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A RECONSTRUCTION COURSE IN THE FUNCTIONAL ANATOMY OF THE NERVOUS SYSTEM *

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The method to be described has been gradually adapted to the needs and demands of physicians and medical students alike, both groping for a clearer and more plastic conception of the nervous system. The underlying principles have been embodied in a course in neuro-anatomy which translates all facts into three dimensions and so incorporates ontogenetic and phylogenetic studies as to help the worker mold his data in a perspective which is thoroughly dynamic. The result is a sound, practical and tangible working basis for the application of the facts as they are experienced.

Since 1893, when Prof. Donaldson granted him the privilege of conducting an elective course in the comparative anatomy of the nervous system at the University of Chicago, and two years later also the regular course in brain anatomy at that institution, Dr. Meyer has had the opportunity from time to time of giving students of greatly varied preparation a review of the essentials and methods of study of the nervous system. The first printed statement appeared in 1898 as part of a review¹ of the neuron doctrine. In it Dr. Meyer presented his plan of the nervous system, which was the outgrowth of his first researches on the forebrain of reptiles and his study of the work of the great English neurologist, Hughlings Jackson, who, in the formulation of his three-level theory, shaped a new and bigger perspective for the neurologist's needs.

Dr. Meyer's duties at the New York Institute forced him to formulate a course for State Hospital physicians, in which an attempt was made to embrace the method of glass-plate reconstructions and the use of plasteline, so as to render the facts convertible into three dimensions,

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1. Meyer, Adolf: Critical Review of the Data and General Methods and Deductions of Modern Neurology, *J. Comp. Neurol.* 8:3-4, 1898.

thereby insuring the acquisition of data in a controllable form. In the meantime, Dr. Oliver Strong used these conceptions in his courses laid down in Bailey's "Text-Book of Histology." Finally, at the Johns Hopkins Medical School, the opportunity presented itself of reaching medical students and graduate workers who were willing to lay their anatomic foundations in this way. During this last year two groups, one of fifty second-year and another of sixty-three first-year students, called for this elective work, and, with the collaboration of Dr. Louis Hausman, the course was given the form we wish to sketch here. Each student made a model—the only way to offer a basis of discussion of difficulties or errors. Each course covered two forenoons a week for a trimester, with one-half to one hour devoted to conjoint discussion and demonstration and the rest to individual work on the models and drawings.

The underlying pedagogic principle is not to allow the worker to think of, talk of or work with, anything that is not clearly established and connected in his own experience. It embraces the data and methods of comparative anatomy, embryology, physiology and experimental and pathologic anatomy. It utilizes nature's experiments in the study of the secondary and experimental degenerations, culminating in a conception of the integration of the nervous system, which, at all times, is readily adaptable to the needs of any situation. By getting away from a burdensome terminology and from endless detail, and by teaching him to work unyieldingly with the facts he can grasp and put together into a practical whole, the student is emancipated from the chaotic and bewildering task usually forced on him, as he is required to combine and survive the diverse teachings of the different courses in his training.

An element of pedagogic philosophy underlies the principle. At no time is the student permitted to lose the view of the whole living biologic organism. Facts and functions must be the issue of the course, not words. Books and written instructions are avoided. Actual material of embryology and comparative neurology furnish all the schemata that are needed; all other schemata are taboo. We begin at once with the individual as we see him and review from head to foot the anatomic parts, as they have to work together in groups; thus is embraced a rational system of segmental or reflex units which the nervous system has to integrate into a personality.

The body is readily viewed as a series of transverse body-segments, held together by a neural tube and ganglion chain, with the following longitudinal arrangement: (1) ventrally the motor-plate, (2) dorso-laterally the receptor-plate, and (3) most dorsally—the roof structures furnishing the later acquisitions. Thus we find a reasonably correct

and simple scheme of transverse and longitudinal groupings, forming a division of the nervous system into two essential mechanisms: segmental and suprasegmental; the former with its intrasegmental and intersegmental components constitute the basis for all reflex activity, whereas the latter, being a later and more specialized development of the intersegmental provisions, meets the needs of economy by centralizing the equilibratory (both static and kinetic) and affective functions, and also the psychobiologic functions, that is, the working together of our cognitive and intellectual resources and the activities largely of the striped muscle system—the whole making up the personality.

By keeping before our eyes the segments of the body and the transverse and longitudinal subdivisions of the neural tube, we obtain an easily remembered rack on which to hang all other data (Fig. 1).

We first consider the divisions of the neural tube and ganglions in the His-models (Fig. 4) and observe the enlargements and transverse constrictions of the tube, giving us the cord, the HB (hindbrain), MB (midbrain) and FB (forebrain). Similarly we recognize in a longitudinal plane (Figs. 2 and 3):

1. The motor or effector plate with its roots, extending to the cephalic end of the MB.
2. The receptor plate and its roots.
3. The dorsal structures, developing the roof membranes and suprasegmental mechanisms.

Then, turning to the body, we group the muscles and viscera and the sense organs into segments (Fig. 1):

1. The olfactory apparatus.
2. The eye socket and its contents.
3. The jaws forming the mastication and gasserian segment, with its peripheral and central distributions.
4. The ear with its vestibular and cochlear apparatus and the intermediate-facial-abducens group.
5. The taste, deglutition, articulation and thoracic and abdominal visceral segment.

6. The cervical, thoracic, lumbar, sacral and coccygeal segments.

Having recognized these divisions of the body and neural tube, the next logical step is to correlate them (Fig. 1): The olfactory and optic mechanisms form the foundation of the forebrain and midbrain; the isthmus corresponds in the face to the lower orbital edge, marking roughly the limit between the midbrain and hindbrain; the mastication and the auditory-facial-abducens and the taste-deglutition-respiration-articulation segments, respectively, form the anterior, middle and pos-

Fig. 1.—*Correlation of Segments.* The motor nuclei and efferent nerves are in solid black; the receptor nuclei are dotted and the afferent nerves outlined. *A*, the segments as they can be read off from the body. *B*, median sagittal section of an adult brain with the nuclei of the midbrain and hindbrain represented on one plane. *C*, left lateral view of the brain of a human embryo about 5 weeks old (13.6 mm.). after a His model. The segmental arrangement is very apparent. The motor and receptor plates are well defined and separated by a slight groove in the hindbrain. The motor plate mesially presents the oculomotor nerve in the midbrain—the trochlear nerve appearing dorsally after decussating in the roof, the abducens in the middle hindbrain and the hypoglossal in the posterior hindbrain segment; laterally the trigeminal in the anterior hindbrain, the facial in the middle hindbrain and the glossopharyngeal, vagus and spinal accessory roots in the posterior hindbrain. In the receptor plate

are seen the afferent roots of the trigeminal in the anterior hindbrain; the nervus intermedius (or the afferent fibers of the facial nerve) and the vestibular and cochlear nerves in the middle hindbrain, and the afferent fibers of the glossopharyngeal and vagus nerves in the posterior hindbrain. *D*, brain of human embryo (10.2 mm.) after a His model. The segmentation is even more clearly defined than in *C*, due to the fewer bendings of the neural tube. *E*, primitive neural tube opened up and spread out on one plane. Situated mesially in the motor plate from above down are the oculomotor, trochlear, abducens, and hypoglossal cell clusters or nuclei; laterally, the trigeminal or mastication, facial and ambiguous nuclei. The receptor plate presents the trigeminal complex, the tractus solitarius with its nucleus, and the vestibular cell-mass.

terior hindbrain segments and the foundation for the cerebellar apparatus; the cord segments are clearly marked by roots and intercostal and equivalent subdivisions of the body (Fig. 3).

This correlation is further enhanced and simplified if we study the neural tube from the inside out, that is, from the ventricle outward. Thus we are readily enabled to establish a direct relation between the

Fig. 2.—Median section through embryo human brain. (After a His model.)

neural tube and what we see in every living patient—a relation to muscle groups and viscera and sense organs and sensory surfaces. Each segment of muscles and glands has its efferent or effector provisions which are played on by definite afferent elements, connected with segmentally arranged sense organs; these effector and receptor ele-

Fig. 3.—Scheme of primitive neural tube opened up, with the various parts represented on one plane.

Fig. 4.—Brain of a human embryo 5 weeks old (13.6 mm). (After a His model.)

ments, which the neural tube presents, are in turn coordinated by intra-segmental and intersegmental components, the ultimate integration of these various parts being achieved by the suprasegmental cerebellar and cerebral mechanisms. Whatever is added to the simple segmental stage grows on the outside (Fig. 5). That is why we begin with the simple neural tube and work from the ventricle outward, instead of beginning with the "pons" and other late surface additions and working backward; the former approach is simpler and more logical. Therefore we start with the segmental parts. The open tube (Fig. 3) gives the fundamental scheme.

We resolve the tube into its various elemental mechanisms by experimental analysis and to that purpose employ the Gudden, Nissl and Wallerian types of degeneration of the peripheral or root elements to establish the actual segmental mechanisms. Further analysis identifies the ground bundles and reticular substance of the tube as the inter-segmental elements. The dorsal excrescences or terminal bulgings of the tube form the suprasegmental organs: (*a*) the cerebellar organ; (*b*) the midbrain roof organs, and (*c*) the forebrain.

Extirpation of a suprasegmental organ singles out in each segment (*a*) the cells of the suprasegmental afferent neurons by the axonal reaction and atrophy, and (*b*) the suprasegmental efferent fibers by outgoing degeneration. These experimental principles are always kept in view, since they give us the objective definition of what we work with. For the reconstruction of the segmental apparatus the reader should consult Figures 6 to 9, inclusive.

SUPRASEGMENTAL ORGANS

As we ascend the vertebrate scale, we find that the pattern of the neural tube becomes more and more differentiated; the nervous architecture takes on various designs; we note that the differentiation runs parallel with the behavior resources of the organism as we get further away from the simple reflex type of the more or less segmental animal.

In the process of evolution, economy develops specialized organs, that is, the suprasegmental structure for the centralizing of definite types of function of the segmental animal. The lack of such economy and centralization would provide a system entirely too cumbersome for the needs of man for prompt activity. In the amphioxus, for example, there are, according to Kölliker,² twelve large cells in the cranial part sending fibers to the more caudal segments, and fourteen similar cells in the caudal segments sending their fibers to the cranial part. For the complex correlations in man, innumerable connections of this type

2. Kölliker: *Handbuch der Gewebelehre des Menschen*, 1893.

would be needed between the head, neck, trunk and lumbosacral segments; the tube would be encumbered and the time of interaction too slow. Instead of this pattern, we find added to the simple reflex segmental components, the suprasegmental structures:

1. The cerebellar station with its afferent elements from the segments and efferent paths carrying to these segments the net result of

Fig. 5.—Photograph of a cross-section through the posterior hindbrain segment of an adult brain, showing from within out—the segmental layer with its motor and receptor plates, the cerebellar layer and finally the forebrain layer with its afferent and efferent components. (Weigert stain.)

cerebellar synthesis—that is, the elaboration of all the equilibration and balancing functions of motility.

2. The colliculi, belonging to the midbrain and highly developed in the lower animals, with their afferent and efferent mechanisms.

Fig. 6.—*Dorsal View*. Reconstruction of the segmental plates of the midbrain and hindbrain, viewed from within the hindbrain ventricle, at the base of which the spinal canal is seen opening into it. Note the marked narrowing of the plates toward the cephalic limit of the midbrain and the extent to which the receptor plates overlap the motor. Owing to the marked flare of the receptor plates in the middle hindbrain segment, the ventricle is broadest at that level. Immediately below this flare, on either side, are seen the projections for the attachment of part of the choroid plexus. Reduced from photograph $\times 4.7$.

3. The forebrain apparatus, for the coordination and central elaboration of all the conditions of psychobiologic functions.

Cerebellum.—Embryology shows us how and where to add the cerebellar organ. This suprasegmental structure, developing dorsally over the vestibular and trigeminal segments, consists of a terminal

Fig. 7.—*Ventral View of Figure 6*. The motor and receptor plates, showing the additional reconstruction of the nuclei which appear on the ventral surface of the former. In the mesial part of the midbrain, the motor plate, containing the oculomotor and trochlear nuclei, forms a beak-like projection which gradually disappears in the anterior hindbrain segment. In the lateral part of the motor plate, we recognize, from above down, the trigeminal or mastication nucleus in the anterior hindbrain segment, the facial nucleus in the middle hindbrain segment and the slender ambiguous nucleus for the glossopharyngeal, vagus and accessory nerves in the posterior hindbrain segment. The ventral horns at the base mark the transition of the motor plate of the spinal cord into that of the hindbrain; $\times 2.8$.

Fig. 8.—*Dorsal View.* Reconstruction of the segmental cell groups appearing in the dorsal part of the motor and receptor plates.

The motor plate presents mesially from above down the round abducens nuclei in the middle hindbrain and the slender hypoglossal nuclei occupying the greater part of the posterior hindbrain segment, in the lateral portion of which is seen the dorsal preganglionic sympathetic nucleus, lying adjacent to the receptor plate.

The right receptor plate presents the large vestibular cell-mass in its entire length and the cochlear complex which juts off perpendicularly to allow sufficient space for the restiform body to pass through (Fig. 15).

In the left receptor plate, the caudal portion of the vestibular mass has been cut away to show the course of the elongated tractus solitarius.

The groove in the anterior hindbrain and midbrain segments indicates the path of the mesencephalic root of the trigeminal, which can be seen more clearly in Figure 10.

The descending or spinal root of the trigeminal being situated in the ventral part of the receptor plate adjacent to the motor (Fig. 11) is not seen in this figure; $\times 2.6$.

Fig. 9.—*Ventral View of the Segmental Nerve Roots.* The motor plate presents from above down and in the midline the nerve roots of the oculomotor nerves in the midbrain, the abducens nerves in the middle hindbrain and the numerous hypoglossal filaments in the posterior hindbrain segment, occupying the greater part of its length; laterally appear the trigeminal roots of the mastication nucleus in the anterior hindbrain, the facial roots in the middle hindbrain, and the glossopharyngeal, vagus and accessory fibers in the posterior hindbrain segment. The receptor plates present in the anterior hindbrain the afferent roots of the trigeminal, in the middle hindbrain the nervus intermedius and the vestibular and cochlear nerves, and in the posterior hindbrain segment the afferent components of the glossopharyngeal and vagus nerves.

The trochlear nerve by reason of the unique course it follows in passing through the substance of the segmental plates to decussate dorsally in the anterior medullary velum is not shown in this stage of the reconstruction, but can be seen in Figure 16, emerging beneath the inferior colliculus. $\times 3$.

sheet (of cortex) and central ganglions. The pons mass and the inferior olives, which are so intimately associated with it, have wandered from the lip structure to the ventral side of the motor plate (Fig. 5). Thus we have these parts: arising over the vestibular cell-mass the "inner cerebellar arm" with the roof nucleus (Fig. 10); outside of this fundamental arch the dentate nuclei (Figs. 11 and 12) giving off the superior cerebellar arms, and the intermediate nuclei (globosus and emboliformis) lying between the dentate and inner arm (Figs. 11 and 15); the restiform bodies swinging around the dentates, conveying from the segments the bulk of the afferent fibers to the vermis (Figs. 14 and 16), that is, the cerebellar cortex. This terminal sheet of the cerebellum consists primarily of vermis and flocculus (Fig. 15) and later of the more recently developed cerebellar hemispheres, which are reached by the pons arms; that the latter are the most superficial of the cerebellar peduncles, coincides with the fact that they are the last to develop, their development running parallel with that of the opposite cerebral hemisphere.

This sketch of the cerebellar apparatus gives the rack within which to study the histologic details and the results of genetic and experimental work. The elimination of the cerebellum in the young leads to atrophy of all the cerebellar afferent cells and fibers united in the restiform complex: the Clarke column cells and direct spinocerebellar tract, fibers from the posterior column nuclei, and the fibers from the opposite inferior olive (Figs. 13, 14 and 16). Fibers from the lumbar region form the ventral cerebellar tract swinging around the trigeminal root and thence over the superior cerebellar arm to the vermis (Fig. 16).

The cerebello-segmental impulses have several outlets. One set is affected by the cerebellar cortex activity through the roof nuclei and the inner arm, finally reaching the segments through the vestibulo-ocular or vestibulo-cephalic tract (the mesial longitudinal fasciculus) and the vestibulo-spinal tracts (Figs. 11, 13 and 15). Another outlet is formed by the superior arm to the opposite red nucleus, influencing the segments through the rubrospinal pathway (Figs. 17 and 18), and the cerebral basal and cortical mechanisms through the rubrothalamic elements. A third cerebellar efferent path is the hook bundle to the tegmentum of the hindbrain.

The great variations of the cerebellar mechanisms in the animal series make it obvious that the term "pons" should not be used for the designation of the tegmentum and the segments of this region. It refers purely to the neocerebro-neocerebellar connection which forms the ventral superficial protruberance. All these parts are built on the

outside of the original segmental parts. The reconstruction of the cerebellar apparatus is presented in Figures 10 to 18 inclusive.

Midbrain.—The midbrain, originally the dominant integrator of all receptor functions, presents in its roof the auditory colliculi and the optic colliculi resting on the midbrain nucleus of the trigeminus (Figs. 14, 15 and 16). The auditory or inferior colliculus receives the lateral fillet, which is the upward continuation of the trapezium or auditory decussation (Figs. 17 and 18). The optic or superior colliculus in-

Fig. 10.—*Dorsal View Slightly from Above.* Fundamental arch of the cerebellar reconstruction, showing the inner cerebellar arm arising from the vestibular mass on either side to terminate in the cells of the mesially placed roof nuclei. Resting on the inner arm and lateral to the roof nuclei are the intermediate cell groups (globosus and emboliformis); these parts are also to be seen in Figures 11, 12 and 15.

The efferent mechanisms associated with the inner cerebellar arm (the posterior longitudinal bundles and the vestibulospinal systems) can best be seen in Figures 11 and 13. $\times 2.5$.

Fig. 11.—*Left Ventrolateral View.* Reconstruction of the superior cerebellar arm, showing the cell-mass of origin (dentate nucleus) and the course of the cell processes as they pass toward the midbrain to decussate (at the level of the trochlear nuclei and ventral to the motor plate) before entering the red nucleus, which has been reconstructed only on the left side of the model; the fibers entering the red nucleus form a distinct shell, which is quite thick on the ventromesial surface (Fig. 15).

Note the posterior or mesial longitudinal bundles which are seen only on the upper part of the motor plate; in the hindbrain they occupy a dorsomedian position and therefore are not seen in this part of the reconstruction. In the lower part of the motor plate the vestibulospinal systems are readily recognized.
 × 3.2.

fluences the lower segments of the neural tube through the colliculo-spinal (or predorsal) bundle (Figs. 17 and 18). For the reconstruction of the midbrain consult Figures 14 to 18, inclusive.

Forebrain.—The forebrain is divided into the median line and lateral wall structures, the former presenting the posterior commissure, the pineal recess and pineal gland, the superior or habenular commissure, the taenia and roof membrane with choroid plexus, the

Fig. 12.—Dorsal View of Figure 11. The posterior medullary velum (in white) has been added. $\times 2.5$.

neuropore region, anterior commissure, lamina terminalis, optic recess and chiasm, infundibulum and pituitary body, tuber cinereum and saccus vasculosus region, and the mamillary region and interpeduncular ganglion. The lateral walls consist of the thalami (with the obliterated eye protrusion) and the olfactory protrusion, carrying also the striatum and the hemisphere cortex.

The construction of the forebrain rests on the midbrain and brings out:

1. The hypothalamus and floor of the median forebrain ventricle (or third ventricle), with the infundibulum, tuber cinereum, corpus mammillare, the hypothalamic nucleus (corpus Luysii) and the substantia nigra.

Fig. 13.—*Ventral View.* Beginning of the reconstruction of the inferior cerebellar arm or restiform body. The inferior olives with the interolivary and olivocerebellar fibers are shown. Note the relation of the hypoglossal roots to the olives. On the right, immediately adjacent to the acoustic and glossopharyngeal nerves, the lateral pocket with its choroid plexus is seen. $\times 3.1$.

2. The thalamus thickness proper: the anterior, median, lateral, dorsal, central and posterior nuclei (pulvinar and geniculate bodies), and continued posteriorly, the red nucleus.

3. The epithalamus: taenia, ganglion habenulae, superior commissure and the retroflex bundle to the interpeduncular ganglion, which in turn is connected with the central gray of the anterior hindbrain segment.

Fig. 14.—*Left Lateral View of Figure 13.* The direct cerebellar tract is seen flowing into the restiform body, which sweeps in broad curves over the superior cerebellar arm and the dentate nucleus. The superior and inferior colliculi have been added, preparatory to the construction of the anterior medullary velum and the cerebellar cortex (Fig. 16). Note the left trochlear nerve appearing between the inferior colliculus and the superior cerebellar arm.

In this figure the tuberculum acusticum has been left off in order not to obscure the part of the restiform body which it embraces; these relations can be seen in Figure 15. The lateral pocket has been cut off. $\times 2.5$.

Having constructed these parts, we next place the optic chiasm and the optic tracts, which should be put on loose enough to let the crus cerebri (to be constructed later) pass to the basal surface. Above the chiasm we build the lamina terminalis, carrying dorsally the anterior commissure which connects the striata and the olfactory bulbs. In relation to this phase of the reconstruction, we consider the paraterminal body, consisting of the anterior perforated substance, with the

Fig. 15.—*Right Lateral View.* Note the addition of the cerebellar cortex (only a slice through the mesial part of the vermis being indicated) and the flocculus with its peduncle. The restiform body, embraced by the cochlear mass, is cut off in order not to obscure the other structures; reduced from photograph $\times 3.3$.

pedunculus septi and its nucleus basalis, and the commissural mass—corpus callosum, septum pellucidum, fornix or hippocampal commissure and fornix column.

The next stage of the reconstruction comprises the olfactory lobe and tubercle, the lateral olfactory root and gyrus ending in the cortex of the amygdala and uncus, and the mesial olfactory gyrus, phylogenetically the first and oldest part of the highest integrator—the cerebral cortex.

Over the amygdala there arises the corpus striatum, perforated by the internal capsule, which anteriorly, and behind and below, only

Fig. 16.—*Left Lateral View.* The restiform body is seen entering the cerebellar cortex. The indirect cerebellar tract described by Gowers has been added; after hooking around the trigeminal roots it passes over the superior cerebellar arm to terminate in the cells of the cerebellar cortex; its spinothalamic component, whose course is here only partly indicated, can best be studied in Figure 17. Ventral to the latter is the rubrospinal tract. Reduced from photograph $\times 3.3$.

partly splits off the caudate from the putamen mass. By means of the striato-Luysian bundle, the large-celled mass, that is, the globus pallidus, is connected with the hypothalamus and substantia nigra.

Fig. 17.—*Left Ventrolateral View*. Reconstruction of the superior olives, lateral fillets, thalamo-olivary and colliculospinal systems. The superior olives occupy the lateral portions of the middle and anterior hindbrain segments; the left lateral fillet is seen entering the inferior colliculus of that side, whereas the right, which follows a similar course, is shown only in part; immediately ventral to the posterior longitudinal bundles are the colliculospinal or predorsal fasciculi, the interolivary fibers having been removed in order to give an unobstructed view; between the superior olive and the colliculospinal tract courses the thalamo-olivary bundle, which is seen to spread out over the lateral surface of the inferior olive. Note the rubrospinal tracts and their crossing in the upper part of the superior cerebellar arm decussation. Attention is directed to the course of the spinothalamic tract as it winds beneath the lateral fillet to ascend along its mesial border. To give a better view of the indirect cerebellar tract, the glossopharyngeal, vagus and accessory nerve roots have been removed. $\times 3.3$.

From the olfactory tubercle to the uncus there extends as the dorso-mesial border of the hemisphere cortex the mesial olfactory gyrus, consisting of the striae Lancisii and cornu ammonis, the latter also giving origin to the mesial wall or fornix radiation of the hemisphere.

Fig. 18.—*Ventral View of Figure 17, with the addition of the trapezoid body and its nucleus. $\times 3.2$.*

Between the mesial olfactory and the lateral olfactory gyri, the convexity of the hemisphere is formed by the neocortex, giving rise to the lateral wall radiation, that is, the internal capsule.

We next add the cerebral afferent tracts consisting of the auditory, visual and general sensory (mesial and superior) fillets and the efferent tracts consisting of the corticopontile and corticosegmental or pyramidal systems.

Thus we find in man essentially three dorsal or dorsolateral blind pockets or terminal bodies of the neural tube, each one a suprasegmental organ: the cerebellum, the striatum and the cerebral cortex. The thalamus is treated as a relay station with some terminal functions, but in the main having definite interdependence with the hemisphere functions. It is the cerebral cortex that brings under one head the psychobiologic integrations.

COMMENT

This bare outline has been set forth with the idea of conveying the perspective we aim to attain in familiarizing the student with the data of neuro-anatomy. Before he is led into a maze of innumerable details, he is first provided with a solid three dimensional foundation and a general frame, in which it becomes comparatively easy for him to insert the discussion of the rubral system or any other special points. It gives him a dynamic concept and a plastic instrument to work with, and every step, building from the inside out, first the segmental and then the suprasegmental structures, is determined in gross specimens and models, serial sections and photographs, and brought to expression in a plasteline reconstruction.

GUIDE TO FIGURES

Figures 6 to 18, inclusive, are photographs of an accurate reconstruction (of the midbrain and hindbrain of an adult) made by Dr. Hausman from a complete series of Weigert-stained cross-sections, each 66 microns thick. The material used is plasteline, which is ideal for this purpose as it provides simplicity without sacrificing accuracy. The original model is enlarged six times, and in colors: blue and brick-red for the receptor and motor segmental elements, respectively, orange for the efferent cerebellar mechanisms and violet for the auditory apparatus.

Figures 6 to 9, inclusive, give the segmental reconstruction; Figures 10 to 16, inclusive, the cerebellar reconstruction with the pons connections left off; Figures 17 and 18, the midbrain.

A model of the forebrain is in process of construction and an article on the forebrain will be published at a later date.