side by side around the genu and caudad at the bottom of the longitudinal fissure. After giving off the first few branches the main trunk may divide into three branches, as stated by Duret, whose description is largely followed; or several successive branches are given off, as in the accompanying plate. Together, they supply the inner two-thirds of the ventral surface of the frontal lobe, the anterior four-fifths of the opposed surface of the hemispheres, the callosum (largely), and a portion of the convexity.

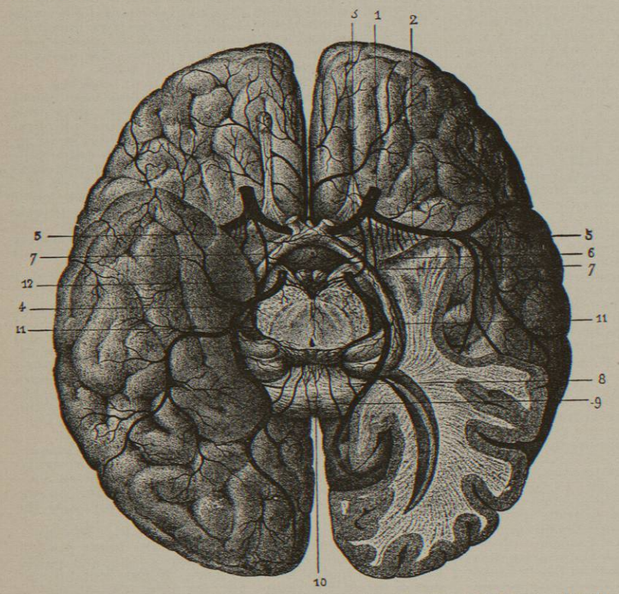

FIG. 818.—Arteries of the Base. (After Duret.) 1, Carotid; 2, medicerebral; 3, precerebral; 4, postcerebral; 5, preperforants (striate arteries); 6, prechoroid; 7, postcommunicants; 8, postchoroid; 9, medichoroid; 10, callosals (termination of precerebrals); 11, medioptics; 12, prethalamic (postperforants). The carotids are drawn frontad to show the preperforants. The left temporal lobe is cut away, exposing the medicerebral trunk at the bottom of the Sylvian fissure, and also its branches crossing the insula.

1. *Subfrontal* twigs, to the olfactory groove and region as far as subfrontal sulcus. 2. *Prefrontal* branch, to mesal surface of superfrontal and convex surface of superfrontal and part of medifrontal convolutions. 3. *Medifrontal* branch, to the callosal convolution, and paracentral lobule. After doubling the crest of the hemisphere it terminates about the dorsal extremity of the central fissure. 4. *Postfrontal* branch, to precuneus and the adjacent portion of the convexity, nearly or quite reaching the occipital fissure. 5. *Callosal* artery. This may pass around the splenium to terminate in the pineal gland, and even posterior commissure. It goes to the callosal convolution and vault, perforating the latter and ramifying over the whole extent of the roof of the paracœles.

The Cerebral Carotid (Fig. 818, 1).—As a rule the postcommunicant is a direct branch of the carotid, though it often starts from the medicerebral. In the former case the carotid, from this branch to its termination at the commencement of the Sylvian fissure in the pre- and medi-cerebrals, forms part of the circle of Willis. In this short course a few lateral branches are given off:

1. Arterioles to the external angle of the chiasm. Either these or the *chiasmic* arterioles from the precerebral supply minute twigs to the first portion of the optic nerve. 2. Frequently, one or more of the *perforantes* to the caudate. 3. *Prechoroid* (Fig. 818, 6). This may come from the medicerebral, or even from the postcommunicant; in any case its origin is peripheral to that of the last named. It is directed obliquely caudad along the outer side of the optic tract to attain the choroid plexus in the lateral horn (through the extremity of the transverse or Bichat's fissure). It gives off: (*a*) internal and slightly recurrent branches to the optic tract; (*b*) internal branches for the central part of the outer aspect of the crus cerebri; (*c*) external branches to the uncus (a terminal arteriole, Heubner); (*d*) extremely fine twigs to the two-thirds of the choroid plexus that it is stated to traverse.

In general, Kolisko's work corroborates that of Heubner. In a large number of examinations this vessel was never absent. It has a pretty constant diameter of 0.5 mm. In the fœtus it is relatively very large. In animals (dogs, cats, rabbits) it was regularly present, but arose from the Sylvian. The branch to the uncus was always present, but has free anastomosis in the pia. The branches in plexus and tela also anastomose freely with others near; but those to the brain substance are terminal.

The prechoroid supplies the following parts: The posterior arm of the internal capsule, with the lamina medullaris externa of the thalamus to the level of the upper angle of the midlenticular segment—usually only the posterior two-thirds; the white substance back of the internal capsule as far as the roof of the medicornu; the inner lenticular segment; the uncus; the optic tract (in its posterior half); the lateral choroid plexus; the endyma of the posterior and lower parts of the paracœle; the greater part of the tail of the caudatum; exceptionally the external parts of the upper half of the thalamus.

But the posterior arm of the internal capsule is also in part supplied by the medicerebral and postcommunicant (the anterior third of this part by the latter vessel), the deeper parts by the prechoroid and postcommunicant, and the upper parts (above apex of midlenticular segment) by the Sylvian (lenticulo-optic ramus of Duret).

Circulatory disturbances in the supply territory of the prechoroid cause opposite hemiplegia by softening in the posterior segment of the internal capsule, involving the pyramidal and cranial-motor tracts.

Hemianæsthesia, hemianopsia, and hemianosmia may likewise follow closure of the prechoroid, but are usually headed off by collateral supply.

When the postcommunicant is large, its blocking may cause opposite facial and hypoglossal paralysis, since these tracts traverse the front part of the posterior arm of the capsule.

The Medicerebral (*vide* Plate XVI. and Fig. 818, 2).—The

EXPLANATION OF
PLATE XVII.

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ARTERIAL SUPPLY OF OBLONGATA (FROM ADAMKIEWICZ), ENLARGED SIX DIAMETERS.

FIG. 1.—At Decussation of Pyramids.

Hs, Dorsal Column.
Ng, Nucleus gracilis.
Nc, Nucleus cuneatus.
Sgc, Substantia gelatinosa centralis.
Ccp, Caput cornu posterioris (aut tuberculum Rolando).
XII, Root of hypoglossus.
Vr, Remnant of ventral column.
Prk, Decussation eminence.
Py, Pyramid.
g, Boundary between Py and Vr.
S, Arteria sulci.
Sa, A. sulci (at deeper layers).
Acc, Aa. centrales cornuum anteriorum.
Aca, Aa. cornu anterioris.
Anl, A. nuclei lateralis.
As R, A. tuberculi Rolando.
Anc, A. nuclei cuneati.
Ang, Aa. nuclei gracilis.
F, A. fissuræ.

FIG. 2.—Opposite Middle of Metepicœle.

H, Hypoglossus nucleus.
Va, Post. vagus nucleus.
Po, Ponticulus (velum medullare posticum).
Gl, Glossopharyngeus nucleus.
Ac, Acusticus nucleus.
Lb, Longitudinal bundle. (Krause's respiratory fasciculus.)
Cr, Corpus restiforme.
X, Ant. vagus nucleus.
IX, Root of glossopharyngeus.
Aro, Angulus restiformio-olivaris.
O, Oliva.
No, Nucleus pyramidalis.
Ozs, Interolivary tract.
R, Raphé.
Py, Pyramid.
Na, Nucleus arciformis.
S, Arteria sulci.
Sce, Affluents to external nest-like capillary coils, from sulcus artery.
Sci, Affluents to inner same.
Aoli, Sublateral olivary artery.
Aso, Olivary ramus from sulcus artery.
Aoli, Subolivary arteries.
Aolm, Medilateral olivary artery.
Aols, Super-olivary artery.
An, Arteries of the nuclei (glossopharyngeus, vagus, hypoglossus).
Vn, Nuclear vessels (glossopharyngeus, acusticus).
F, Arteria fissuræ.

FIG. 3.—Longitudinal Section through Olivary Body.

O, Oliva.
Br, Pons.
Aoli, Aa. olivæ laterales inferiores.
An, Aa. nuclearіæ.

Arterial Supply of Oblongata (from Adamkiewicz.)

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Ac, Acusticus nucleus.
Lb, Longitudinal bundle.
(Krause's respiratory fasciculus.)
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Fig 1.

Fig 2.

Fig 3.

Arterial Supply of Oblongata (from Adamkiewicz.)

vessel represents the most direct continuation of the cerebral carotid. It lies at the bottom of the Sylvian fissure, as do also the primitive portions of its larger branches as they spread out over the insula. When the postcommunicant starts from the medicerebral, the previous short (4–6 mm. long) portion of the latter participates in the circle of Willis. No branches are assigned to this part.

The medicerebral in its further course yields two classes of branches: (*a*) direct, perforating, or nutrient arterioles; (*b*) large and small pia arteries.

(*a*) A few perforantes (Fig. 818, 5, 5) from the earlier part of this artery may pass directly to the caudate head, with those described under precerebral and mentioned under carotid. But the main group from this source take a somewhat different course, and, as stated by Heubner, are often detached from the trunk farther out in the fissure. These have been divided into two sets. The first to leave the trunk—*lenticular arteries*—are the finer, and are similar in deportment to the preceding, except that they go to the first and second segments (apex) of the lenticular nucleus. The second, coarser set runs along the base of the lenticular nucleus on the limit of the external capsule. A portion of these pass caudad and dorsad to the thalamic extremity of the lenticular nucleus, and terminate in the thalamus—*lenticulo-thalamic arteries*. One arteriole, noticeably larger than any of the others and the frequent source of hemorrhage in this region, passes dorsad and mesad to the third segment of the lenticular, where it gives off many side twigs, and finally divides into four or five terminal branches, supplying also the adjacent internal capsule, etc. Two or three accompanying arterioles extend toward the third segment, and may attain the tail of the caudate. Collectively these are termed *lenticulo-striate arteries*.

A further group might be made of the small direct vessels traversing the insula to gain and supply the claustrum; as this is, however, a derivative of the external gray layer, these twigs more nearly correspond to the general cortical and albal arterioles.

Of the perforantes as a whole, it may be said that they all emanate at right angles from the inner side of the mother vessel. Their size varies from 0.5 to 1.5 mm. They immediately enter the brain substance, only occasionally dividing, and never anastomosing before doing so. They usually run a further short course before branching. The ultimate distribution of each is pencil-shaped. They are destined to supply the central gray nuclei and the capsules, notably the inner. They are all true terminal arteries, without any anastomoses either between themselves or with other arteries. According to the French school, even their finest capillaries do not connect, but on this point the Germans teach otherwise.

(*b*) Pia branches of the medicerebral. After a course of 1 to 2.5 cm. the main trunk, either at one stroke or successively, divides into several large branches. 1. Previously, however, there are usually a few small rami for the adjacent borders of the frontal, and especially the temporal, lobes (see Plate XVI.).

2. *Frontal* branch. This is generally the first large ramus. Like the succeeding, it runs some distance deep in the sulcus and subdivides often, at least before appearing externally. It is especially destined for the subfrontal convolution. It supplies the orbital surface of the frontal lobe external to the orbital fissure, and the convexity dorsad to the middle of the medifrontal gyrus, caudad to the precentral sulcus. Duret found a very constant corresponding artery in several species of animals.

3. *Preparietal.* This nourishes the precentral and adjacent extremity of medifrontal convolutions, and may by an early branch include the postcentral also.

4. *Mediparietal.* This may gain the fissure of Rolando to supply not only the postcentral convolution, but dorsad a portion also of the precentral. It may also reach the adjacent parietal region.

5. *Postparietal.* This is a large branch in the horizontal Sylvian fissure. Its ramifications do not extend beyond the parietal or occipital fissure, but may pass beyond the supertemporal.

6. *Temporal.* This is included under the last by many, but it is often an early and large branch of the medicerebral. By its numerous considerable subdivisions it then covers practically the whole external temporal surface. At least the supertemporal convolution and much of the meditemporal are regularly supplied. Its distribution extends nearly to the suboccipital convolution.

There is no special artery for the insula, but it receives several small branches from the preceding as they cross it.

The Postcommunicant.—Connecting the pre- and post- (carotid and vertebral) systems. They start from the carotid or medicerebral, and run directly caudad to inosculate with the corresponding postcerebral at 5–12 mm. from the latter's origin. They pass ventrad of the optic tracts and also encounter the crura cerebri. In size and occurrence these vessels are variable, and frequently unsymmetrical. The left is more often the smaller or even absent, though some filiform anastomosis from a corresponding branch of the carotid usually does exist. As a very large branch from the carotid, especially the right, it may replace the corresponding postcerebral wholly or in part, or conversely; a large left communicant has been observed to arise from the postcerebral and supply the same medicerebral. Aside from disparity in size (43 times) the postcommunicants were normal in 175 of Windle's cases. Excepting slight anastomosis, both were absent in 3 cases, the right in 9, the left in 13. In 7 both were very small; in 28 the right was much larger than the left; in 15 the reverse.

Anomalies, says Bullen, are more common in the postcommunicants than in all the others. Of these vessels, either (1) may be absent; (2) may be replaced by a branch from the subcerebellar, internal carotid, postcerebral, or two small nutrient branches respectively from the last two vessels; (3) may supply unusual regions; or (4) may be unconnected with the carotid system.

This vessel gives off laterally pia branches, (*a*) internal, (*b*) external, and (*c*) inconstant penetrating rami.

(*a*) 1. Chiasmic branches to the caudal side of the chiasm. 2. Twigs to the tuber cinereum and infundibulum, a descending ramus supplying the pituitary body. 3. Two to the mammillary bodies.

(*b*) 1. To the optic tract. 2. To the cerebral crura. 3. Often considerable branches to adjacent temporal gyri.

(*c*) 1. *Prethalamic Artery* (internal and anterior optic of Duret). It penetrates between the tuber cinereum and mammillary bodies, and ramifies in the more anterior part of the aula, on the walls of the infundibulum, etc. 2. Medithalamic artery (posterior internal optic). At times large, it enters the postperforated space and passes directly dorsad near the inner thalamic wall, to which and the gray commissure it is distributed. This vessel comes as often from the postcerebral as from the postcommunicant. The prethalamic may also have the same origin.

The Postcerebrals, from the end of the basilar to the postcommunicants, complete the circle of Willis. This part furnishes: (1) three or four arterioles to the internal aspect of the crura cerebri, supplying its basal layer, the locus niger, etc.; (2) little branches entering the thalamus through the postperforated space. These accompany, and often include, the above-described medithalamic artery.

Windle found the postcerebral arteries normal in 173 cases. The vessel was derived from the carotid instead of the basilar in 11 cases on the right, 9 on the left, and 4 on both sides. There were 2 postcerebrals on the same side—the smaller from the basilar, the larger from the carotid—in 3 cases: 1 on the right and 2 on the left. Either of the postcerebrals may (Bullen) (1) be absent; (2) be a branch of the carotid system; (3) be replaced by a large postcommunicant; or (4) be replaced by two thread-like vessels from the basilar.

This trunk, in passing around the crus, describes a kind of semicircle, directed toward the transverse fissure. Dorsad of the crus, at about 1 cm. from the optic lobes,

it turns latero-caudad to gain the calcarine fissure, where it breaks up to supply the basilar postcerebral region. From its crural portions it supplies, besides other branches, nearly all the nutrient arteries of the cœlian walls.

1. Little twigs to the outer part of the crus, penetrating almost immediately. Instead of several in the thalamo-crural sulcus, there may be a single larger one, parallel to the main stem.

2. The fairly constant *Medioptic* (median quadrigeminal), giving fine offshoots in its course to the crus, and terminating in a bunch of fine vessels in the interval of the optic lobes.

3. *Postthalamic* (so-called posterior and external), two or three, or a single larger one, starting midway from this portion of the postcerebral, and following the crus to enter the thalamus between the geniculate bodies.

4. *Geniculate*, emanating directly, or from the thalamic.

5. *Postchoroid* (posterior and lateral), starting near the optic lobes, and entering between the layers of the velum. It always divides into two principal rami: a lateral one for the third of the choroid plexus not supplied by the prechoroid artery, *i.e.*, for the plexus over the thalamus; the other more median one for the velum (*ramus velaris*).

6. *Medichoroid* (posterior and median choroidal), from the postcerebral at its nearest approach to the median line. It courses beside the conarium, to which it yields some rami, and immediately divides into two branches, one to the velum of the aula, the other exclusively to the choroid plexus of the same cavity.

The choroid plexi and velum represent a double layer (fold) of the pia, within which the cœlian arteries and veins course. Duret states that in all the cœles the arteries to the velum are distinct from those to the plexus, often even from their origin at the postcerebral, and always at their entrance into the corresponding cavity, and that they never mingle in their distribution. From the velar arteries are detached a multitude of little arterioles, which penetrate the thalamus 1 to 1.5 cm. They have the arrangement of cortical arterioles, and are pencillated. The two velar branches terminate in the head of the caudate, either simply subependymal or passing deeply into its substance. The velar branches to the aula emit little arterioles laterally at intervals of about a millimetre. These penetrate perpendicularly the adjacent wall. They supply also the posterior and gray commissures, and terminate in a fine pencil in the anterior commissure. The plexus arteries, on the contrary, do not usually participate in the nutrition of the cœlian walls. They divide into four or five long parallel branches from which little arterioles pass into the plexuses, properly speaking. They enter the little tufts by their base, and form very attenuated and sinuous capillary meshes. It has been suggested that they are the remains of former branches ramifying in the embryonic cœlian pia, and that they became coiled up when this membrane retracted.

7. *Preoptic* (anterior quadrigeminal), very short, coming from the most median part of the postcerebral, or from some branch of the latter. It forms a very delicate pencil over the preoptic body. This makes the third pretty constant pair of optic arteries, as these lobes are very vascular. They have some anastomoses across the median line.

8. Artery of the cornu Ammonis, oftener from some branch of the postcerebral than arising directly. It does not ramify on the cœlian surface, but passes between the Ammonshorn and the hippocampal convolution, to traverse the cortex in the manner of external arteries.

9. Variable branches to adjacent temporal gyri.

Final Divisions of Postcerebral.—These may be brought under three general heads (see Plate XVI.).

1. *Pretemporal* branches to the uncus in part, and the basal surface of the temporal lobe as far as the border of the convexity, except the third nearest the apex of the lobe, which is supplied from the medicerebral.

2. *Posttemporal* to the basal surface of the occipital lobe, including a variable amount of the adjacent temporal region, and doubling the border of the convexity to supply a little of the external occipital region. The hippocampus may be supplied from the parent stem, or from either 1 or 2.

3. *Occipital* artery. This runs along the calcarine fissure, sending a large branch through the occipital fissure; it supplies the cuneus and general median surface of the postcerebral lobe, and a considerable strip of the adjacent occipital convexity. Spitzka says that an artery large enough to cause fatal hemorrhage enters the gray and white of the right occipital lobe.

General Features of the Arterial Supply.—The distribution of each primary trunk includes: (*a*) basilar or nuclear branches; and (*b*) pia or cortical branches.

(*a*) These are the pre- and post-perforating and cœlian arteries, arising in part from the circle of Willis. They supply the central ganglia, cœlian structures, and in part the centrum semiovale. To the same class belong the direct arterioles from the basilar to the nuclei in the pons. Excepting occasional and unimportant anastomoses, these are all true terminal vessels. They divide within the brain substance at an acute, and not a right, angle.

(*b*) The pia branches or divisions as described are only averages, complementary variations therefrom always being present; though it is claimed that while "their origin is often very variable, their distribution is constant." The larger arterial trunks correspond to the main fissures. To a marked extent it is true that the same branch does not supply both sides of a sulcus. Branches usually leave the parent stem at almost or quite a right angle. Some writers try to show a freer supply to the left hemisphere. Duret's attempted correlation of arterial distribution and physiological function was at least premature (1877) and faulty.

Anastomoses.—The basal circle of Willis comprises all the communications readily demonstrable on the uninjected pia arteries of the cerebrum. Only within this circle and over the optic lobes are there any minute connections across the median line of the hemispheres.

There has been a dispute as to the extent to which the ramifications of adjacent branches on either hemisphere are connected. Duret, after numerous, varied, and evidently careful examinations, says: "Never have we found an anastomotic network in the pia." He also notes the frequent superposition in the pia of fine arterial ramifications. Nevertheless he found considerable individual differences, and regularly some fine (0.2 to 0.25 mm.) communications, especially at the periphery, *i.e.*, between adjacent territories of distribution. On p. 927 he acknowledges that in the great majority of cases, owing to anastomoses, "however rare and unimportant," softening from occlusion of any of the large basilar trunks spares the peripheral parts of the artery's territory. In the four-months fœtus he found abundant fine anastomoses. Heubner (p. 174), on the contrary, says: "The chief [pia] branches end in a kind of communicating canal system or reservoir, which is spread out in the shape of a tubular net over the whole surface of the brain." By injecting "under weak finger pressure" he found plentiful anastomoses up to 1 mm. in diameter. Heubner's description harmonizes with that of older writers, and is corroborated by Lucas, who by sufficiently penetrating injections was able to demonstrate an abundance of communicating arterioles up to 0.25 mm. (*vide* Plate XVIII., Fig. 2). It remains true, however, that when the communicants of the circle of Willis are poorly developed, the peripheral anastomoses are, in a large number of cases, incapable of substituting them.

Direct or Nutrient Arterioles of the Convolutions.—These emanate at right angles from the pia branches, of all sizes. They penetrate the crests of the convolutions perpendicularly, the inclined surfaces obliquely. They are innumerable—scarcely more than 1 mm. apart. According to size and distribution there are two classes:

1. Cortical, 0.05 to 0.03 mm. in diameter. The finer stop in the cortex proper; the others go to the boundary of gray and white. The capillary network from these rami has been divided into three somewhat differently characterized layers, each parallel to the rolling surface.

2. Albal (arteriolæ longæ), 0.08 to 0.14 mm. in diameter. These are almost rectilinear, can be followed a distance of from 3 to 4 cm., and branch at an acute angle. They supply a considerable portion of the centrum semiovale. One often passes down along the axis of the convolution. A group of five or six at the bottom of a fissure (in section) diverge on entering. The capillary network of the albals is more elongated than that of the corticals, and accompanies the fasciculi of nerve fibres.

Both classes anastomose freely in their finer branches, though in general pencillate.

From the anatomical arrangement it is believed that the intravascular pressure is less in the gray than in the white substance.

It has been claimed by many that the thyroid gland acts as a safety diverticulum to the cerebral supply; and furthermore, that the lack of this regulator explained the occurrence of so-called cachexia strumipriva after removal of that gland; but any such special function of the thyroid is at least not proven.

Width of Brain Arteries.—To make a relative estimate of the capacity of the arteries at the base, Bevan Lewis ("Examination of Brain," 1882, pp. 20–22) determined their average diameters in 45 cases (insane). That of the vertebral was, r. 3.147 mm., l. 3.42; of basilar, 3.82; of postcerebral, r. 2.658, l. 2.56; of carotid, r. 3.951, l. 4.02; of medicerebral, r. 3.133, l. 3.55; and of precerebral, r. 2.73, l. 2.66. The sectional areas are of course proportional to the square of these diameters. As a rule, the united areas of branches equal very nearly the area of the parent trunk—excepting the preponderance of the vertebrals over the basilar (22.4 to 14.8).

Löwenfeld has found that the relation of the artery width to the brain weight is, even normally, somewhat variable, and that often, though not by any means in all cases, the width of the brain vessels rises and falls with the width of the aorta; moreover, that not rarely abnormally small brain arteries occur in otherwise well-developed arterial systems. He also made out a difference in the two sides, the left carotid being usually wider than the right.

Pressure in the Brain Arteries.—A further matter, noted by St. John Bullen (*loc. cit.*), may partially indicate the relative pressures in the main brain arteries. He remarked atheroma of the basal vessels in 410 of 1,565 autopsies, or 26 per cent. of the total. It was present to a considerable extent, either generally dispersed or in special trunks only, in 175 cases, and to a less extent in 235. The relative frequency by location was: medicerebral, 38 per cent.; basilar, 30 per cent.; postcerebral, 21 per cent.; carotid, 10 per cent.

Mendel (1891) has found experimentally that the pressure in the cortical arteries is materially less than that in the carotids, while that in the striatal arteries is not materially less. This he attributes to the fact that the latter are terminal vessels, though it is doubtless quite as much due to their less circuitous supply. He further thus explains the frequency of hemorrhage in the striatal region.

Tedeschi's conclusions regarding the brain arteries refer in part to moot points, but really contain nothing new and are deceptive in statement.

Veins.

The venous passages of the brain and its membranes include:

I. The dural veins.
II. The intrinsic veins, or those of the brain proper.
III. The sinuses.
IV. The venous exits from the skull.

All the intrinsic and most of the dural veins discharge into the sinuses, or appendatory spaces, which in turn convey the blood to the exits. Otherwise these two sets of veins are separate systems, not interanastomosing, unless occasionally near their mouths. The intrinsic veins without exception have thin, readily collapsing walls, while the sinuses are held open by the firm enclosing dura. In general it may be stated that *the walls of all these vessels are devoid of muscular elements*, though occasional unstriped fibres have been observed in the intrinsic veins. From this absence of actively contracting fibres, it follows that these vessels play a merely passive rôle in the encephalic circulation. The encranial veins, like the external veins of the head, are devoid of true valves. However, at the orifices of the diploë veins (Dupuytren, Langer, doubted by Trolard) and in the ophthalmo-dural vein, valves *may* occur. It has also been claimed that the supercerebral veins in part present a valvular arrangement at their discharge into the longitudinal sinus. The general impression that valves never occur in any of the veins above the common jugular is therefore incorrect.

I. Veins of the Dura (including those of the diploë).—These are many in number, but all of small size. They anastomose so freely that they might almost be denominated a plexus. In position they are comparable to the plexus venosus existing between dura and periosteum of the spinal canal. In their ultimate distribution they form two vascular nets, according to Langer, one in the outer, the other in the inner, layer of the dura. The beautiful, almost regular, interlacing of the former, figured by Langer from the fœtus, the writer is able to corroborate. By means of small veinlets penetrating the inner plate of the skull, the dural veins communicate extensively with those of the diploë. They include:

1. *Medidural*, or *Venæ Comites*, accompanying the medidural artery and its branches. The two on either side of an artery repeatedly connect with each other and with neighboring veinlets. The largest pair is about the common trunk of the artery. One of these passes externally through a basal foramen to the pterygoid veins. The other ends in the medicerebral vein or its temporal sinus, or directly in the sphenoidal or cavernous sinus, with which latter it usually at least connects. The diploic canals have some special openings into the larger medidural veins.

2. *Superdurals.* These appear in part as direct continuations of the preceding, and then are double. They pass to the longitudinal sinus, largely through the intermediation of its lateral spaces. Labbé suggests that the supra- and medi-dural veins may constitute a small collateral path between the long sinus and basal conduits.

3. *Falcial Trunklets* (Fig. 819, *k*), running to the longitudinal sinus and to the falcial sinus when present, otherwise to the tentorial. The tentorials go to the lateral and tentorial sinuses, also in part by way of the parasinual spaces.

4. The numerous veinlets for the other dural arteries, *e.g.*, in the occipital fossa, have a more independent course and end in adjacent sinuses.

Venous Canals of the Diploë, even less yielding than the sinuses. Breschet's description is somewhat modified by Trolard. The diploë is made up of little areolæ. These canalize in any direction, though in general ventrad to discharge near the base. These canals are quite unsymmetrical, and do not increase in size in their course, excepting where there are casual enlargements; areolæ, conduits, and lacunæ are lined with a smooth membrane. Generally the diploë begins to appear about the tenth year, though small straight veins are evident earlier. Resorption of the cancelli goes on continuously, and after fusion of the sutures they may pass from one bone to another. In the aged we find a sort of wide-spaced venous plexus, no longer canals. There are several exterior outlets and numerous interior ones. Even the one through the supraorbital notch passes to the ophthalmic vein and so to the cavernous sinus. Casual mention will be made of most of the special terminations.

II. Veins of the Pia and Brain Substance.—From their derivation and discharge, these vessels naturally fall into three classes: A. The supercerebrals, passing to the longitudinal sinus. B. The internal or Galen's system, tributary to the tentorial sinus. C. Basal veins, ending in the various sinuses of the base.

A. The *Supercerebral* veins return the blood from the convexity as far as the Sylvian fissure, and from the