 17th*). Popular résumé.

44. The Relation of the Brain to the Stomach. Bh. Hlasko (*Karow, Dorpat*, 1887. 8vo. 31 pp.).

45. The Significance of the Nervous System for the Kidneys. E. Sehrwald (*Fischer, Tend*, 1887. 8vo. 88 pp.).

46. Studies in the Central Destination of the Vaso-motor Nerve-routes. K. Helveg (*Kjöbenhavn*, 1887. 8vo. *Danish.*)

Histology.

47. Histological Alterations in the Central Nervous System in Experimental Rabies. Golgi (*Arch. Ital. de Biol.*, vol. viii., fasc. ii., p. 192).

Deals with karyokinetic changes in the nucleus of nervous, epithelial and neuroglial cells, and also appearance in nerve-cells of peculiar nuclear mass.

48. On the Histology and Function of the Mammalian Superior Cervical Ganglion. W. Hale White, M.D. (*Journal of Physiology*, vol. viii. pt. 2, p. 66, pl. iii.).

Account of the variations in size of the superior cervical ganglion in man and comparison with mammalia. Description of its histological elements. Attention particularly called to great frequency in man, and to less degree in monkeys, of pigmentary degeneration and atrophy of its cells. This change regarded as "normal" and unassociated with disease.

49. Degeneration and New Formation of Medullated Nerve-Fibres. Giuseppina Cattani (*Archivio per le Scienze Medichi, Turin*).

Treats of the histological changes which lead to the first formation of a nerve filament after section from the central system, and of its further acquisition of a medullary sheath.

50. Minute Anatomy of Teleostean Brains. R. Fusari (*Internat. Monatschr. f. Anat. u. Hist.*, vol. iv., Nos. 7 and 8, p. 275, pl. ix–xi.).

Brains hardened in Müller's fluid and osmic acid. Detailed description of the histological elements occurring in the cerebellum, valvula cerebelli, and optic lobes.

51. Nerves in Epithelium. Dr. S. Frenkel (*Virchow's Archiv*, 1887, *Sept.* 1).

Criticism of observations hitherto recorded. Original observations and comparison of results with gold chloride and osmic acid. Demonstration of the connection of cells of rete Malpighi with one another by means of filaments (feine fäden). Relation of this intercellular network to the nervous functions of epithelium. Theory with regard to the histological differentiation of epithelial cells into nervous and supporting elements.

52. Golgi's Researches into the Minute Structure of the Central Nervous System. Köllicker (*Anat. Anzeiger*, 1887. No. 15, *July* 1).

Results of examination of certain preparations submitted by Golgi. Controverts Golgi's conclusion, that the protoplasmic processes of the nerve cells are not of a nervous nature. Calls attention to the importance of Golgi's discoveries as to the complicated constitution of the plexus of fine processes and the number of elements entering into it, and confirms his observation of the origin of medullated nerves in the grey matter by direct association in the plexus of protoplasmic processes.

Degeneration.

53. Ascending and Descending Nerve Degeneration. Feodor Krause. *Phys. Society in Berlin* (*Archiv f. Anat. u. Phys.; Phys. Abth.*, 1887, p. 370).

54. Degeneration of the Optic Nerve and Chiasm. Julius Michel (*Bergmann, Wiesbaden*).

Brain Weight.

55. Weight of Pranzini's Brain (*Revue Sci.*, 1887, *Sept.* 5), 1280 grammes.

Circulation.

56. Variations in the Development of the Brain-vessels, their Physiological and Pathogenetic Relation. Dr. L. Löwenfeld (*Archiv f. Psychiatrie*, xvii. pt. 3, p. 819).

Great variation in the relation of arterial calibre to brain-weight. Difference in the calibre of the two carotids, most frequently in favour of the left; possibly associated with the frequent preponderance of the left hemisphere.

Methods.

57. Methyl-blue Staining as a Histological Method. Arnstein (*Anat. Anzeiger* 1887, No. 17, p. 551, *Aug.* 1).

For nerve tissues; using picrocarmine or picrate of ammonia as a fixing agent.

Current Nerve Anatomy and Physiology.—Titles and Indication of Contents of Papers which have appeared during the Quarter (Michaelmas to Christmas 1887). By Alex. Hill, M.D., Fellow of Downing College, Cambridge.

Anatomy.

1. Brain of Man in its intimate relations and connections, Bechterew (*Archives Slaves de Biologie*, iv. 1, *July* 1887).

Contains an account of the connections of the various nuclei of grey matter in the cerebral axis, as determined by recent researches.

Comparative Anatomy and Morphology.

2. Nervous System and general Morphology and Classification of the proso-branchiate Gasteropods. E. L. Bouvier (*Annales des Sciences Naturelles*, 1887, vol. iii. pp. 1–336, plates 1 to 14, to be continued).

3. Nervous System of Gasteropods (type Aplysia). Lacaze Duthiers (*Comptes rendus Acad. des Sciences, Paris*, Nov. 21, 1887).

4. Electrical Fishes, part 1, Malopterurus electricus. Fritsch (*Leipsic*, 1887. *Veit & Co.* Folio, 90 pp., 12 plates).

5. The Metamerism of the Head and the Vertebra Theory of the Skull. Gegenbaur (*Morph. Jahrbuch*, xiii. 1, *Nov.* 1887).

General Physiology. Duality.

6. Duality of the Brain and Spinal Cord, as shown by the fact that Anæsthesia, Hyperæsthesia, Paralysis and various states of Hypo and Hyperthermia due to Organic Lesion of the Cerebro-spinal Centre, can be transferred from one side of the body to the other. Brown-Séquard (*Comptes rendus Acad. des Sciences, Paris, Oct.* 17, 1887).

First of a proposed series of communications, demonstrating that each half of the brain and spinal cord can serve for all the functions of both sides of the system. For example, section of one side of the base of the brain leads to anæsthesia of the opposite leg and hyperæsthesia of the leg of the same side. Subsequent section of the opposite side of the dorsal cord leads to a reversal of these sensory disturbances. If the internal capsule on one side is cut, followed by section of the opposite side of the dorsal cord, the

result is the same as in last experiment. Section of the right cerebral peduncle produces paralysis of the left side. Section of the right half of the medulla, above the crossing of the pyramids, transfers the paralysis to the opposite side. In the frog, section of the left cerebral hemisphere produces loss of power on the right side and increased force on the left. Subsequent section of the right cerebral hemisphere restores the equilibrium. Evidence of the same kind is adduced with regard to body temperature.

7. Researches into the two Fundamental Principles of the doctrines received with regard to Cerebral Duality in voluntary movements. Brown-Séquard (*C. R. Acad. Sci., Nov.* 7, 1887).

Section of right anterior pyramid, and then stimulation of its fibres, is almost always followed by movement of the right leg. The same movement results if the stimulation is at the level of the decussation. Conclusion, that each motor region acts on both sides of the body, and that each half of the base of the brain conducts fibres from both motor zones.

Cerebral Physiology.

8. The Brain and Cerebral Activity from the Psycho-physiological point of view. Herzen (*Paris, J. B. Baillière,* 1887).

A popular explanation of recent advances in psycho-physics. Starts with the proposition, that thought necessitates chemical action (metabolism) of brain tissue, and that therefore it is a form of motion comparable to muscular action. Infers that every psychic act is a transmission or modification of an external impulse. Illustrates the proposition by experiment. Explains "reaction time." Shows that it is longer with children than with adult, with boys than with girls, but after adolescence less in men than in women. External exhibition of cerebral activity in increased temperature. Latter part of the book deals with philosophical deductions. Discusses the question of free-will and consciousness, and shows the limits within which they are reconcilable with the mechanical definition of thought as a redirected sensory impulse.

9. Physiological Psychology. Sergi, trans. from Italian into French by Mouton, revised by the Author (*Paris, Alcan,* 1888).

10. The Motor Functions of the Brain and Cerebral Epilepsy. Franck (*Paris*, 1887, 8vo. 571 pp.).

11. The Time it takes to Think. J. McK. Cattell (*Nineteenth Century*, *Nov.* 1887).

A popular exposition of the objects and possibilities of time measurements as applied to psychic actions.

Reflex Action—Knee-jerk.

12. The Variations of the Normal Knee-jerk, and their relation to the Activity of the Central Nervous System. Lombard (*American Journal of Psychology*, vol. i. No. 1, pp. 5–71, *Nov.* 1887).

A series of experiments made under favourable conditions as to position of the body and regulation of the force and place of incidence of the blow. Knee-jerk shown to be exceedingly susceptible to alteration in force under the influence of external conditions. Depressed by hunger, fatigue, enervating weather and sleep. Reinforced by any condition which increases the activity of the central nervous system, by irritation of the skin, voluntary action, exciting the attention, music, dreams, &c.

Reflex Action—Respiration.

13. Respiration Centre in Medulla Oblongata and the Conditions of its action. Loewy (*Berliner Phys. Gesellsch. Archiv f. Anat. u. Phys.* 1887, Hft. v.).

14. Respiratory Reflex from the Nasal Mucous Membrane. Sandmann (*Berliner Phys. Gesellsch. Arch. f. Anat. u. Phys.* 1887, Hft. v.).

Cortex Anatomy.

15. Morphology of the Island of Reil. Guldberg (*Anat. Anzeiger* ii. 21, *Oct.* 1887).

The island of Reil appears on the outer surface of the lateral ventricle, as an elevation at the bottom of a slight hollowing, at the third month, after the olfactory bulb has made its appearance as a button-like out-growth. Paper contains, in addition to account of development, an account of the form assumed by the island in such mammals as possess it.

Cortex Physiology.

17. Cortex-Field of the Facial, and its Connections in the Dog and Rabbit. Exner and Paneth (*Pflüger's Archiv*, xli. 7 and 8, p. 349, *Nov.* 22, 1887).

Anæsthesia was induced by subcutaneous injection of morphia, followed by intravenous chloral. In one case narcotism was very superficial, and in another case morphia only was used, and yet only crossed action obtained even with the strongest stimulus; same-sided and crossed action at the same time were very rarely obtained. In the dog the area for the facial nerve lies in the gyrus lateral to the sigmoid. It was noticed that stimulation of the dura mater gave rise to a reflex contraction of the orbicularis on the same side. This could be obtained over the whole convexity of the brain, but most easily from the anterior part. The reflex was often induced when breaking the skull. In the rabbit, stimulation of one side of the cortex produced without exception movements of both sides of the face. This was not prevented by section of the corpus callosum, nor by dividing the pons, nor by destroying the opposite cortical centre. Section of the medulla, however, stopped it at once, and it is hence inferred that there is total crossing for the facial nerves in the medulla.

Cortex.

16. The Homology of the Fissura Parieto-occipitalis in Carnivores. Max Flesch (*Leipsic*, 1887, *Engelmann*, 4to, 15 pp., 1 *plate*).

18. Physiology of the Brain. Munk (*Real-encyc. der ges. Heilkunde*).

Contains an account of the physiology of the cortex, expressed in terms consonant with the author's well-known views, and also an account of the bibliography of the subject.

19. Further Minute Analysis by Electric Stimulation of the so-called Motor Region of the Cortex Cerebri in the Monkey (*Macacus sinicus*). Charles E. Beevor, and Victor Horsley (*Proceedings of the Royal Society*, xliii., No. 258, *issued Oct.* 1887).

This paper, being but a brief abstract of one about to appear in the Transactions, can hardly be further analysed for this index.

The region investigated comprised the gyrus coursing in front of the precentral sulcus for its whole length; the posterior third of the middle frontal convolution; the posterior half of the superior frontal; upper end of the ascending frontal; and the whole of the ascending parietal, except the lower half of its anterior border. Head and eyes are turned to the opposite side on stimulating within the broad zone in front of precentral sulcus, and including the posterior half of the middle and superior frontal convolutions as far as the margin of the hemisphere. Lower limb region includes the posterior fifth of the superior frontal, upper third of the ascending frontal, and the upper third of the ascending parietal. Upper limb region includes the middle of the ascending frontal, reaching into the middle frontal and extending upwards slightly into the superior frontal, and backwards over the lower two-thirds of the ascending parietal as far as the intra-parietal sulcus. An account of the "march," &c., will appear in the full paper.

Corpus Callosum.

20. Absence of the Corpus Callosum in the Human Brain (*continued*). Kaufmann (*Arch. f. Psychiatrie*, xix. 1, p. 229, *plate* 2, 1887).

Further details with regard to case already reported (cf. this index for last quarter). Conclusion that the tapetum, which always up to this time has been considered a part of the corpus callosum, has nothing to do with it, but belongs in reality to the superior longitudinal fasciculus. This case is regarded as one in which the corpus callosum has never commenced to develop owing to hydrocephalus internus. Second case in which the corpus callosum was totally destroyed by an embolism originating in an aneurism of the arteria corporis callosi dextra. Subject was a man 45 years old. There were no opportunities of examining the patient's condition before death. As in the first case the internal capsule revealed no traces of change, even to microscopic examination, as the result of the total destruction of the corpus callosum.

Optic Thalamus and Corpus Striatum.

21. The Four Cerebral Heat Centres. Izaac Ott and William S. Carter (*Therapeutic Gazette, Sept.* 15, 1887).

The skull being trephined, a fine instrument was passed through

the brain tissue to the region, puncture of which was desired. The wound was washed out with corrosive sublimate and closed with sutures, the animal being then allowed to run about. Injury to various regions about the optic thalami and corpora striata, but particularly, (1) in front of and beneath the corpus striatum, (2) the parts on the median side of the nodus cursorius, (3) the parts about Schiff's crying centre, (4) the anterior end of the optic thalamus, are followed by a rise in temperature lasting for several days, and not accompanied by increase in respiration, pulse-rate, or blood pressure.

Optic Thalami.

23. The Significance of the Optic Thalami as deduced from Experimental and Pathological Data. Bechterew (*Virchow's Archiv*, vol. 110, part 1, pp. 102–154, *Oct.* 3; *continued in* part 2, pp. 322–366, *Nov.* 1887).

Critical summary. General conclusion, that the optic thalami have a prominent rôle in the reception of sensory impressions, and are the seats of complex reflex actions.

22. The Minute Structure of the Corpus Striatum and Optic Thalamus. Marchi (*Rivista speriment. di Freniatr., etc.*, 1887, xii., p. 285).

The nerve cells in these organs are scattered throughout the ground substance and not grouped, nor are their long axes arranged in any particular direction. In the nucleus caudatus they have a size of 15–20 μ. In the nucleus lenticularis, 30–50 μ. In the thalamus they are somewhat larger. All the cells have a single nerve process and numerous protoplasmic processes. The nerve process either passes into a medullated nerve, or loses its individuality and breaks up into a plexus; the first type is more common in the optic thalamus, the second in the corpus striatum. Fibres from crus cerebri and from corona radiata go into both ganglia. These results are obtained with Golgi's method (bichromate of potassium and nitrate of silver).

Pineal Gland.

24. Structure of the Pineal Gland. Cionini (*Riv. speriment. di Freniatr. e di Med. leg.*, 1887, xii., p. 364).

The author is unable to find any nervous structure in this body with the exception of its vaso-motor nerves.

Cerebellum.

25. The Nucleus Dentatus of the Cerebellum. Sacozzi (*Rivist. speriment. di Freniatr.*, &c., 1887, xiii., p. 93).

The development of this nucleus increases as we ascend the mammalian scale, it being much more important in man than in animals. Using Golgi's method, the author finds in it cells belonging to each of Golgi's two types, "motor" and "sensory."

26. The Cerebellum of the Frog. Wlassak (*Archiv f. Anat. u. Phys.-Physiol. Abth.* 1887, Supplement, *Dec.* 8).

Brain hardened in sublimate solution, or bichromate of potassium and sulphate of copper. Series of sections made either in paraffin or between layers of celloidin, stained with Weigert's hæmatoxylin or with Gaule's method. Author claims to be able to trace into cerebellum the several sets of fibres which connect it with the rest of the cerebro-spinal axis. (1) Posterior-column fibres without crossing to upper part. (2) Lateral-column fibres, partly crossed and partly uncrossed. Uncrossed to under part, crossed to middle part. (3) Fibres from optic lobes for the most part cross over to opposite side of middle part; a few go to deepest layer of same side. (4) Crossed (outer) arcuate fibres to the middle part of opposite side. (5) Direct (inner) arcuate fibres with posterior column fibres on same side. (6) Fibres from pars peduncularis of optic lobes to deepest part of opposite side. (7) Commissural fibres with the posterior column fibres, uncrossed.

Histologically, the nuclei of the nuclear layer are identical with those of the medullary sheath. The nuclear layer arranges for its breaking up. The axis-cylinder of the nerve goes to a basal process of a Purkinje cell. The medullary sheath forms its capsule. Both are continued into the molecular layer by the branching processes of the Purkinje cell. There is, in the frog, no limitans interna. Confirms Beevor in all points, but unable to recognise any connections of branching processes of Purkinje cells, or arrangement of nerve fibres indicative of a centripetal connection.

Cranial Nerves—Facial.

28. The Nuclear Origin of the Orbito-Facial. Mendel (*Neur. Centralbl.* No. 23, *Dec.* 1, 1887).

Both in cases of cerebral apoplexy, and also in bulbar-paralysis, the orbicularis palpebrarum commonly escapes, while the other

muscles innervated by the facial nerves are paralysed. It is usually stated that the cortical centre for the former muscle lies in the inferior parietal lobule, while the centres for the other muscles are situated in the inferior third of the ascending frontal. Author makes use of Gudden's method. Concludes that in rabbits and guinea-pigs, the orbito-facial has its nuclear origin in the hinder part of the centre for the oculomotorius, which probably also innervates the levator palpebræ superioris.

Cranial Nerves—Third, &c.

27. The Crossed Relation beween the Central Origins of the Eye-Muscle-Nerves. Nussbaum (*Wiener Med. Jahrb.* 1887. II.).

29. Facial Nerve in the Domestic Cat. T. B. Stowell (*Proc. American Phil. Soc.*, xxiv. p. 8, 1887).

Cranial Nerves—Vagus.

30. On the Physiology of the Heart of the Snake. Mills (*Jour. Anat. and Phys.*, vol. xxii. pt. 1, *Oct.* 1887).

In the snake both vagi are effective—stimulation leads afterwards to increased force and frequency of beat, or to the former only, and according to the law of inverse proportion previously announced by the writer. During vagus-arrest the sinus and auricles are inexcitable.

31. Action of the Vagus upon the left side of the Heart. Pawlow (*Archiv f. Anat. u. Phys. Phys. Abth.* 1887, Part 5, Dec. 8).

Cranial Nerves—Spinal Accessory.

32. Origin and Central Course of Nervus Accessorius Willisii. Dees (*Allg. Zeitschr. f. Psychiatrie*, xliii. p. 453, 1887).

Studied by means of a series of sections in human embryo, and also in two rabbits in which the nerve was cut six weeks before death. The nerve in its central course can be recognised by the great size of its fibres (15 μ.). Absence of the nerve fibres was associated with the absence of segmental groups of large multipolar nerve cells (30 to 40 μ.). The cells lie in the medulla in the midst of the anterior horn, and incline outwards as the group descends the cervical cord. At C. 4. they lie on the side of the

anterior horn, at C. 6. at the base of the lateral horn. Above, they shade off into the vagus nucleus.

Nerve Endings.

33. Changes in Nerve Endings during Inflammation. Grossmann (*Mitth. aus dem Embryol. Inst. Wien. Nov.* 1887).

Experiments carried out on the thick skin of the duck's beak, which, as is well known, is very rich in Herbst and Grandry corpuscles, and Merkel's touch-cells. Inflammation was induced by mechanical destruction of the skin. Consequent changes consisted, for the most part, in transudation between the nerve endings and surrounding tissues, followed by various minute alterations.

34. Motor Nerve-endings as seen in Cross-section and in Section-series. Kühne (*Verhandl. des Natur. med. Vereins zu Heidelberg*, vol. iv. p. 1, 1887).

35. The Nerve-endings in the Electric Organ (second article), Krause (*Internat. Monatschrift f. Anat. und Phys.*, vol. iv. 1887).

Continuation of memoir published in the same Journal, vol. iii. p. 385, 1886.

Animals examined—Torpedo ocellata, and also for pseudo-electric organ, Raja asterias and other Selachians. As is well known, the electric organ arises from the modified striated musculus constrictor arcuum branchialum superficialis. The paper deals more especially with the minute structure and development of the curved fibres (bogen-fasern). A trace of cross-striation is recognised in them. In the smallest embryos they are merely granular; later on, they exhibit a fine cross striation and also longitudinal fibrillation. Differentiation between nerve fibre and muscle fibre then appears. Ventral half of fibre outgrows dorsal; becomes multinucleated, and expands transversely into a plate; the nerve fibre which enters it ventrally is carried to one side. It is possible to follow the development of the arched fibres from the striated muscle fibrillæ to the complete electric lamellæ of the adult animal.

Degeneration.

36. Secondary Degeneration of the Crus Cerebri. Bechterew (*Arch. f. Psychiatrie*, xix. 1. 1887).

Records the symptoms during life and autopsies of three cases. Among other points of interest the first case exhibited atrophy of the substantia nigra Soemmeringii, which the author associates with atrophy of the corpus striatum. In the third case there was hypertrophy of the substantia nigra, and an unusual development of the corpus striatum.

Regeneration.

37. Lectures on Injuries of the Nerves: delivered at the Roy. Coll. of Surgeons. Bowlby (*The Lancet*, 1887, vol. i. pp. 863, 921, 968, 1021, 1121; vol. ii. p. 53, 99).

Nerve Conduction.

38. Conduction by Nerves in both Directions. Kochs (*Biol. Centralbl., Nov.* 1, 1887).

Criticism of the results said to be obtained by Paul Bert, by grafting the tip of rat's tail into the cellular tissue of its own back. It was stated by Bert that the abnormal tail acquired sensation in the course of some months. Kochs has repeated this experiment upon forty rats, in thirty cases with satisfactory healing and adhesion of the new tail. In no case, however, was there a return of sensation during the eight months that some of the animals were under observation.

Nerve Muscle Physiology.

39. The Stimulus Action of Stöhrer's Machine. Grützner (*Pflüger's Archiv*, xli. 6, *Oct.* 17, 1887).

40. Chemical Nerve-Stimulation and Action of Salts. Lomburg (*Pflüger's Archiv*, xli. 7 and 8, *Nov.* 22, 1887).

41. The Tiring of Nerves. Herzen (*Arch. des Sciences phys. et natur.* 1887, *Sept.*).

Finds that, contrary to usual belief, when a muscle has been tetanised for a long time until it no longer reacts, the nerve-endings are functional, although the nerve trunk is tired out.

Sympathetic System.

42. The Central Course of Vaso-motor Nerve-paths. Helweg (*Archiv f. Psychiatrie*, xix. 1, pp. 104–182, 1887).

Studying sections of the cords of lunatics, the author believes he has discovered in the upper part of the cord a triangular tract which is very probably vaso-motor. The triangle lies just at the junction of anterior and lateral columns, with its base on the periphery and the apex reaching half-way to the anterior horn. It stains strongly with carmine. The fibres are exceedingly slender (1·5 to 2 μ.), with the exception of a few scattered large ones. The author traces the triangular tract upwards through the lateral region of the medulla, the "oval" tract of the tegment, the superior olive, the fillet, &c.

43. Action of the Excised Mammalian Heart. Waller and Reid (*Phil. Trans. Royal Society*, 178, pp. 215–256; *issued Oct.* 8, 1887. *Read Dec.* 16, 1886).

Minute analysis of the alteration in form and electro-motor changes in the excised mammalian heart, and comparison of these phenomena with those hitherto obtained for the frog's heart. Spontaneous beats were observed for a much longer period than usually supposed—in the rabbit's heart as long as seventy-two minutes after excision. Owing to the enormous retardation in the action, an analysis of the phases of contraction, impossible in the heart *in situ*, can be made after it is exposed. Conclusion, that the irregularity in the sequence of changes in the contracting mammalian heart, as compared with the heart of the frog, can only be explained by supposing that, in the former case, conduction occurs along intermuscular nervous channels, in the latter case along muscular channels. With regard to the electro-motor phenomena, for example, it was found that there was not an invariable diphasic variation as in the frog's heart, but that the movements of galvanometer and electrometer indicate a monophasic variation, negativity predominating either at the apex or the base. A monophasic variation shows a simultaneity of action, which is difficult to understand apart from nervous conduction and co-ordination.

44. The Innervation of Blood-vessels. Pietrowski (*Centralbl. f. Physiologie*, 1887, p. 454, *Dec.* 10).

Experiments upon the antagonistic effects, upon the vessels of the tongue, of stimulation of the hypoglossal and lingual nerves. Determination of influence of temperature upon the contracting action of former nerve and dilating action of the latter.

45. Action of Sympathetic on Bird's Pupil. JEGOROW (*Pflüger's Archiv*, xli. 7 and 8, p. 326, *Nov.* 22, 1887—*plate* v., *showing dissection*).

In birds, stimulation of the region in which the first cervical ganglion lies, even after death, is followed by alterations in the pupil. Stimulating soon after death, or nearer to the beak, causes contraction. Stimulating some time after death, or on the side away from the beak, causes dilation. Seeing, however, that direct stimulation of the region, or stimulation of the region after the first cervical ganglion has been taken away, produces the same effect, it is clear that the sympathetic system has nothing to do with it. No effect can be obtained after the fifth nerve has been cut at its exit from the temporal bone.

Physiologically, the cervical sympathetic of birds differs altogether from that of mammals, inasmuch as it does not determine dilation of the pupil. The form of the inter-transverse canal varies very much among birds. In the hen it is well closed. In the turkey it consists only of rings.

The sympathetic in birds has nothing to do with movements of the iris, but contains vasomotor fibres for the skin of the neck and head, the conjunctiva and eyeball.

46. On the Action of Muscarin upon the Heart, and on the Electrical Changes in the Non-beating Cardiac Muscle brought about by stimulation of the Inhibitory and Augmentor Nerves. W. H. GASKELL (*Journal of Physiology*, vol. viii. No. 6, p. 404, Dec. 1887).

Introduces a new method into the study of the physiology of the heart, and particularly the study of the action of poisons upon that organ. The author had already found that, if in making a first Stannius section the coronary nerve was left uninjured, stimulation of the vagus nerve during the period of quiescence, although it produced no visible effect, was yet acting upon the heart, for it affected the character of the contractions of the auricle when it again began to beat. He investigates the electric condition of the quiescent auricle, and finds that stimulation of the vagus is accompanied by an electrical change of an opposite sign to that which accompanies contraction. Muscarin is supposed to stop the heart by stimulating the vagus endings, but Gaskell finds that muscarin does not produce this electric change. After muscarin has brought the heart to a standstill stimulating the

vagus produces the electric change already noticed, even when a mechanical or chemical stimulus is used. Muscarin therefore depresses the motor activity of the heart. The augmentor (sympathetic) nerves produce an electrical change of the same sign as that which accompanies contraction. The two nerves therefore, when unable to show their action upon the heart by changing its form, still produce opposite electrical changes.

Histology.

47. Nervi Nervorum Periphericorum. Prus (*Archives Slaves de Biologie*, iv., 2 *Sept.* 1887).

Ehrlich discovered that methylene blue, injected into the veins of a living animal, has a great affinity for fine non-medullated nerves, colouring the terminations of such sensory nerves as the gustatory and olfactory; also the nerves of plain and cardiac muscle fibres. The author finds that, when he makes use of this method, filaments appear in the sheaths of nerve trunks, taking an oblique or transverse course with regard to the fibres contained in the nerve. He supposes that the presence of these nervi nervorum accounts for the spots of local tenderness in the course of nerve trunks in neuralgia.

48. Structure of Nerve Fibres. Schiefferdecker (*Archiv f. Mikrosc. Anat.* xxx. 3, pp. 435-494, 1887, *Oct.* 1).

Boveri having suggested classification of nerves into, (1) *segmented* peripheral medullated, and (2) *unsegmented* peripheral non-medullated and central medullated nerves, Schiefferdecker directs attention to this point, and finds distinction does not hold. Old classification into, (1) medullated, (2) non-medullated. Discovery that axis cylinder is surrounded by an exceedingly delicate elastic "rind." Conclusion, that all medullated nerves, whether central or peripheral, exhibit Lantermann's and Ranvier's segmentation in the living fibre; watery coagulable substance between segments; reagents penetrate between segments; myelin sheath has no proper nuclei; all central fibres supported by glia substance; white peripheral fibres have connective tissue investment of Schwann's sheath, which has its own nuclei and does not vary in thickness at Ranvier's nodes; axis cylinder is uniform in thickness, and not segmented; within its elastic sheath ("rind") is contained very fluid watery albumen, in which it is possible but not probable that fibrillæ lie; when coagulated it shrinks away from

the medulla; the periaxial space being filled with lymph, a coagulum layer (gerinnselscheide) breaks off the axis cylinder; Fromann's lines lie in this coagulum layer; it has nothing to do with the axis cylinder rind. Weigert's hæmatoxylin stains different elements according to the chromium salt used in hardening.

Histogenesis.

49. Cell Division in the Central Nervous System. Merk (*Denkschriften der Math. Naturw. Classe der K. Acad. in Wien*, liii. *Also separate Publ. Karl Gerold's Son*, 1887).

After proper preparation, it is easy to recognise in what part of the embryonic nervous system cell-division is occurring by the presence of karyokinetic nuclear figures. Author investigates various parts of nervous system during their development in all classes of vertebrates. For the spinal cord nuclear figures are most commonly recognizable in the lining epithelium, to which cell-division appears to be more or less restricted.

Brain-Weight.

50. Gambetta's Brain. Rüdinger (*Sitz. der K. B. Akad. zu München*, 1887, p. 69).

At the time of Gambetta's death, it went the round of the newspapers that his brain was phenomenally small, 1100 grammes. This is shown to be quite a mistake, Duval's estimate of 1241 grammes being confirmed. It is stated that the third left frontal convolution exhibited an unusual development.

Circulation.

51. Circulation in the Brain. Gärtner & Wagner (*Medic. Wochenschrift*, 1887, parts 19 and 20).

Experiments on curarised dog. Sinus transversus was placed in connection with the vena facialis postica. Quantity of outflowing blood was measured by Ludwig's kymograph. When the blood-pressure was raised by compressing the aorta there was a corresponding increase in the venous blood flowing from the brain. When the vena cava was compressed, the reverse effect was produced. Raising the blood-pressure by asphyxia, strychnia, stimulating a sensory nerve, and other methods, always increases the outflow of blood from the brain. Chloroform dilates the blood-vessels, but the accompanying fall in blood-pressure may

reduce the outflow to zero. Morphia has no action. Amyl nitrite dilates the blood-vessels. The onset of an epileptic attack is marked by a great acceleration of the cerebral circulation.

LITERATURE.

52. Supplement to the Account of Acquisitions to the Anatomy of the Central Nervous System. EDINGER (*Schmidt's Jahrb. der Ges. Med.* vol. ccxv., 115).

The Metamerism of the Head and the Vertebrate Theory of the Skull.—C. GEGENBAUR (*Morphologisches Jahrbuch*, vol. xiii., part i., pp. 1–114, Nov. 1887).

In the index of papers published during the last quarter will be found the title of this most important article by Gegenbaur, which appears in the current number of the *Morphologisches Jahrbuch*. It was impossible to include amongst the Abstracts an outline of this article, for dealing as it does with one of the most abstruse problems in morphology, and attacking this problem from its most technical side, it is one long closely-reasoned argument. The subject, however, is of great importance to the neurologist; for no one can hope to understand the constitution of the central nervous system without taking its metamerism into account; and although it is impossible to give an abstract of Gegenbaur's paper, for it does not contain a word which could be left out without detracting from the lucidity and force of the argument, it may be possible, from the great quantity of material which is here collected, to construct a less technical account, which will convey to the reader, who is not by profession a morphologist, an idea of the present position of the subject.

It will be remembered that it was Goethe who recognised, with the instinct of a great poet for nature's harmonies, that the elements used in the construction of the skull are the same which in the trunk enter into the formation of the vertebral column. In Oken's hands, the theory received a scientific form. Huxley, by his researches into the minutely discrete elements of the skull of the bony fishes, carried the problem as far as it was possible to carry it by an examination of the hard parts of the head. It was a question, up to this time, of the homology of the skull with the vertebral column.

With the publication of Gegenbaur's researches into the arrangement of the nerves of the head in Hexanchus, the question enters upon a new and greatly extended phase; for Gegenbaur shows that

it is not merely a matter affecting the bony elements of the skull, but a question as to the segmentation of the whole head, which can be best studied in cartilaginous fishes, more especially with regard to the arrangement of the cranial nerves. This is the form in which the problem has for nearly twenty years occupied the attention and tested the ingenuity of morphologists. There can be no doubt that the vertebrate head, complex and heterogeneous as it now is, has been gradually evolved from the anterior end of the body of an animal consisting of similar segments. The elements which enter into its formation can be classified, according to their function, in each single simple segment or metamer of the body of the vertebrate ancestor. The problems to be solved are, (1) the fundamental constitution of a metamer; (2) the number of such metamers entering into the formation of the head. The solutions of these problems are to be found in the arrangement of the elements of the head in the lowest vertebrates, and in the embryos of those higher in the scale. In studying the former, allowance must be made for digression from the primitive type; in the latter, for abbreviation of ancestral history. In both directions a vast amount of work has been done, and naturally the views of those most interested in the problem have become, with increased knowledge and thought, further and further elaborated, difficult to explain and difficult to reconcile.

In this masterly paper Gegenbaur does not attempt to add anything to our knowledge, but, to use a commercial phrase, takes stock of the additions and inferences of recent years, and subjects them to a searching criticism. Many a piece of fine-spun inference is, to our thinking, crushed by his titanic blows, and little more than the framework of the theory escapes annihilation.

For a long time the tendency has been to increase the number of metamers fused in the head. From the four vertebræ at one time supposed to enter into the constitution of the skull, the number of head-segments has been increased to nine or even more, and this because morphologists have formed a conception of each segment as consisting of a dorsal portion or somite, including a piece of the bas-cranial axis and brain case, with its musculature and nerve; and a ventral portion depending from this as a hoop of bone or cartilage, with its muscles and nerves. Between each two visceral arches is a cleft, the visceral (or gill) cleft, and at the upper end of the cleft, perhaps formed from it, a sense organ with its nerve. All the visceral arches supplied by cranial nerves are included in the head, and regarded as pre-

supposing segments of its dorsal part. The face in front of the mouth is also supposed to be formed of visceral arches, which again pre-suppose a segmentation of the anterior portion of the head. Indeed Dohrn goes so far as to regard the mouth itself as due to the coalescence in the median line of two visceral clefts.

It is against this extreme view that Gegenbaur's criticisms are levelled. If we may reduce his detailed reasoning to general terms, the argument runs thus:—The visceral arches are for the support of the pharynx, the gill clefts for the escape of water entering the mouth; there being no reason to suppose that the mouth has shifted backwards, the presence of visceral arches *in front* of it would be meaningless. Again, while the second somite obviously belongs to the mandible (first visceral arch), and the third somite to the hyoid bone, the fourth somite gives rise to no musculature, and its relation to a visceral arch is uncertain. We have no evidence that the posterior dorsal segments are congruent in their formation with the posterior visceral arches. The number of gill clefts in adult Selachians is subject to variation, and there are other indications of fusion and subsequent redivision, on account of which the visceral arches lose all value in determining the segmentation of the posterior part of the head. In the same way the branches of the vagus nerve which supply them are not primitively independent, but are formed by the splitting of an originally single nerve. Before, however, discussing Gegenbaur's conclusions, it would be well to give an account of that part of the evidence most interesting to neurologists, derived from the disposition of the cranial nerves.

1. *Olfactory.*—Marshall has attempted to bring this into the category of "segmental nerves," and regards the nose as a "gill cleft." In this he is followed by Beard, who, however, considers the nose as not itself a modified gill cleft, but as the sense organ developed in connection with a pre-existing cleft. It will be readily understood from what we have already stated with regard to Gegenbaur's views that he ridicules the gill-cleft idea. He discusses seriatim the reasons adduced in proof of the segmental character of this nerve, and finds that they have none of them anything to do with metamerism.

2. *Optic.*—This nerve hardly comes into the discussion. Gegenbaur regards it as like the olfactory outside the pale of segmental nerves.

3. *Oculomotor.*—This Gegenbaur considers as clearly proved to belong to the first somite, a somite, however, which since it has no

visceral arch is not an independent head segment. Van Wijhe has done important work in showing that the ciliary ganglion is not, as Krause supposed, the ganglion of the third nerve, but belongs to the ramus ophthalmicus profundus (nasal), *plus* a sympathetic ganglion. The ramus ophthalmicus profundus he looks upon, however, as originally an independent nerve and not a branch of the Trigeminus. Gegenbaur cannot regard this as proved.

4. *Trochlearis.*—This is of all nerves the most difficult to account for. In mammals a purely motor nerve, it gives in selachians also a sensory branch. Ontogeny has brought no new facts to light with regard to this nerve. Van Wijhe shows, however, that the muscle which it supplies is developed from the second somite. He concludes, that it is a ventral nerve-root of a segment for which the ramus ophthalmicus profundus is a dorsal root. Considering, however, the peculiarity of its origin, in which respect it has all the characters of a dorsal root, Gegenbaur finds it very difficult to subscribe to Van Wijhe's view.

5. *Trigeminal.*—Marshall and Spencer have shown that the superior maxillary nerve is a branch of the inferior maxillary, just as the upper jaw which it supplies is in origin an outgrowth from the lower. Gegenbaur looks upon the ophthalmic division of the fifth as the ramus dorsalis of this segment. He considers the fifth nerve as a single nerve appertaining to the first complete cranial metamer.

6. *Abducens.*—Its development shows that this nerve belongs to the third somite, to which also the second visceral arch or hyoid bone answers. Connections with other nerves have not been observed, and we find ourselves in the same case as with the oculomotor and trochlearis. It is interesting to notice that, although no one can suppose that it belongs to more than one segment, the sixth nerve arises by several roots, a character which we may hence infer is without metameric significance. Both Marshall and Van Wijhe look upon the abducens as an anterior root of the facial, but its place of origin proves that it and the trochlearis cannot have the same morphological value.

7. *Facial and Auditory.*—There is no doubt about the origin of these two nerves from a primitively single trunk. The double nature of the nerve is however regarded by several anatomists—as Wiedersheim, Van Wijhe, and Beard, as proving the existence of two segments; but all that ontogeny has done is to show that no second ventral branch exists, and that there is consequently no evidence of two ventral metameric portions.

8. *Glosso-pharyngeal.*—This is the only nerve with regard to which there is no controversy. It courses along the arch comprising the hyoid bone. That no ventral root is known for this segment is in accordance with the fact observed by Van Wijhe, that its somite is not developed into muscle.

9. *Vagus.*—While Gegenbaur looks upon this as typically a segmental nerve, he does not consider that we have any evidence as to the relation to the head of the gill arches which it supplies. The study of its development teaches us, that in origin it is a single outgrowth, which only subsequently becomes divided into several roots.

10. *Hypoglossus.*—This nerve Gegenbaur regards as the ventral root or roots of the vagus. He also looks upon the branches, which have been described as ventral roots of the vagus, as belonging to the hypoglossal.

In this Journal it would be perhaps out of place to analyse the evidence brought to bear upon the question from a study of the development and adult constitution of the bones and muscles of the head. Enough has been said to show that this paper is a protest against the treatment of the subject which has recently come into vogue. Gegenbaur considers that it is impossible to reconstruct the head of a series of similar segments composed of parts of equal value. The formation of the visceral arches and the consolidation of the cranium are events belonging to different epochs. Only two segments, the mandibular and hyoid, present an equal development throughout, the rest have undergone fusions and subsequent divisions by which the relation to one another of the somitic or cranial portion and the branchial portion has been permanently dislocated.

The morphological value of the head metamers is not the same for all. The first six are palingenetic; but even of these, four to six are rudimentary in their dorsal sections; seven to nine are cainogenetic; indeed the original head segments have probably fallen away, and their place has been taken by trunk segments. The lower branches of the vagus nerve belong to these secondary segments.

It is very interesting to follow the author of this paper, in his description of the changes by which he imagines the permanent head has been evolved. Amphioxus, he thinks, although not perhaps in the direct vertebrate stem, affords valuable data as to the structure of the animals which preceded the Craniota. It indicates that they possessed more somites and gills, and a more

extended pharynx, than the Craniota. The specialisation and increase in the development of the sense organs led to the formation of a brain. This again necessitated the consolidation and fixation of the anterior end of the body. The result was that of the somatic muscles, only those which found some new work to do —i.e. the movement of the eyes—were any longer of use; the rest disappeared. The head became more compact. The anterior gill arches increased in size; the posterior ones atrophied, and their place was taken by trunk segments. As the eyes grew, the animal became more effective. It adopted a better means of obtaining food, and turned one of its gill-arches into a jaw.

The author does not tabulate his conclusions (a table would have enabled one more quickly to grasp his results), but from what has been already said it will be seen that he arranges the head segments thus:—

The first somite with the oculomotorius and ramus ophthalmicus profundus do not constitute a metamer, since no ventral element belongs to it.

The first metamer comprises the second somite, the jaw, the trochlearis, the inferior maxillary, and its branch, the superior maxillary, to the upper jaw.

The second metamer, the third and part of the fourth somite, the hyoid bone, the abducens and facial and auditory nerves.

The third metamer presents a somite (the fifth), which gives rise to no musculature, and has consequently no nerve; to its visceral arch (the first permanent gill arch) belongs the glossopharyngeal nerve.

Of the remaining metamers, only the first comprises a head-somite (which gives rise to no musculature), the others are defective dorsally. The vagus nerve is common to them all.

As we remarked at the commencement, the paper is one which might be translated with profit, but which will not bear abstracting, and we can only hope that, by attempting to give an outline of its general tenor, we have not distorted its meaning by suppressing the subtleties and qualifications inherent to the subject.

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