tally different from each other. Above the corpora quadrigemina is situated the splenium of the corpus callosum; between the two is the transverse fissure of Bichat (the fissura choroidea).

The frontal section through the anterior pair of the corpora quadrigemina (Fig. 61) shows the three divisions: the crusta, tegmentum, and quadrigeminal ganglia. Toward the outer side is the pulvinar, with the lateral geniculate body. Emerging below the pul-

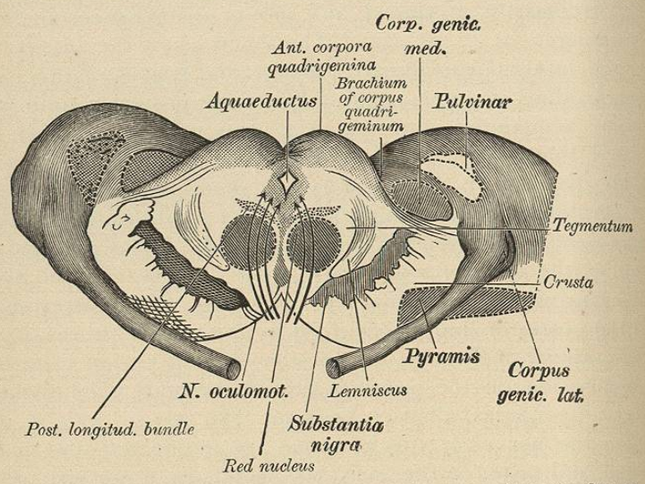

Fig. 61.—Diagrammatic Cross-section through the Anterior Corpora Quadrigemina. (After Edinger.)

vinar is the crus, which contains the pyramidal tract. Between it and the tegmentum, in which is seen the red nucleus, is situated the substantia nigra. Below the aqueduct are the root fibres of the motor oculi, and in characteristic transverse section the posterior longitudinal bundle. The position of the latter is made still clearer in the longitudinal section represented in Fig. 62.

The manner in which the fibres from the red nucleus pass under the posterior pair of the corpora quadrigemina toward the middle line and then decussate with the fibres of the opposite side—the so-called "crossing of the brachia conjunctiva" (sup. peduncles of the cerebellum)—is represented in Fig. 63.

Isolated lesions of the corpora quadrigemina are almost as rare as similar lesions of the capsule; nearly always neighboring structures are implicated. The data which we possess in this connection seem to indicate that lesions of the anterior pair produce visual disturbances, amblyopia, amaurosis, and loss of

pupillary reaction. Physiologically important is the fact that a root going to the optic tract is given off from this anterior

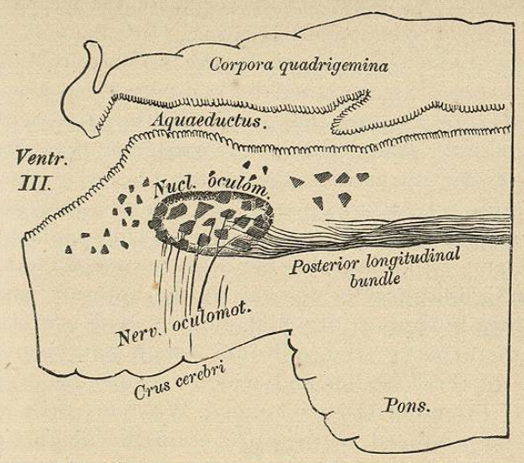

Fig. 62.—Longitudinal Section through the Region of the Corpora Quadrigemina of a Human Fœtus Twenty-eight Weeks Old. (After Edinger.) Shows that the posterior longitudinal bundle terminates in the nucleus of the oculo-motor nerve.

pair, and that radiating fibres pass to the nucleus of the third nerve, so that a connection exists between stimulation of the

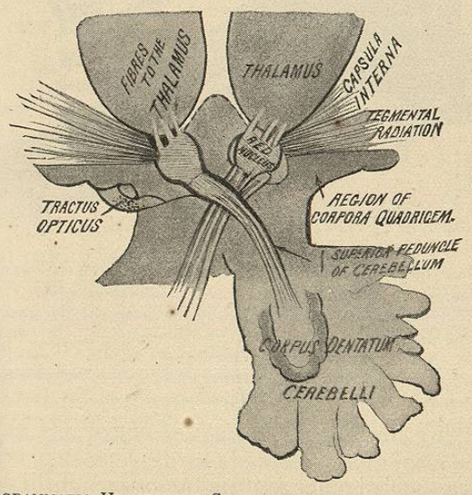

Fig. 63.—Diagrammatic Horizontal Section through the Decussation of the Superior Peduncles of the Cerebellum. (After Edinger.)

optic nerve and stimulation of the oculo-motor (pupillary reflex) (Mendel). Authors seem to differ, however, about the extent to which this reflex is influenced by disease of the anterior pair of the corpora quadrigemina. Impairment of certain movements of the eyes, especially the upward motion of the ball, has been repeatedly noted by competent observers (Gowers). Nothnagel assumes that a lesion of the same oculo-motor branches on both sides, without the existence of an alternating paralysis of the extremities, speaks for a lesion of the corpora quadrigemina (cf. *loc. cit.*, p. 220). As to the function of the posterior pair of the corpora quadrigemina, all explanations are uncertain and hypothetical. Baginsky assumed them to have a singular significance for the ear, as the anterior pair for the eye—an idea in support of which further evidence is needed; and the disturbance of equilibrium which has been ascribed to disease of these bodies, and which recently has again been studied by Eisenlohr (Deutsche med. Wochenschrift, 1890, 42), may well be produced by pressure upon the neighboring vermiform process of the cerebellum. On this point nothing positive is known.

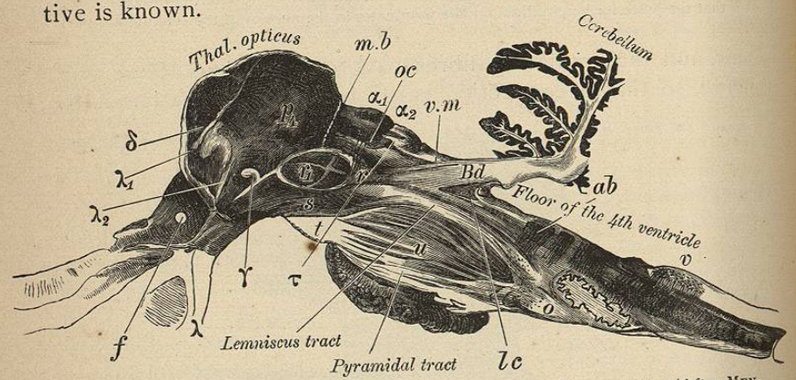

Fig. 64.—Sagittal Section through Pons and Medulla Oblongata. (After Mendel.) *f*, anterior commissure. p_4, pulvinar. *s*, substantia nigra. *r*, tegmentum of crus cerebri. r_1, red nucleus. *t*, pes pedunculi. *u*, pons. *v*, hypoglossus nucleus with fibres emerging from it. α_1, corpus quadrigeminum anterius. α_2, corpora quadrigeminum posterius. γ, ansa lenticularis. δ, Vicq-d'Azyr's bundle. λ, optic tract. λ_1, external thalamus-root of optic tract. λ_2, internal thalamus-root of optic tract. *v*, olivary body. *o*, anterior pyramid. τ, posterior longitudinal body. *lc*, locus cæruleus. *v. m*, valve of Vieussens. *m. b*, Meynert's bundle. *ab*, abducens nucleus with emerging fibres. *Bd*, superior peduncle of cerebellum. *oc*, oculo-motor nucleus with emerging fibres.

The crura cerebri emerge from the pons Varolii as two thick cylindrical white bundles of fibres; on leaving it they diverge,

having between them the posterior perforated space and the corpora albicantia (mammillaria s. candicantia). The situation of the crusta and the tegmentum, and the masses of fibres contained in them, is once more shown in Fig. 64, which represents a longitudinal, sagittal section made almost in the middle line (*r*, tegmentum; *s*, substantia nigra; *t*, crusta). That the crusta forms the path for the voluntary, the tegmentum the path for the reflex movements, and that the latter also contains the sensory paths, as Meynert assumes, has not yet been proved by physiology. That the crusta, however, contains the motor path—namely, the pyramidal tracts—is a fact established beyond doubt; hence its lesions will for the present be of more practical interest. Only a small number of instances of lesions in the tegmentum have been reported. A case of Buss (cf. lit.) presented ataxia of all four extremities, anæsthesias, disturbances of the muscular sense, and an affection of the right hypoglossus. At the autopsy a focal lesion was found in the tegmentum of the crus and the pons.

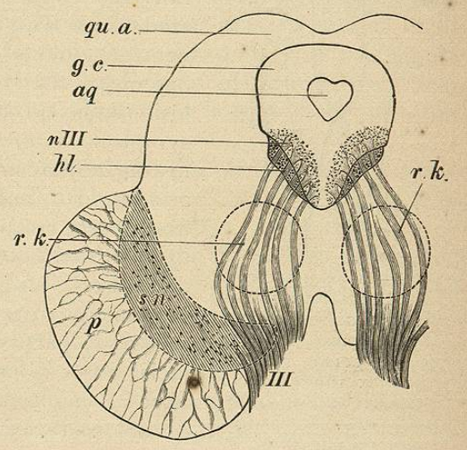

Fig. 65.—Cross-section through the Region of the Anterior Corpora Quadrigemina. *qu. a.*, anterior corpora quadrigemina. *g. c.*, gray matter around the aqueduct of Sylvius. *aq.*, aqueduct of Sylvius. *nIII*, nucleus of the third nerve. *hl.*, posterior longitudinal bundle. *r. k.*, red nucleus (tegmentum). *sn*, substantia nigra (locus niger). *p*, cerebral peduncle.

Considering the relation which the third nerve bears to the median part of the crus cerebri, as is shown in Fig. 65, we can well understand that in lesions of the latter the oculo-motor is not rarely implicated, and autopsies have frequently demonstrated that wherever an oculo-motor paralysis has been associated with paralysis of the extremities on the opposite side, the lesion is situated in the crus cerebri. For example, in a patient with oculo-motor paralysis of the right side and hemiplegia of the left side (if both come on at the same time!), we may without hesitation diagnosticate a focal

lesion in the right crus cerebri; if, in addition, anæsthesia exists on the paralyzed side, an implication of the tegmentum must be suspected. Mendel has called attention to the fact that patients with tumors of the crura sometimes urinate frequently. How far this observation may be taken as confirmatory of the view of Budge, who holds that the centre for the secretion of urine is situated in the peduncles, future studies will have to teach us.

The pons Varolii, which connects the two hemispheres of the cerebellum, contains, as we have said above, the nuclei for several nerves and the fibres passing from them to the brain. The nuclei, which are situated in the upper segment, are those of the fifth, the facial, and the abducens. Since the pons naturally also contains the motor fibres, situated, as we said above, in the lower or ventral segment, while in its dorsal part one meets the sensory bundles, pontine lesions may produce a complication of symptoms as characteristic as those following lesions in the crus. As we have attempted to make clear in Fig. 66, the fibres of the facial nerve decussate higher up than the motor fibres of the pyramidal tracts. Keeping this fact in mind, we can easily understand that a lesion of the lower part of the pons concerns the facial fibres after their decussation, the fibres going to the extremities, however, before they cross, and consequently gives rise to a facial paralysis on the side of the lesion, but a paralysis of the extremities on the opposite side (hemiplegia alternans) (Gubler, 1859). A lesion of the upper part of the pons concerns both of these paths before their decussation, and produces, therefore, hemiplegia, with a facial paralysis of the same side, which, however, is distinguished from the typical hemiplegia in that the facial paralysis in this case resembles somewhat the peripheral type, as it takes in all three branches of the facial, and as, though but rarely, reaction of degeneration may be present.

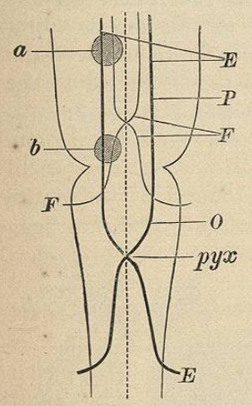

Fig. 66.—Diagram showing the Decussation of the Fibres going to the Extremities, and of those going to the Face, in the Pons and Medulla Oblongata. *F* facial fibres. *E*, fibres going to the extremities. *P*, pons. *O*, medulla oblongata. *pyx*, decussation of the pyramidal tracts. *a*, a focus in the upper, *b*, a focus in the lower, part of the pons (the latter is situated below the decussation of the facial fibres).

If, then, we meet with a paralysis which affects the facial on one, the extremities on the opposite side (alternating paralysis), simultaneously, we are justified in assuming the lesion to be situated in the pons, and more especially in its lower part. If paralysis first occurs in the face alone, and does not develop in the extremities until later, and if the whole process is gradual, it may arise from a tumor at the base of the brain. If, besides the symptoms described, the patient complains of pain in the face, the trigeminus is included in the lesion. A paralysis of the external rectus points to the implication of the abducens nerve, in which case a paresis of the internal rectus of the other side not rarely coexists, so that a conjugate deviation of the eyeballs toward the paralyzed side—that is, away from the focus—may occur.

Bilateral lesions of the pons must be thought of in combined paralyses of the extremities and cranial nerves, or in cases of bilateral facial paralysis or bilateral paralysis of the extremities (either of both legs or of all four extremities). The diagnosis, however, as a rule, can not be made with certainty.

Convulsions will be observed if by acute lesions the spasm centre, as Nothnagel calls it, becomes excited. Tonic spasms in the paralyzed limbs are not uncommon. Anarthric speech disturbances in bilateral affections of the pons have been noted by Markowski (Inaugural Dissertation, Dorpat, 1890). Psychical changes, which occur in connection with lesions in the pons, are very irregular in their occurrence, and assume the most diversified forms. They deserve a more careful study than has as yet been devoted to them. Their entire absence has been repeatedly noted. Anæsthesias in the distribution of the trigeminus, as well as in the extremities, are comparatively frequent, but we are not at present able to utilize them for the purpose of topical diagnosis.

To enable us to point with certainty to the cerebellum as the seat of disease, the implication of the vermiform process is necessary, since, as Nothnagel has pointed out, we may have extensive disease in the hemispheres without the manifestation of a single symptom during life. In the cases, however, in which the vermiform process is affected, marked disturbances of co-ordination and equilibrium ensue; the patient staggers and complains of severe vertigo on walking and standing. This is almost a pathognomonic symptom, especially if it be as-

sociated with occasional spells of more or less serious vomiting. Since, however, cerebellar ataxia may be absent in tumors of the vermiform process (Eisenlohr), we are not surprised that it is often very difficult to make a diagnosis.

Lesions of the middle peduncles of the cerebellum produce highly characteristic symptoms, so that a diagnosis can be made with a fair amount of certainty. The body is involuntarily gyrated around its longitudinal axis ("forced movement"). This symptom, however, can only be observed as a consequence of irritation of the peduncles, but is absent if the latter are wholly destroyed—e. g., by hæmorrhage. Sometimes the patient has an irresistible inclination to lie on one side, and this is, if the remaining symptoms point in the same direction, also to be estimated as a forced movement, or rather a "forced position." It is not uncommonly accompanied by a corresponding twist of the head and eyeballs. This phenomenon, however, is not a pathognomonic symptom for lesions of the middle peduncles. The direction in which the body is turned is sometimes toward the diseased side, sometimes away from it, a fact for which no explanation has as yet been found.

For lesions of the other peduncles of the cerebellum (the superior and inferior) no diagnostic points are known.

The lowest part of the encephalon is called the medulla oblongata. It becomes continuous below with the spinal cord on a level with the lower margin of the foramen magnum. On its anterior (lower, ventral) aspect we observe the pyramids with their decussation, and the olives, while to the outer side of these are to be found the restiform bodies, the inferior peduncles of the cerebellum. The last contain the so-called direct cerebellar tracts, which, coming from the outermost portion of the lateral columns in the cord, pass, through the anterior commissure of the vermiform process, to the cortex of the cerebellum. That a relation exists between the olives and the cerebellum is apparent from the fact that wherever we have a congenital atrophy of the cerebellum these bodies are also atrophic (Flechsig).

On the posterior (dorsal, upper) aspect is the floor of the fourth ventricle, the fovea rhomboidalis (Fig. 67), which is bounded below by the diverging restiform bodies, above by the diverging superior peduncles of the cerebellum. The median columns are called the posterior pyramids (funiculi graciles). They are the continuations of Goll's columns of the spinal cord. To the tracts situated to the outer side of these the name funiculi cuneati, or Burdach's columns, has been given.

To diagnosticate the medulla oblongata as the seat of a lesion is only possible if the nuclei in the floor of the fourth ventricle are diseased, in which case we get the clinical picture of bulbar paralysis. Other characteristic symptoms do not exist, and more especially it must not be forgotten that foci in

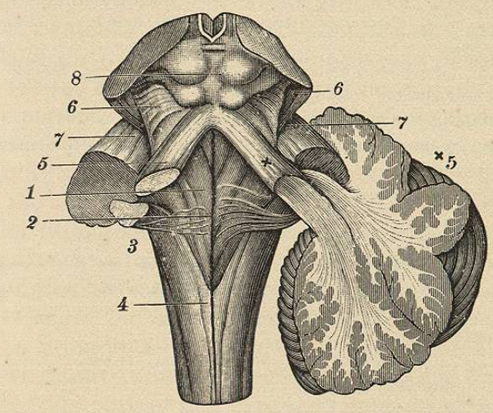

Fig. 67.—THE CONNECTIONS OF THE CEREBELLUM—with *a*, the midbrain (superior peduncles), 5; *b*, the pons (middle peduncles), 7; *c*, the medulla oblongata (inferior peduncles or restiform bodies), 3. 1, fourth ventricle. 2, striæ acusticæ. 4, funiculi graciles. 6, lemniscus. 8, corpora quadrigemina.

the medulla may give rise to a paralysis only in the extremities, which presents nothing characteristic during life. If, however, the nerve nuclei of the medulla are implicated, a characteristic picture is presented which can hardly be mistaken. Another point of which, in making our topical diagnosis, we must not lose sight, is the fact that certain brain lesions may give rise to a similar combination of symptoms constituting the clinical picture of the disease which we have described above as pseudo-bulbar paralysis. Other diseases of the medulla—traumatism, acute and gradual compression, hæmorrhage, and embolism—are of no practical significance, since they cause death so quickly that a certain diagnosis is impossible. Hence we will pass them over without further remark.

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II. The Study of Cerebral Lesions with Reference to their Pathological Nature.

Pathological Diagnosis.—We have before pointed out that the question as to the nature of a brain disease is not only of interest to the physician, but of the greatest importance to the patient, as on this the prognosis as well as the mode of treatment turns. An error in the topical diagnosis may deserve the censure of scientific criticism, but does not necessarily entail damage to the patient. If, on the other hand, we mistake the nature of the lesion in a given case—if, for instance, a disease of the vessels is taken for a new growth, if the tuberculous or syphilitic nature of the affection is overlooked, or, again, a severe alcoholic intoxication is diagnosticated where in reality an apoplexy exists—when such errors have influenced the treatment, not only opportunities may be lost for the patient which may never present themselves again, but an unfavorable event of the disease may actually be brought about or at least precipitated. On these grounds we ought to be particularly careful and conscientious in forming this part of our diagnosis, and no symptom, however small it may seem, should be overlooked, as we never know but that it may later perhaps become of diagnostic value.

In looking over the several pathological processes which here concern us, we find that their number is comparatively limited. First of all, we shall devote our attention to diseases of the blood-vessels, which so frequently are the cause of cerebral lesions. We shall have to determine the nature of these diseases, and carefully distinguish the affections of the blood-vessels from the secondary changes produced by them. The clinical symptoms, the complaints of the patient, and the objective signs are a direct consequence of the latter only, and it is therefore not the disease of the blood-vessels which we have practically to deal with, but the changes in the brain substance which they entail. The clinical manifestations vary according to the seat of the diseased vessel and the portion of the brain supplied by it. The symptoms we shall describe in detail later; but first let us speak of the pathological nature of the diseases of the cerebral vessels.

Affections of the Brain due to Disease of the Blood-vessels.

A. **Diseases of the Cerebral Vessels and their Consequences.**—The arteries of the brain are derived from the internal carotids and the basilar, which is formed by the two vertebrals.