with the help of both macerated and recent specimens. Empyema of the ethmoidal cells is frequently associated with pus formation in one or several of the other pneumatic spaces, and may lead to very grave complications involving vision or even life.

The ethmoidal cells are usually absent in infant skulls. They appear about the fourth year, and reach their full development about the twentieth year.

The only effective treatment of disease of the ethmoidal sinuses is to open them freely through the nasal fossa and then to curette them. As a preliminary step, however, the middle turbinal should be more or less extensively removed.

The *orbital sinus* is situated in the orbital process of the vertical plate of the palate bone (Fig. 4314, *3*). The orbital process, therefore, from an ophthalmological and rhinological point of view, is a very important structure, whose relative anatomy should be carefully studied. It presents five surfaces, three of which are *articular*, and two free or *non-articular*. The maxillary surface looks forward, outward, and downward, and articulates with the superior maxilla; the ethmoidal surface looks inward, forward, and upward, and articulates with the lateral mass of the ethmoid, helping to close in the posterior ethmoidal cells; the sphenoidal surface looks backward, inward, and upward, and articulates with the vertical portion of the sphenoidal turbinated bone. The zygomatic surface lies in the spheno-maxillary fossa, looking toward the zygomatic fossa. The orbital surface helps to form the floor of the orbital fossa at its apex. Ordinarily the orbital pneumatic space or sinus communicates with the sphenoidal sinus. Sometimes it communicates with the posterior ethmoidal cells. On several occasions I have seen it communicate not only with both of the above-mentioned pneumatic spaces, but also with the antrum of Highmore, so that there has been a direct continuity between the maxillary, orbital, posterior ethmoidal, and sphenoidal sinuses. Under these circumstances a severe empyema of these sinuses, leading to caries of bone, could produce grave complications, jeopardizing life through extension to the brain, or vision through extension to the orbit and its contents.

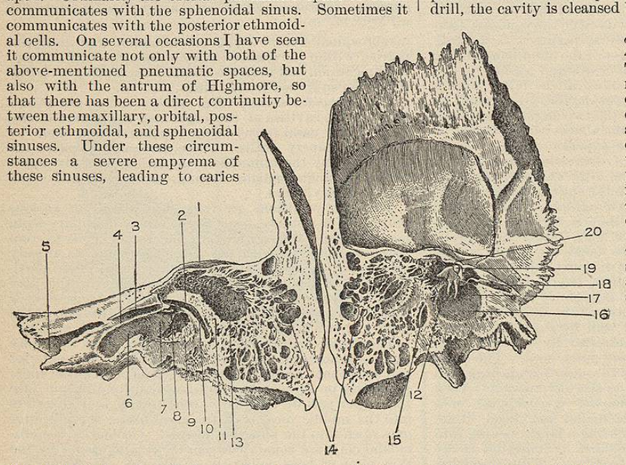

FIG. 4316.—Section through Temporal Bone showing Tubotympanic Air Chamber and Mastoid Cells; also Membrana Tympani and Auditory Ossicles. 1, Tegmen tympani over antrum; 2, external semicircular canal and aquæductus Fallopii; 3, tegmen over tube for tensor tympani muscle; 4, processus cochleariformis; 5, carotid canal; 6, Eustachian tube; 7, promontory; 8, crosses fossula rotunda to the stapes; 9, recessus hypotympanicus; 10, aquæductus Fallopii; 11, diploetic tissue at posterior part of atrium with the aquæductus Fallopi idescending through it; 13, antrum; 14, mastoid cells; 15, aquæductus Fallopii; 12, body and short ramus of incus in the attic; 16, membrana tympani; 17, manubrium of malleus; 18, tensor tympani muscle: 19, head of malleus in the attic; 20, tegmen tympani roofing attic.

The *sphenoidal sinuses* (Fig. 4314, *8*), very variable in shape and size, are usually separated from one another by a sagittally placed bony septum. This septum is frequently displaced to one or other side, and may be more or less oblique. The sinuses are situated in the body of the sphenoid and often extend well down into the pterygoid processes and out into the bases of the great wings of the sphenoid.

In front and below they are bounded, in part, by the sphenoidal turbinated bone. Above the latter an irregular opening is left by which the sphenoidal sinuses communicate with the upper and back part of the nose in the region of the spheno-ethmoidal recess. Occasionally they communicate with the posterior ethmoidal cells.

One or both of the sinuses may be absent or replaced by diploë. The sphenoidal sinus is not present at birth. The time of its appearance is stated to be the third year (Steiner), seventh year (Laurent), or the twentieth year (Tillaux).

The location of the nasal opening into the sphenoidal sinus varies very much. In empyema of the sinus a probe, or the long, slender nozzle of a syringe, can sometimes be made to enter the cavity by passing it directly backward along the inferior margin of the middle turbinal. In other cases the sphenoidal opening is more laterally placed and on a higher level. Under these circumstances the probe must cross the posterior third of the turbinal and curve outward. Certain diseases of the sinus require that it should be freely opened. The distance of the anterior wall of the body of the sphenoid from the end of the nose should be ascertained and indicated on the drill. The anterior wall should then be drilled carefully and, sufficient allowance for the penetration of the wall being made, the surgeon knows precisely the distance beyond which the drill should not be passed. A sufficient opening having been made by the drill, the cavity is cleansed by curetting.

The Tubotympanic Cavity or Pneumatic Chamber (Figs. 4309, 4315, 4316, and 4317).—This cavity, though varying much in its dimensions in individual cases, is practically of full size at birth. From an anatomical and pathological point of view it is well to remember that the tympanum consists of three very important divisions, viz., the *mastoid antrum*, the recessus epitympanicus or *attic*, and the tympanum proper or *atrium* (Fig. 4315). The recessus hypotympanicus is an arbitrary subdivision of the atrium, interesting because of its relation to the jugular fossa. At birth the mastoid cells do not exist.

The *mastoid antrum*, like the other subdivisions of the tympanum, is practically of the same size at birth as in the adult. Its roof is formed by the thin *tegmen tympani*, and extends forward as the roof of the attic and tensor tympani canal. It communicates in front with the attic. In the rest of its course it is bounded by the diploëtic and pneumatic tissue of the bone. Its vertical measurement is about 7 mm.; the transverse measurement is about 9 mm.

At birth the outer wall is bounded by a thin plate of bone belonging to the squamous portion of the temporal bone (squamosal) (Fig. 4312, *A*, *1*), and is only about 1 or 2 mm. thick, but it increases to about 10 mm. at the ninth year. Coincidently with the development of the mastoid process (which begins at the second year and reaches its maximum growth after puberty) the mastoid cells (Fig. 4315, *6* and *13*) develop

backward and downward as radiate or racemose diverticula from the tubotympanic pneumatic space, especially from the antrum, and show in different skulls the greatest possible variations. Up to the second year the tiny mastoid contains only diploëtic structure, and in the developed bone this may never be wholly displaced. Randall states that in his study of a thousand bones he found scarcely two per cent. which could be classed as diploëtic, and only about ten per cent. revealed a notable amount of diploë combined with the pneumatic spaces. No mastoid is entirely pneumatic, though we may meet with a large, thin-walled, single pneumatic space occupying the greater part of the process in senile bones.

Through osteosclerosis a solid mastoid process may occasionally be seen. The pneumatic cells, when present, are not limited to the mastoid process, but extend upward toward the squama, forward over the roof of the external auditory canal, and may extend into the zygomatic process; some generally extend into the floor of the Eustachian tube lying in close relation with the carotid artery; others may extend inward toward the temporo-occipital suture, sometimes invading the pars jugularis of the occipital bone. While a dolichocephalic skull is more likely to present a pneumatic mastoid than a brachycephalic one, and while a prominent, large mastoid is more liable to be pneumatic than a small, ill-developed one, there is no method of determining beforehand the condition of the interior of the bone.

The antrum merges, anteriorly, almost imperceptibly into the attic through a triangular-shaped, hour-glass contraction called the *aditus*, made by the outward bulging, from the inner wall of the tympanum, of the horizontal semicircular and facial-nerve canals. The boundaries of the *aditus* (Fig. 4317, *1*, *2*, *12*) are very important surgically and are as follows, viz.: *above*, the base of the triangle is formed by the tegmen tympani; the *inner boundary* is formed by a prominence of compact bone containing the external semicircular canal, and below and in front of this is the portion of the aquæductus Fallopii winding above and behind the fenestra ovalis. The bony wall of the aqueduct at this point is very thin, and at times entirely lacking, so that an inflammation of the tympanum can readily extend to the facial nerve. The *outer wall* of the aditus is formed by the deepest part of the postero-superior wall (squamosal) of the bony external auditory canal. The *apex* of the triangular aditus is formed by the junction of the outer and inner walls in this region. Ordinarily the aditus will admit an instrument about 5 mm. in diameter.

The *attic* (Figs. 4315, *3*; 4309, *24*) is broadest above where it has as its roof the *tegmen tympani*, the latter extending backward as the roof of the antrum and forward as the roof of the canal for the tensor tympani muscle. It is about 7 mm. in its antero-posterior direction, about 5 mm. vertically, and 4 mm. in breadth. The roof, sometimes deficient to a varying degree, separates the tympanic cavity from the cranial cavity; it is limited externally by the *petrosquamous suture* (Fig. 4318, *A 1*, *B 1*). This suture may remain unossified for several years after birth or even permanently and thus afford a channel by which pyogenic infection may spread from the tympanum to the meninges and brain.

The attic overhangs markedly the inner end of the external auditory canal (Fig. 4309, *7*, *24*). It opens backward into the antrum and downward and inward into the *atrium* or tympanum proper. In the rest of its course it is surrounded by the diploëtic tissue of the bone. It contains, enveloped by mucous membrane, the head of the malleus, the body and the short process of the incus, the latter projecting into the aditus.

The *atrium* or tympanum proper (Fig. 4315, *9*) is that portion of the general tympanic cavity which is below the attic and internal to the membrana tympani. It is bounded externally by the tympanic bone or annulus and the membrana tympani, which is fixed in the tympanic groove of the bony ring.

On a level with the upper edge of the membrana tympani in front of the annulus is the tympanic end of the *Glaserian fissure* (remnant of the fissura petrotympanica). Close to the inner end of this fissure, and forming a division of it, is the commencement of the *iter chordæ anterius*, which transmits the chorda tympani from the tympanum.

It is bounded internally by the outer surface of the labyrinth or internal ear. It presents, in the macerated bone, (1) a reniform opening (*fenestra ovalis*) which leads into the vestibule of the labyrinth, but in the recent state of the bone this opening is closed by the foot of the stapes, surrounded by its *ligamentum annulare*. Below this is (2) a rounded eminence (*promontory*) due to the first turn of the cochlea. (3) Above and behind the fenestra ovalis is a portion of the *aqueduct of Fallopius* or canalis facialis. (4) In front of the fenestra ovalis is the *processus cochleariformis*, which here makes a sharp turn outward, and forms a pulley over which the tendon of the tensor tympani muscle plays. (5) A funnel-shaped recess (*fossula fenestræ cochleæ*) is situated at the postero-inferior part of the promontory, and is directed toward the *fenestra rotunda*, which in the macerated bone leads into the cochlea, but in the recent state is closed by a membrane (*secondary membrana tympani*).

The anterior wall of the atrium is narrowed vertically by the ascent of the floor and descent of the roof, and transversely by the approximation of the inner and outer boundaries of the cavity. At this point are two bony parallel canals separated by the bony *processus cochleariformis* and placed one above the other. The upper is the canal for the tensor tympani muscle, while the lower is the osseous Eustachian tube. The latter communicates with the nasopharynx through the membrano-cartilaginous Eustachian tube.

The posterior wall of the atrium presents from above downward the following: 1. A minute conical bony eminence (*pyramid*). The pyramid is hollow and contains the stapedius muscle. The tendon of the stapedius perforates the apex of the pyramid, and is inserted into the posterior surface of the neck of the stapes. The base of the pyramid communicates with the aqueduct of Fallopius by one or two small foramina for the passage of the nerve and vessels to the stapedius. 2. Immediately below the pyramid is the minute aperture of the *iter chordæ posterius*, which communicates with the aquæductus Fallopii and transmits the *chorda tympani nerve* from the facial nerve to the tympanic cavity. The chorda tympani, covered by mucous membrane, passes along the upper border of the drumhead between the handle of the malleus and the vertical ramus of the incus to enter the iter chordæ anterius. 3. There is sometimes seen below the aperture of the iter chordæ posterius a rounded eminence (*prominentia styloidea*) which is caused by the forward and upward prolongation of the styloid process. The aqueduct of Fallopius continues down from the posterior part of the fenestra ovalis through the diploëtic tissue of the posterior wall of the atrium to the stylomastoid foramen.

The front part of the *floor* of the atrium is in relation with the first bend or convexity of the carotid canal. At this point the bony septum may be absent and the artery separated from the tympanum only by membrane.

It may be well to state at this point that the outer wall of the carotid canal is in very close proximity to the bony Eustachian tube, and since dehiscence of the bony septum is here more frequent, the aural surgeon should always exercise great care in bougieing this passage.

The back part of the floor of the tympanum is in relation with the jugular fossa and presents small depressions separated by slight bony trabeculæ, thus producing an irregular region that has been called the *recessus hypotympanicus*. It is important because it is often quite encroached upon by the bulb of the internal jugular vein in the jugular fossa.

At times the lateral sinus is unusually large and arches far forward. Under these circumstances the bulb of the internal jugular is unduly large, and the jugular fossa which contains it may arch well up into the floor of the tympanum and be separated from the cavity by a thin

and translucent septum of bone, or even the bone may be dehiscent. In such cases as this the bulb of the internal jugular has been wounded in performing a paracentesis of the tympanic membrane or drumhead.

In the antero-posterior direction the atrium measures about 12 mm., of which 9 mm. is bounded by the membrana tympani; from the floor of the atrium to the commencement of the attic is about 10 mm.; the narrowest part of the atrium, 2.5 mm., is caused by the outward projection of the promontory and the inward traction of the centre of the membrana tympani (*umbo*). Owing to the great obliquity of the drumhead the handle of the malleus is very obliquely placed in the drum; also the long ramus of the incus is quite oblique. The stapes, since it is placed at a right angle to the tip of the long ramus of the incus, passes upward and inward very obliquely toward the fenestra ovalis. The atrium is placed in the midst of the temporal bone, about 20–35 mm. from the entrance of the external auditory canal.

Bony Landmarks of the Skull (Figs. 4303, 4304, 4305, 4319).—Among the many landmarks of the skull the following can readily be palpated, viz.: the inion, lambda, glabella, nasion, mastoid process, the supramastoid crest, suprameatal spine, nasal spine, osseous anterior nares, the bridge of the nose, the superciliary ridges, the external and internal angular processes of the frontal bone, the infra- and supra-orbital margins, the supra-orbital notch, the malar bone, the anterior part of the temporal crest, the region of the canine fossa of the superior maxilla, the lower portions of the borders of the ramus, the angle and mental tubercle of the mandible, and the zygomatic arch.

The *inion* is about 50 mm. above the spine of the axis or second cervical vertebra and 25 mm. below the posterior pole of the cranium. The inion not being developed in the child, its position is defined by taking a point at the junction of the middle and upper thirds of a line drawn from the spine of the axis to the posterior pole of the cranium.

The *lambda* can generally be felt through the scalp and is situated about 63 mm. above the inion. The parieto-occipital fissure, in the adult, lies opposite, or a few millimetres in front of, the lambda; in the child the fissure may be as much as 25 mm. in front of it.

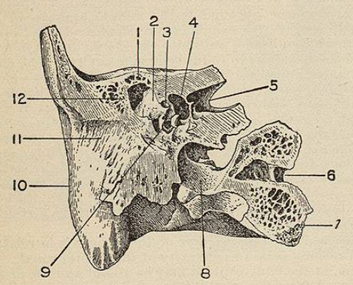

Fig. 4317.—Transverse Section through Temporal Bone and Condyle of Occipital Bone, showing especially the *Aditus*. 1, Tegmen tympani roofing in the aditus; 2, inner wall (external semicircular canal) of the aditus; 12, outer (squamosal) wall of aditus; 3, aquæductus Fallopii; 4, vestibule; 5, internal auditory canal; 6, part of anterior condyloid foramen; 7, condyle of occipital bone; 8, jugular foramen; 9, pyramid with foramen at apex for exit of tendon of the stapedius muscle; 10, mastoid portion of temporal bone; 11, external auditory canal.

The *bregma*, in the child, is occupied by the anterior fontanel; in the adult it is about a third of the distance from the nasion to the inion.

The *zygomatic arch* is a very important landmark. In the natural position of the head it is horizontal, and is on the same level as the inion and the infra-orbital margin. Its upper border about indicates the level of the lower lateral margin of the cerebral hemisphere. By tracing the upper border of the zygoma backward we shall find that it passes immediately above the tragus and the external auditory canal to become continuous with the *supramastoid crest* or posterior root of the zygoma (posterior portion of the temporal crest).

If a line is carried in a vertical coronal plane from the *pre-auricular point* on one side to that on the other, it will pass through the bregma. The *lower end* of the fissure of Rolando is situated 50 mm. vertically above the pre-auricular point.

The *pterion* cannot be felt, but may be located two fingers' breadth (37 mm.) vertically above the middle of the zygomatic arch. It locates the *Sylvian point*—the point where the fissure of Sylvius divides into its three branches; it overlies also the anterior branch of the middle meningeal artery.

The posterior extremity of the *left* inferior frontal convolution (*Broca's convolution*) is situated about three fingers' breadth (56 mm.) above the middle of the left zygomatic arch.

The junction of the motor areas for the face and arm is situated at the junction of the lower and middle thirds of the Rolandic area, which is indicated by the highest part of the *temporal crest*.

The *parietal eminence* overlies the supramarginal convolution of the brain, and therefore also the terminal part of the posterior horizontal limb of the fissure of Sylvius.

The *frontal eminence* overlies the middle frontal convolution of the cerebrum.

Slightly above the outer canthus of the eyelids is located the *fronto-malar suture*, directly above which is the *external angular process* of the frontal bone. The lower lateral margin of the frontal lobe of the cerebrum is situated 12 mm. above the tip of the external angular process. About 12 mm. below the process is a small *tubercle* on the posterior border of the malar bone; a line drawn from this tubercle to the lambda overlies the superior temporo-sphenoidal fissure (*parallel fissure*) and corresponds to the descending horn of the lateral ventricle. That part of the temporal crest which extends between the external angular process and the coronal suture is located a little above the level of the inferior frontal fissure.

Situated at the junction of the inner and middle thirds of the supra-orbital margin is the *supra-orbital notch*. A line carried downward from this notch to the lower border of the mandible and crossing the interval between the lower bicuspid teeth will pass over the *infra-orbital* and *mental* foramina, the latter being situated about midway between the upper and lower borders of the mandible, while the former is about 12 mm. below the infra-orbital margin. These foramina furnish the guides for the operation of neurectomy to relieve neuralgia of the trifacial nerve.

On a level with the crown of the last molar tooth and midway between the posterior and anterior borders of the ramus of the mandible the inferior dental nerve enters the inferior dental canal on the inner surface of the ramus of the mandible. Consequently neurectomy of this nerve can be performed by trephining the corresponding outer surface of the ramus. Since the lingual nerve lies a little anterior to the inferior dental nerve, it can be exposed through the same opening.

A landmark of interest to ophthalmic surgeons is the *lachrymal tubercle*, which is situated at the junction of the infra-orbital margin belonging to the body of the superior maxilla, and the anterior border of the lachrymal groove on the nasal process of the superior maxilla. In the operation for lachrymal fistula it serves as a guide to the position of the lachrymal sac.

The lachrymal groove is a bony groove situated between the crest of the lachrymal bone and the nasal process of the superior maxillary bone. It contains the lachrymal sac, which is the most important part of the lachrymal apparatus, since it is the seat of very disfiguring

diseases. The lachrymal groove is directly continuous with the nasal duct. The latter passes downward and slightly backward and outward to open, under cover of the anterior extremity of the inferior turbinated bone, into the inferior meatus of the nose, at the junction of its anterior fourth with its posterior three-fourths, at a distance of from 30 to 35 mm. from the posterior boundary of the nostril.

The general direction of the duct is best expressed by a line extending from the inner canthus of the eye to the interval between the premolar and the first molar tooth of the upper jaw.

The sac measures from 12 to 15 mm. in length, from 4 to 5 mm. in breadth, and about 7 mm. antero-posteriorly. It is narrowest at its termination in the nasal duct.

The nasal duct has a diameter of 3 or 4 mm., and averages about 18 mm. in length. The duct is somewhat narrower near its middle than at its lower or its upper extremity.

On the living subject by drawing the lids outward, the *internal palpebral ligament* (tendo oculi) is made tense, and can be felt as a narrow tense band passing inward transversely, and in front of the lachrymal sac, to be attached to the nasal process of the superior maxillary bone. The ligament passes a little above the centre of the lachrymal sac, and is a guide to its position. Spontaneous rupture of an abscess of the lachrymal sac almost invariably takes place just below the internal palpebral ligament. In opening a lachrymal abscess in this the best location, the incision should be made a little external to the angular artery.

The position of the mastoid antrum is represented by Macewen's *suprameatal triangle*, situated a little behind and above the bony external auditory canal. This triangle is bounded by the postero-superior segment of the bony external auditory canal below, by the supramastoid crest above, and by an imaginary line joining the above boundaries. According to Macewen, if the aperture of the bony external auditory canal be bisected horizontally, the upper half would approximately be on a level with the mastoid antrum. On bisecting this upper segment vertically its posterior half would correspond roughly to the junction of the antrum and the attic, and immediately behind this is the suprameatal triangle.

Macewen states that the level of the base of the brain will be 1 or 2 mm. above the supramastoid crest and about 5 or 6 mm. above the roof of the osseous external auditory canal.

The supramastoid crest, which indicates the roof of the antrum as well as the floor of the middle cranial fossa, may vary as much as 20 mm. down or up. Measurements on large numbers of skulls show that the middle cranial fossa is never 10 mm. below the supramastoid crest. But the crest is sometimes imperfectly developed and cannot be relied upon as a landmark.

The *suprameatal spine* is situated at the postero-superior portion of the aperture of the bony external auditory canal, and has the suprameatal triangle or fossa back of it (Fig. 4304, *28 a*). This spine can almost invariably be recognized as indicating the postero-superior portion of the opening of the bony meatus. Randall states that he has found the floor of the middle cranial fossa as low as this spine only five times in one thousand bones. It averages about 6 mm. above the spine. The suprameatal spine is a safer guide for avoiding the middle fossa of the cranium than is the supramastoid crest.

In opening the mastoid sinuses it should be borne in mind that the *mastoid foramen*, extending from that portion of the groove for the lateral sinus called the *sigmoid fossa*, and terminating on the exterior at or near the occipito-temporal suture, is very variable in size. It usually transmits a small emissary vein from the lateral sinus to the occipital vein. Sometimes the foramen may be so large as to transmit all the blood from the lateral sinus to the external jugular vein.

The sigmoid fossa, and consequently the lateral sinus, varies very much in its outward curving; it may even project to the external cortex or table of the mastoid process.

In operating upon the mastoid antrum the surgeon chisels away the bone immediately behind and above the postero-superior quadrant of the osseous external auditory canal and endeavors to avoid the *middle fossa* of the cranial cavity by keeping below the suprameatal spine. In opening the mastoid cells he hopes to avoid the *lateral sinus* by chiselling obliquely to the surface and keeping parallel with and close to the external auditory canal. He avoids the *descending portion* of the *facial nerve* by not encroaching upon the lower half of the deepest portion of the posterior wall of the osseous canal.

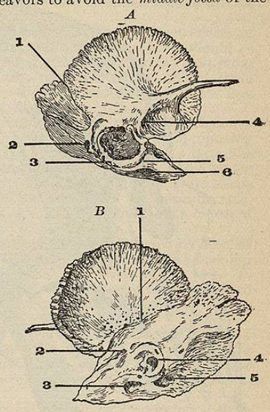

Fig. 4318.—Temporal Bone at Birth. *A*, Outer view. 1, Petrosquamous suture; 2, stylomastoid foramen; 3, tympanic plate; 4, postglenoid tubercle; 5, petrotympanic suture; 6, carotid canal. *B*, Inner view. 1, Petrosquamous suture; 2, hiatus Fallopii; 3, internal auditory canal; 4, floccular fossa; 5, aquæductus vestibuli.

On account of the non-development of the mastoid process and the tympanic plate in the infant the stylomastoid foramen is situated upon the *lateral surface of the skull* instead of at its base (Fig. 4318, *A*, *2*). Hence the facial nerve emerges from the foramen immediately behind the annulus, and is unprotected. Therefore in infants the incision through the integument and subjacent soft parts, for the purpose of reaching the cranial wall, should not extend too far forward and downward, otherwise the facial nerve will be severed.

Cranio-encephalic Topography (Fig. 4319).—In the study of what is commonly called *cranio-cerebral* topography, it should be clearly understood that we are to deal not only with the cerebrum, but also with the cerebellum, the ganglia of Gasser, and the brain's meninges or coverings; and the dura mater contains the middle meningeal arteries, and those venous channels called lateral sinuses and superior longitudinal sinus, not to mention other structures of less conspicuous importance from the point of view of applied anatomy. Also in relation with the arachnoid mater is the *cisterna magna*, the largest of the subarachnoidan spaces.

It would seem that the use of the term *cranio-encephalic* topography would be more conducive to accuracy than the more commonly employed expression craniocerebral topography. It may not be amiss to recall the fact that cranio-encephalic topography must not be confounded with the cranioscopy of the phrenologists, a pseudo-science founded by Gall. Gall quite arbitrarily localized the different intellectual faculties in various parts of the brain, and attempted to establish a relation between certain irregularities or bumps on the surface of the skull and the parts of the brain in which were resident the intellectual faculties. It is now known that the irregularities and bumps of the external table of the cranial walls have no relation whatever with the inequalities of the internal table, and still less have they anything in common with the configuration of the brain's various components.

The human skull varies greatly, in the details of its

conformation, according to race, age, sex, and even stature, not to mention pathological variations. In no two individuals of the same race, age, sex, and stature are the skulls ever precisely alike; nor, under such circumstances, are the fissures and convolutions of the brain ever identical in pattern. The relations of the brain's convolutions and fissures to definitely chosen anatomical points on the surface of the skull or scalp vary in individuals of the same race, etc. Lastly, as the convexity or surface area of the brain is always less than the outer surface area or convexity of the skull, and still less than the surface of the scalp, lines drawn on the scalp cannot always correspond exactly to the fissures and convolutions of the brain.

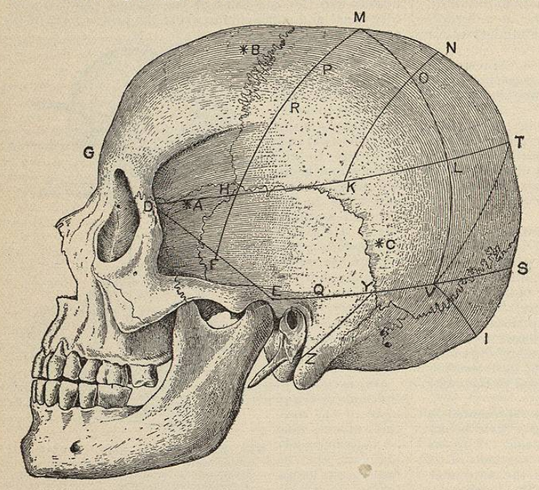

FIG. 4319.—Chiene's Guiding Lines in Cranio-Encephalic Topography. *G*, glabella; *I*, inion and indicates site of torcular Herophili; *M*, mid-point between *G* and *I*; *T*, three-quarter point between *G* and *I* and overlies parieto-occipital fissure; *S*, seven-eighth point between *G* and *I*; *E*, pre-auricular point on root of zygoma; *Q*, post-auricular point on supramastoid crest; *Y*, a finger's breadth behind *Q*; *V*, mid-point of line *E S* and marks highest convexity of lateral sinus; *Z*, near tip of anterior border of mastoid process; *D*, external angular process of frontal bone; *F*, mid-point on line *D E* and overlies point of bifurcation of middle meningeal artery; *H*, Sylvian point located by intersection of the Sylvian line *D T* and the line *F M*; this Sylvian point overlies the Sylvian point of the fissure of Sylvius and also the anterior division of the middle meningeal artery; *L* indicates angular gyrus and extremity of parallel fissure and is located by the intersection of line *D T* and line *V M*; *K*, mid-point of line *H L*; *H M*, precentral line and overlies precentral fissures; *K N*, line drawn from *K* to median sagittal plane parallel with *H M* and is the postcentral line; *H A*, anterior horizontal limb of the Sylvian fissure; *H K*, posterior horizontal limb of the Sylvian fissure; *O K L*, triangular area indicating parietal eminence, supramarginal convolution, and terminal part of Sylvian fissure; *R*, at the level of the temporal crest and on line of inferior frontal fissure; *P*, on line of superior frontal fissure; *T V* courses a little in front of the lambdoid suture; *T V I*, triangular area indicating occipital lobe of cerebrum; *I V Y Z*, guiding lines for lateral sinus; below *I V Y Z* is the region of the cerebellar hemisphere; *F E V L H*, pentagon indicating temporal lobe of the cerebrum except the apex which projects a finger's breadth downward, forward, and inward from *F*; *H K N M*, parallelogram indicating cortical motor area (Rolandic area); **A*, site for opening subarachnoid space; **B*, Kocher's point for tapping the lateral ventricle; **C*, Keen's point for tapping the lateral ventricle; *Y Z*, indicating anterior limit of lateral sinus.

In view of the preceding facts the well-informed anatomist knows that the anatomical lines used in cranio-encephalic topography to locate fissures, convolutions, and areas of the brain are simply approximations—approximations that have been correlated from examinations of many brains and skulls. Fortunately, these approximations are found to be exceedingly useful as reliable guides in surgical anatomy. Practically, the surgeon uses the lines and points correlated by the anatomist, and overcomes the difficulties due to variations in individuals, by removing a greater area of the cranial wall than that indicated to him by the anatomist's lines and points as corresponding to the portion of the encephalon which he desires to expose. The brilliant results of modern cerebral surgery clearly proclaim the practical utility of the anatomist's approximations in cranio-encephalic topography.

Many methods have been devised for mapping out the relations of the scalp to the cranial contents. From a clinical point of view, that introduced by Professor John Chiene, of Edinburgh, is a very simple and useful one (Fig. 4319). His method is as follows, viz.: The head being shaved, the *mid-point* (*M*) is located in the sagittal plane of the vertex from the glabella (*G*) to the inion (*I*); then the *three-quarter point* (*T*); and then the *seven-eighth point* (*S*). Next locate the *pre-auricular point* (*E*) on the root of the zygoma, and the *external angular process* (*D*) of the frontal bone. Having located these points join *D T*, *E S*, and *D E*. Bisect *E S* at *V* and *D E* at *F*. Draw the line *F M* and also the line *V M*. Bisect *H L* at *K* and draw a line from *K* to *N* parallel to *H M*. Trisect *H M* at the points *R* and *P*. Draw a line from *T* to *V* and another from *V* to *I*. A finger's breadth (18 mm.) posterior to the *post-auricular point* (*Q*) is the point *Y*; at the tip of the anterior border of the mastoid process is the point *Z*. A line drawn from *Y* to *Z* indicates the anterior border of the mastoid portion of the *lateral sinus*. The line *H M* corresponds to the *precentral fissures*, and may be called the *precentral line*. The points of its trisection correspond to the posterior extremities of the *superior* (*P*) and *inferior* (*R*) *frontal fissures*. The line *D T* is called the *Sylvian line*; it intersects the precentral line at the point *H*, which corresponds to the *Sylvian point* of the fissure of Sylvius, and also to the *anterior division* of the middle meningeal artery. *H A* corresponds to the anterior horizontal limb of the Sylvian fissure, and *H K* indicates the posterior horizontal limb of the fissure of Sylvius. This posterior limb of the Sylvian fissure terminates at the parietal eminence in the triangle *K O L* at the level of the temporal crest, indicating the position of the supramarginal convolution. The point *T* is the termination of the Sylvian line, and is somewhat in advance of the *parieto-occipital fissure*. The triangle *T V I* corresponds to the outer surface of the occipital lobe of the cerebrum. The line *I V* about corresponds to the tentorium cerebelli and the upper margin of the *lateral sinus*, while the line *V T* is a little above the *lambdoid suture*. The upper portion of the line *K N* corresponds to the *superior postcentral fissure*, but the lower part of the line is somewhat behind the *inferior postcentral fissure*; the line *K N* may be called the *postcentral line*.

The parallelogram *H K N M* overlies the ascending parietal and ascending frontal convolutions separated by the *central fissure* (fissure of Rolando), and hence corresponds to the cortical motor area (*area of Rolando*). The pentagon *F E V L H* outlines the *temporal lobe* of the cerebrum, except the apex; the latter is directed forward, downward, and inward about 18 mm. (a finger's breadth). About 18 mm. below the line *H L* is the superior temporal fissure (*parallel fissure*), which turns upward and terminates at *L*, thus indicating the position of the *angular gyrus*.

By drawing a line on the scalp from a point 12 mm. behind the mid-sagittal point (*M*) downward and forward for 8.5 cm. and at an angle of 67° to the sagittal line, the *fissure of Rolando* will be mapped out.

The inion *I* corresponds to the *torcular Herophili* and thus overlies the point of junction of the superior longitudinal, straight, lateral, and occipital sinuses. The groove for the lateral sinus may be mapped out by drawing a line from a point 1 or 2 mm. above the inion, in a slightly curvilinear direction with the convexity upward, to the point *V* at the postero-inferior angle of the parietal bone. The point *V* forms the highest part of the convexity of the sinus. From this point the upper margin of the sinus follows the line *E V* for 25 mm.; it then curves forward and downward to a point 18 mm. below and behind the centre of the external auditory canal. The anterior border of the mastoid portion is indicated by the line *Y Z*.

The groove for the superior longitudinal sinus extends from the glabella to the inion. It increases in size from before backward and usually becomes continuous with the right lateral sinus. The edge of the trephine should be maintained at least 18 mm. from the mesial plane when the skull is opened over the posterior part of the vertex.

After the *middle meningeal artery* enters the middle cranial fossa through the foramen spinosum it runs outward and forward for about 37 mm. to the point *F*, which is located about a finger's breadth (18 mm.) above the mid-point of the zygomatic arch. It here divides into anterior and posterior divisions. The anterior division passes, with a slight convexity forward, across the pterion upward and slightly backward behind the coronal suture. It gives off branches which ascend over the Rolandic area corresponding to the parallelogram *H K N M*. This anterior branch corresponds to the lower two-thirds of the precentral line *H M*. In trephining over the lower part of the Rolandic area, especially over the cortical motor centres for the face and tongue, this anterior division will be encountered.

The *posterior division* of the middle meningeal artery passes backward almost horizontally toward the postero-inferior angle of the parietal bone. It may be indicated on the exterior of the cranial wall by drawing a line backward from the point *F* (which is 18 mm. above the mid-point of the zygomatic arch) parallel to the line *E V*.

When the calvarium is removed in the recent state the meningeal arteries will be found intimately adherent to the dura mater. The middle meningeal artery is the only one of them that is of surgical importance. In fractures of the skull the artery is frequently ruptured; the extravasated blood will generally be found between the cranial wall and the dura mater, and beneath the clot will be found the bleeding point of the artery.

To expose the anterior division of the artery the point of the trephine should be applied over the Sylvian point *H*.

To expose the posterior division of the artery the point of the trephine may be applied a finger's breadth (18 mm.) above the zygomatic arch and the supramastoid crest between the points *E* and *V*.

To expose the main trunk of the meningeal artery between the foramen spinosum and the point of bifurcation at *F*, the trephine is applied immediately above the mid-point of the zygomatic arch. When the anterior division of the meningeal vessel is ruptured the extravasated clot presses upon the temporo-parietal portion of the cerebrum and induces motor symptoms through pressure upon the centres for the face and arm; when the *frontal* branch of the meningeal's anterior division is wounded, the clot of blood is in the temporo-frontal region of the cerebrum and produces pressure symptoms in the motor area for the face, and in addition, on the left side, involves Broca's convolution. Wounds of the meningeal's posterior division involves the occipito-parietal region and the pressure symptoms are sensory.

To reach the lateral hemisphere of the cerebellum the point of the trephine is placed over the mid-point of a line drawn from the inion to the tip of the mastoid process. In turning down the flap for this operation the mastoid emissary vein and the occipital vessels will be divided.

To tap the lateral ventricle at the commencement of its descending horn the point of the trephine should be placed a finger's breadth (18 mm.) below the mid-point of the line *K L*; in this operation only 1 cm. of brain tissue is penetrated through the posterior half of the first temporal convolution.

The asterisk at *C* overlies the site chosen by Keen for tapping the lateral ventricle; he makes an opening through the cranial wall 31 mm. above Reid's base line and the same distance behind the external auditory canal; he then passes the instrument into the brain tissue toward the summit of the auricle on the opposite side. The undistended ventricle will be reached at a depth of 5 cm. from the surface.

The asterisk at *B* indicates the site selected by Kocher for draining the lateral ventricle. He makes an opening two fingers' breadth (31 mm.) in front of the point *P*, the instrument being directed backward and downward through the superior frontal fissure for a depth of 4 or 5 cm.

The asterisk at *A* overlies the site at which the point of the trephine is entered for draining the subarachnoid space; a small trephine should be used and the operator should be careful to keep in front of the middle meningeal artery.

The cisterna magna is reached by trephining a little above the foramen magnum and a little to one side of the external occipital crest so as to avoid the occipital sinuses.

Daniel Kerfoot Shute.

SKULLCAP.—(*Scutellaria*, U. S. P.). The dried herb, *Scutellaria lateriflora* L. (fam. *Labiatæ*). This genus consists of bitter perennials, nearly destitute of the aromatic properties found in most species of this large family, and further distinguished by a peculiar helmet-like development of the upper sepal, to which it owes its name. Calyx two-lipped, persistent; closed-in fruit until maturity, when it splits and opens widely. Corolla bilabiate, ascending; stamens four, also ascending, and under the upper lip of the corolla; lower anthers one-celled. Leaves opposite, petiolate; flowers axillary, usually solitary, sometimes in apparent spikes or racemes. There are nearly two hundred species, forming a very distinct and natural genus, distributed over nearly the whole north temperate zone. There are about a dozen in the United States, and several of them are used like the official, from which they are distinguished in trade by the appellation "Western skullcap."

The official drug is thus described:

Dark green, smooth, or slightly puberulent on the younger portions, the branches elongated, slender, sharply quadrangular; leaves opposite, exstipulate, shortly petioled, the blades rarely exceeding 8 cm. (3 in.) long and about a third as broad, ovate, rounded or truncate at the base, acuminate, obtusish or acutish, shortly and obtusely serrate, thin, veiny; flowers in axillary, peduncled, mostly simple and secund racemes, nearly sessile, about 6 mm. (¼ in.) long, the calyx bilabiate, in fruit becoming closed and developing a large helmet-shaped crest, the corolla deep blue, bilabiate, the stamens didynamous; fruit of four depressed, globose, papillose nutlets.

So-called "Western scutellaria," more or less rough gray-hairy and with much larger flowers, in terminal panicles, is not of this species.

Skullcap contains a very little volatile oil, and its bitter principle has been called *scutellarin*.

The Scutellarias have had from time to time some transient or popular reputation in medicine for the cure of mad-dog bites, chorea, epilepsy, or other nervous diseases; also as tonics, antiperiodics, etc. The official species is considerably used by the eclectic school of prac-