inches, according to the locality from which they are taken and the skill of the operator and his assistant. Very wide grafts may be got from the comparatively flat surface over Scarpa's triangle. As fast as cut, the grafts should be dropped into a bowl of salt solution.

The manner of cutting the grafts is illustrated in Fig. 4301.

In about ten minutes oozing will have ceased, the compress may be removed, and the grafts applied. It will be found that they have curled, with the cut surface inside. To uncurl them, place one end on the surface to be grafted, uncurl it, and keep it uncurled by pressure with a finger of the left hand. The whole graft may now be uncurled by making a rapid to-and-fro motion with a finger of the right hand, and carrying it along the entire length of the graft. The graft is now flat upon the surface and can be moved about with the fingers or probe. The grafts should be made to meet or overlap each other, and also the surrounding skin. Overlapping does no harm, for the superficial edge of a graft will die from lack of nutrition and come away, leaving a mere line of union visible. If not enough grafts have been cut, more should now be cut and applied directly. When the whole surface has been covered, douche it gently with salt solution, and apply the gutta-percha strips in the following manner: Lay one end upon the sound skin at one side of the wound and secure it by a thumb, then, with a winding motion, lay the strip across the wound and out upon the sound skin beyond. In this way the strip is laid on without in any way disturbing the grafts. Let the next strip slightly overlap the first. Continue imbricating each upon the last till the whole surface is covered by the tissue. If the surface is on an extremity, take a wet gauze bandage and apply a snug spiral to hold the tissue and grafts firmly in place. Next apply damp salt gauze, a sheet of gutta-percha tissue to maintain the moisture, sublimate gauze, cotton, a bandage, and a splint suitable to the region. The surface from which the grafts have been taken may be covered with gutta-percha tissue and moist gauze. This is a particularly comfortable dressing, but any simple dressing will answer.

It is advisable to change the dressings every two days for the first eight days. At the end of six days the gauze had best be allowed to dry, by omitting from the dressings the sheet of gutta-percha tissue. This will obviate too great maceration of the horny layer of the grafts, and fit them sooner to withstand the wear and tear of exposure. At the end of ten days the gutta-percha strips are no longer needed. If there are any spots of granulation from faulty adjustments of the grafts, they had best be covered with yellow adhesive plaster. If the surface is uniformly covered with grafts, it needs only to be protected for a few days by a piece of cloth spread with lanolin or vaseline.

Fig. 4301.—Taking the Grafts.

To illustrate the value of Thiersch skin-grafting, the citation of a single case in which it was particularly called for and achieved its fullest function will suffice.

In August, 1889, C. A——, a girl, aged twelve, met with an injury by which a very large skin flap was torn from about the right knee. It involved the inner side of the thigh, knee, and leg, and extended outward beyond the ligamentum patellæ and crest of the tibia. In the following November I grafted the surface. Her general condition was poor, and I did not think it wise to continue anæsthesia long enough to cover the large area completely; a portion was only partially covered with grafts, and intervening spaces about half an inch wide were left to cicatrize. In four weeks healing was firm. The limb had been in splints for more than a third of a year, and, when they were left off, there was scarcely any motion at the knee. A cylinder of cloth, stiffened by a covering of oiled muslin, was spread with vaseline and suspended about the limb for a few weeks to guard it from harm. Exercise of the limb was encouraged, and occasionally moderate force was used to aid flexion. In March, 1890, the knee came to a right angle, and she was able to go upstairs one foot after the other. Freedom of motion became progressively greater until it was as perfect in the right knee as in the left, and the limb as useful as before the injury. The accompanying figure (4302) is from a photograph of the case taken in May, 1892, and shows how the grafted area offers no hindrance whatever to complete flexion.

Theodore Dunham.

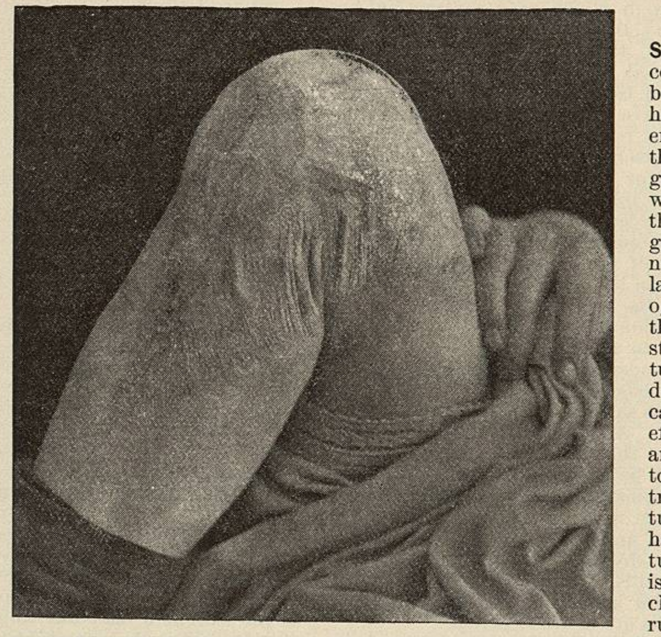

Fig. 4302.—Shows the Condition of the Knee (in Case C. A.) in May, 1892.

SKIN, TUBERCULOSIS OF THE.—The discovery of the tubercle bacillus by Koch has had two effects on modern dermatology. One is the formation of a new group of dermatoses in which actual proof of the existence of the organism has been furnished according to the laws of general pathology, and the other is the attempt at reconstruction in the disturbed pre-existing dermatological classifications. This second effect has in turn caused another group of diseases to appear which in contradistinction to the true tuberculoses of the skin have been called toxituberculids. The group is a large one and includes lichen scrofulosorum, erythema induratum, lupus erythematosus, lupus pernio, and certain rare dermatoses. Although it is not unlikely that future investigations may yet place some of the toxituberculids in the list of cutaneous tuberculosis, they should not at the present time be so regarded.

As in tuberculosis situated in other parts of the body,

three methods are known by which a lesion may be recognized as tuberculous. (1) The recognition of the tuberculous granuloma which consists of new-formed connective tissue and giant cells, and which is sufficiently characteristic for diagnostic purposes. (2) The actual presence of the bacilli. (3) The test by inoculations of guinea-pigs with the suspected tissue. Briefly speaking, all the cutaneous diseases which have up to the present time been identified by either of the last two methods as tuberculous have all contained the tuberculous granuloma, and those diseases which have from time to time been regarded as of possible tuberculous nature on clinical grounds, and which have not contained the specific granuloma, have failed to give positive bacteriological results in the end.

While there are a few other rare affections which might be added, roughly speaking, true cutaneous tuberculosis may be classified under five heads:

(1) Tuberculosis verrucosus cutis.
(2) Tuberculosis cutis orificialis.
(3) Tuberculosis disseminata.
(4) Lupus vulgaris.
(5) Scrofuloderma.

I. Tuberculosis Verrucosus Cutis. — (Synonyms: Verruca necrogenica; Lupus verrucosus; Lupus scléreux [Vidal]).

This type of cutaneous tuberculosis was first well described in 1886 by Riehl and Paltauf. These authors gave a description of the histology of the lesions and identified the bacillus in cases inoculated from diseased animals. They also showed the similarity of their cases with anatomical wart, and since the publication of their paper the two affections have been classified together.

Verruca necrogenica, or anatomical wart, consists in a lesion due to the handling of dead bodies, and is due to direct inoculation from this source. Its favorite site is on the back of the knuckles, and consists of the occurrence of pea-sized warts, which are extremely chronic in their course. They are apt to be fissured and pigmented, and at times become crusted from superficial infection and pustulation. The typical lesion of tuberculosis verrucosus cutis has slight clinical differences. Its favorite site is the back of the hand and forearm. The lesions start as small ovoid warty patches which extend peripherally at an extremely slow rate until they involve considerable areas of the skin. Associated with the warty development are often papules of a dark purple color and more or less hyperæmia of the skin. The surface is apt to be moist and crusted, and pus can usually be expressed from between the warty excrescences. The central portion may undergo involution into the scar-like atrophic skin seen in an old lupus case. True ulceration does not occur, but involvement of the lymph glands draining the area is not infrequent. As rare sequelæ may be mentioned infection of the lymph channels with the formation of tuberculous nodules which break down and form ulcers, and the extension of the disease to the lungs.

Etiology.—The known sources of infection are the sputum of phthisical subjects and infected meats. As regards the first, mention may be made of children who in creeping around the floors of hospital wards have become infected on the front of the knees, direct infection during ritual circumcision, and cases of auto-infection in phthisical subjects. Infection from meats occurs in cooks, butchers, handlers of hides, and in those who have charge of tuberculous cattle.

Pathology.—In these lesions the tubercle bacilli exist in larger number than in lupus vulgaris, but they are less numerous than in tuberculosis cutis miliaris. They cause less reactive connective-tissue growth than in lupus vulgaris, and the corium is not completely filled with the granulomatous development. The papillæ above the infiltration are enormously hypertrophied in height, and if seen without the underlying tuberculous corium they cannot be distinguished from many other warty growths. In this type the tuberculosis appears as a linear infiltration quite unlike the nodular appearance of lupus vulgaris, but both giant cells and cheesy degeneration are always present. In cases that have been infected from without, small abscesses and cocci can be noted in the superficial portion of the section, but they have no pathological value.

Diagnosis.—Small anatomical warts may at times be distinguished with difficulty from simple warts, especially if the history of the patients does not show the mode of origin. In such cases excision of a piece for diagnostic purpose is justifiable, and will clear up the diagnosis. The larger types of verrucous tuberculosis somewhat resemble patches of chronic eczema, but they can usually be differentiated by the fact that eczema is harder and less friable, instruments do not easily penetrate the lesion, and there is never any tendency to the formation of scar tissue in eczema.

Treatment.—The indications for treatment do not differ from that of other forms of tuberculosis of the skin. The overlying hypertrophic tissue should be removed by instruments and the tuberculous tissue thoroughly scraped away with the curette or destroyed by caustic applications. Strong salicylic-acid plasters repeatedly applied have been recommended for the removal of the excessive epithelial growth. These in turn have to be followed by some caustic, as acid nitrate of mercury. This method is especially valuable in lesions of large area in which it is desirable to treat small portions at a time, but it has the disadvantage of being painful.

II. Tuberculosis Cutis Orificialis. — (Synonyms: Tuberculosis cutis vera; Miliary tuberculosis of the skin; Tuberculosis ulcerosa.)

This form of cutaneous tuberculosis is due to the secondary involvement of the skin either by contiguous extension from tuberculosis of the mucous membranes or by an infection from a contaminated discharge of a remote tuberculosis of the viscera.

In the beginning the lesions consist in a number of miliary tubercles. These rapidly coalesce and break down, the resulting ulcer forming the typical lesion of the disease. The main characteristics of the ulcer are the same as those of tuberculous ulcers situated on the mucous membrane. The floor is made up of indolent reddish-yellow tuberculous tissue in which the single miliary tubercles are apparent, if they are not covered up by a superimposed development of granulation tissue, and the edges are, as a rule, rather irregular in contour. The compactness of the tuberculous tissue and the superficial nature of the ulceration allow of only a thin purulent discharge, which may or may not result in the formation of a crust. Generally there is little pain. The course is slow, although more rapid than that of lupus vulgaris. Although cases have been reported to have healed by cicatrization, nearly all the ulcers show no tendency to improve, but gradually spread by peripheral extension.

The regions commonly affected are those of the mouth, anus, and genitalia. Kaposi has reported twenty-two cases, and has added much to the accepted knowledge of the disease. He states that the condition is not of extreme rarity, nor is it confined to advanced stages of tuberculosis of the lungs or other viscera.

Treatment.—Treatment consists usually in palliative methods, as dusting with iodoform or applying antiseptic solutions, but little hope can be entertained of a cure of the lesions without destructive interference with the base of the ulcers.

III. Tuberculosis Disseminata.—In this class are included the rare examples of tuberculosis which show a general cutaneous distribution. Very few cases have been reported, but they are in sufficient numbers to demonstrate the possibility of tuberculosis becoming disseminated by the circulation. The diagnosis in the cases reported by Pelagatti and others was confirmed by pathological findings. Most of the patients were young children, but the lesions do not seem to be identical. At times the eruption is unusually acute for a tuberculosis, and consists in the formation of papules, pustules, and vesicles in which the bacilli can be demonstrated, and at other times the lesions have appeared more like the papules of lichen scrofulosorum, in which case their evolution shows the distinctive chronicity of the process.

Little needs to be said on the diagnosis, for it depends on the demonstration of the germs either by sections or by inoculation. The prognosis is subservient to that of the other lesions of tuberculosis which are commonly present. The treatment does not differ from that of lupus vulgaris or other tuberculous deposits.

IV. LUPUS VULGARIS. See *L. Vulgaris*.

V. SCROFULODERMA. See *Scrofuloderma*.

Oscar H. Holder.

SKULL, THE.—The characters that may be noted in the skull are very numerous. They can be divided into *descriptive*, which gives an account of the conformation of the bony structure of the skull and its parts; *topographical*, which is of special importance in practical medicine; *craniometrical*, which gives the dimensions of the various parts of the skull by exact measurements taken by means of special instruments; and *comparative*, in which the human skull is contrasted more particularly with those of the anthropoids.

The skull may also be investigated from the points of view of embryology and general morphology.

This article will deal especially with the applied anatomical and the craniometrical characters of the skull, though presenting very briefly such descriptive and comparative matter as is necessary for an adequate treatment of the subject.

THE EXTERIOR OF THE SKULL (Figs. 4303 to 4305).—The skull in a general way is spheroidal in shape. It is flattened and uneven below, compressed from side to side, and smooth above. It presents, externally, six regions for investigation, viz.: an inferior region or base (*norma basilaris*), two lateral regions (*norma lateralis*), a posterior or occipital region (*norma occipitalis*), an anterior or frontal region (*norma frontalis*), and a superior region or vertex (*norma verticalis*).

Many *sutures* can be noted. The sutures are the lines of union of the facial (excluding the mandible) and cranial bones.

The uneven edges of the bones form closely fitted articulations (*synarthroses*) and are separated only by a fibrous membrane continuous with the dura mater and periosteum. The only places where cartilage intervenes, forming *synchondroses*, are the basilar and jugular portions of the occipital bone at the base of the skull. These cartilages are ossified in the adult. The sutures bind the bones so firmly together, by being bevelled alternately on each side, that dislocations are practically impossible. They diminish shocks, and during early life permit a rapid growth of the skull. The sutures, with the exception of the coronal (fronto-parietal), sagittal (interparietal), and lambdoid (occipito-parietal), are best named from the bones which form them.

The skull, whether viewed from the norma frontalis, the norma lateralis, the norma basilaris, or the norma occipitalis, displays well the teeth.

In its highest development the typical mammalian dentition is indicated by the following formula:

$$i\,\tfrac{6}{6}\;c\,\tfrac{2}{2}\;pm\,\tfrac{8}{8}\;m\,\tfrac{6}{6} = \tfrac{22}{22} = 44.$$

Man presents the following formula:

$$i\,\tfrac{4}{4}\;c\,\tfrac{2}{2}\;pm\,\tfrac{4}{4}\;m\,\tfrac{6}{6} = \tfrac{16}{16} = 32.$$

Accordingly in man two incisors and four premolars are wanting in each dental arch. Anatomists entertain divergent views as to which teeth have been suppressed; most probably the second incisors on either side of the median line, and the first and second premolars on either side are the ones that have disappeared.

All the teeth are alike in form in most vertebrates below mammals and in them the dentition is *homodont*. The dentition is described as *heterodont* in most of the mammals, since in them the teeth are arranged in groups of different form and size.

The jaws of the oldest known fossil mammals have tritubercular teeth with the tubercles arranged in an antero-posterior line. Since practically all the lower vertebrates possess simple conical teeth, it is quite prob-

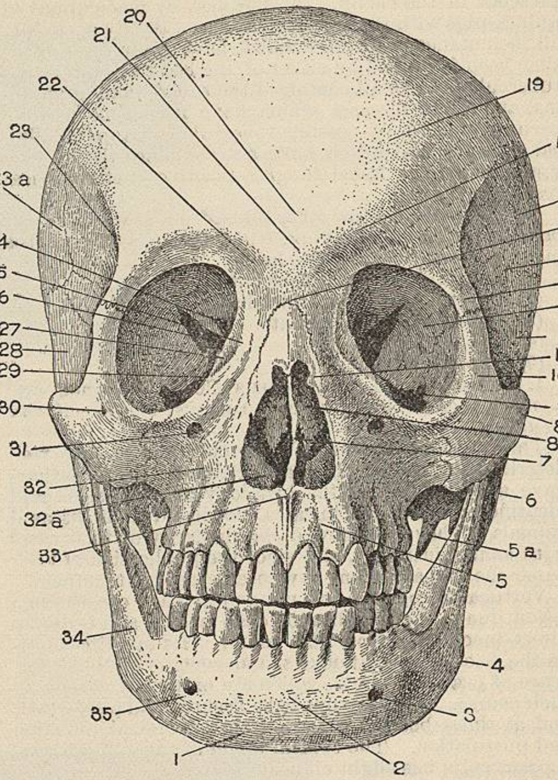

FIG. 4303.—Norma Frontalis. 1, Mental tubercle; 2, symphysis menti; 3, mental foramen; 4, angle of jaw (gonion); 5, incisor fossa; 5*a*, styloid process; 6, mastoid process; 7, nasal septum in middle of anterior nasal aperture; 8*a*, middle turbinated bone of ethmoid; 8, zygomatic arch; 9, sphenomaxillary fissure; 10, malar bone; 11, nasal bone; 12, 15, 17, temporal fossa, the sutures of which are obliterated; 13, orbital surface of great wing of sphenoid; orbital sutures are obliterated; 14, external angular process of the frontal bone; 16, nasion; 18, superciliary ridge; 19, site of frontal eminence; 20, ophryon; 21, glabella; 22, supra-orbital margin; 23 temporal crest of frontal bone; 23*a*, antero-inferior angle of parietal bone, articulating with frontal, great wing of sphenoid, and squamous portion of temporal; 24, optic foramen; 25, nasal process of superior maxilla; 26, sphenoid fissure; 27, lachrymal groove bounded posteriorly by lachrymal crest; 28, squamous portion of temporal bone; 29, lachrymal tubercle; 30, malar foramen; 31, infra-orbital foramen; 32, canine fossa; 32*a*, inferior turbinated bone; 33, subnasal point at root of anterior nasal spine; 34, ramus of mandible; 35, mental foramen.

able that the earliest toothed vertebrates in the phylogenetic series likewise possessed simple conical teeth. The method of development of the tritubercular mammalian tooth from the simple conical one has given rise to much speculation. One theory teaches that the single conical tooth developed lateral buds which, growing larger, induced in the tooth the antero-posterior tritubercular form. A second theory is that in consequence of the shortening of the jaw and crowding together of the several simple conical teeth, fusion into tritubercular teeth occurred. By rotation of two of the tubercles from the antero-posterior direction *laterally* either in or out, a form of tritubercular molar was produced in certain other fossil skulls which makes easy the transition to an ordinary mammalian molar.

The roots of the upper bicuspids and of the lower canines and incisors are flattened, and hence must be loosened by lateral movement in extracting them; the lower bicuspids and the upper incisors and canines have cylindrical roots, therefore these teeth should be first loosened

Skull.
Skull.

by a slight rotatory movement during extraction; the roots of the first and second upper molars are three and they are frequently divergent; the roots of the wisdom teeth are convergent, generally curved backward and welded together, particularly in the lower jaw.

THE INTERIOR OF THE SKULL.—A study of the interior of the skull is of the greatest importance from a topographical point of view. In order that the interior of the skull may be investigated to the greatest advantage it is necessary to make sections in three different planes —horizontal, sagittal, and coronal. These sections not only facilitate the study of the numerous points on the interior of the skull, but also reveal the great preponderance in size of the cranial cavity over those situated in other parts of the skull.

A skull bisected in any of the planes recommended shows that its walls consist of an outer and inner table of compact bone and an intervening or connecting cancellous diploë. The spaces of the diploë contain veins communicating in the interior of the cranium with the meningeal veins and the sinuses of the dura mater, and on the exterior of the skull with the veins of the pericranium. There are other apertures in the cranial wall through which *emissary veins* pass that also establish communication between the sinuses of the dura mater inside the skull and the veins external to it.

These veins pass through the mastoid, parietal, the posterior and anterior condyloid foramina; others pass through the foramen ovale, the foramen lacerum medium, and through the foramen of Vesalius. Through these diploic and emissary veins pyogenic infection may extend from the outside of the skull, leading to osteophlebitis of the diploë and inflammation of the membranes of the brain. By means of the emissary veins blood may be abstracted almost directly from the sinuses of the dura mater, as, for instance, where leeches are applied over the mastoid process to abstract blood from the lateral sinus.

The thickness of the cranial wall varies very much in different places; it is very thick at the external occipital protuberance, and along the ridges bounding the grooves for the lateral, longitudinal, and occipital sinuses, the mastoid process, and the lower part of the frontal bone. It is comparatively thin and translucent in the cerebellar fossæ, the squamous portion of the temporal bone, and the antero-inferior angle of the parietal. The average thickness of the bones of the cranial vault is 5 mm. In *trephining*, the pin of the trephine should not penetrate over 3 mm.

A Horizontal Section of the Skull.—This section of the skull should be made to traverse the ophryon and the maximum occipital point, passing 1 or 2 mm. above the pterion.

The removal of the calvarium or vaulted skull cap by a horizontal section (Fig. 4307) shows the floor of the cranial cavity, consisting of three irregular depressions, viz., the anterior, middle, and posterior fossæ.

The weak areas of the floor of the cranial cavity through which fractures are liable to extend are: The horizontal plates of the ethmoid and frontal bones in the anterior cranial fossa; the region of the foramen ovale of the sphenoid bone, and of the glenoid fossa of the temporal, in the middle cranial fossa; the cerebellar fossæ of the occipital bone in the posterior cranial fossæ. The internal auditory canal and the tympanum weaken the otherwise strong petrous portion of the temporal bone.

A Sagittal Section of the Skull.—A sagittal section should be made a little to one or the other side of the mesial plane so that one-half will reveal the nasal septum in position while the other half will display the lateral wall of the nasal fossa (Fig. 4308, *A*).

It will be very instructive to remove the middle turbinated bone in order to observe structures of great importance. There will then be observed two prominent objects on the lateral wall of the middle meatus, viz., a bulging of one of the ethmoidal cells (*bulla ethmoidalis*), and immediately below it the well-defined curvilinear border of the uncinate process (*processus uncinatus*) of the ethmoid bone. A narrow semilunar opening (*hiatus semilunaris*) occurs between the two projections. The air cell in the bulla communicates directly with the meatus by an opening upon or close to its superior surface. The hiatus serves as a direct and only communication between the meatus and the important *infundibulum*, and is a deficiency in the mesial wall of the latter. The infundibulum is a small gutter-like channel immediately external to the hiatus. It corresponds in direction and length to the border of the uncinate process. In the majority of cases the infundibulum continues up, as the *naso-frontal duct*, to the *ostium frontale*. Sometimes

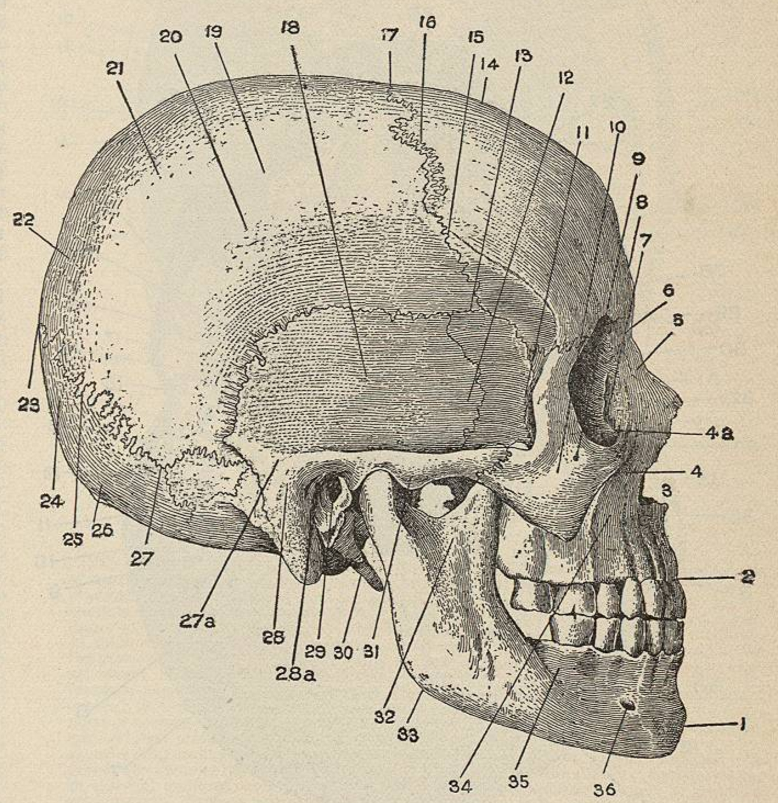

FIG. 4304.—Norma Lateralis. 1, Mental tubercle; 2, alveolar point; 3, anterior nasal spine; 4, infra-orbital foramen; 4*a*, lachrymal tubercle; 5, nasal bone; 6, nasion; 7, lachrymal groove for nasal sac; 8, glabella; 9, malar foramen; 10, malar bone; 11, great wing of sphenoid; 12, temporal fossa; 13, pterion; 14, frontal bone; 15, stephanion; 16, coronal suture; 17, bregma; 18, squamous portion of temporal bone; 19, site of upper temporal ridge; 20, site of lower temporal ridge; 21, parietal bone; 22, obelion; 23, lambda; 24, occipital bone; 25, lambdoid suture; 26, inion (or external occipital protuberance); 27, asterion; 27*a*, supramastoid crest; 28, mastoid process; 28*a*, suprameatal spine with the suprameatal fossa immediately back of it; 29, aperture of external auditory canal; 30, styloid process; 31, zygomatic arch; 32, ramus of mandible; 33, gonion; 34, superior maxilla; 35, body of mandible; 36, mental foramen.

the supero-anterior end of the infundibulum terminates in a bony lamina; in these cases the naso-frontal duct opens into the middle meatus in front and independently of the infundibulum.

The opening of the maxillary sinus (*ostium maxillare*) is situated in the most depressed part of the infundibulum beneath the bulla. It is concealed from view by the uncinate process. The size of the opening varies from 2 to 18 mm. There may be one or more accessory maxillary openings in the membranous portion of the outer wall of the middle meatus, varying in size from 1 to 8 mm. They do not open into the infundibulum but directly into the meatus at the posterior part of the infundibulum. The middle ethmoidal cell, when present, opens into the meatus above the bulla. The anterior ethmoidal cells open into the superior part of the infundibulum.

A Coronal Section of the Skull.—The most instructive coronal section of the cranium is through the basio-bregmatic axis (Fig. 4309). Such a section of the skull facilitates the examination of the parts about the posterior nares; it divides the parietal bones slightly in front of the parietal eminences, and thus makes it possible to indicate the greatest transverse measurement of the cranial cavity by a line drawn transversely across the cavity. The section will traverse the petrous portion of the temporal bone in such a way as to pass through the external auditory canal and expose the tympanum proper (atrium) and its attic, as also the vestibule. It will also pass through a part of the internal auditory canal.

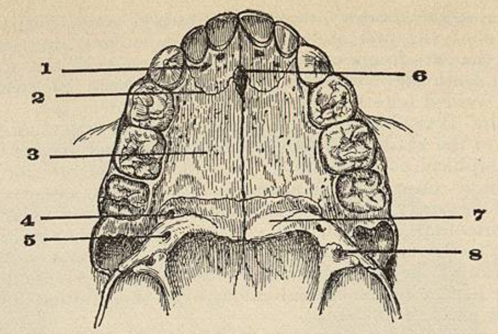

FIG. 4306.—Hard Palate of a Child (about the sixth year). 1, Premaxilla; 2, maxillo-premaxillary suture; 3, palate process of maxilla; 4, posterior palatine canal; 5, and 8, accessory palatine foramina; 6, anterior palatine fossa; 7, horizontal plate of palate bone.

The inner surface of the cranial wall shows certain grooves and depressions, viz., for (1) the meningeal arteries (especially the middle meningeal), (2) the dural sinuses, (3) the Pacchionian bodies, and (4) the cerebral convolutions. In trephining, these facts should be borne in mind.

It may be stated here that in studying the macerated skull, through which no sections have been made, *transillumination* with a small electric bulb, such as that used in laryngological work, will be found very instructive. Especially is this the case in studying the nasal fossa, the grooves for the lateral sinuses, the maxillary sinus, the tympanum, the relations of the carotid canal and jugular fossa to the tympanum, etc.

The skull presents certain *buttresses* where the bones are thicker and stronger than the intervening thinner and weaker regions. The latter regions are the more readily fractured. These buttresses pass from the vertex to the foramen magnum. The *anterior buttress* is represented by the median portion of the frontal, the ethmoid, the body of the sphenoid, and the basilar portion of the occipital. The *posterior buttress* passes through the external occipital protuberance and crest to the foramen magnum. On either side there are two *lateral buttresses*—an antero-lateral one which extends from the vertex to the external angular process of the frontal and thence through the great wing to the body of the sphenoid; and a postero-lateral one which runs through the parietal eminence, the mastoid process, the posterior part of the petrous portion of the temporal bone, the jugular process and condyle of the occipital bone.

There are several factors that lessen the liability of the cranial wall to fracture: (1) The elasticity of the wall due to its shape and its formation of a number of elastic bones separated by sutures and suture membranes which act slightly as buffers; (2) a rounded form favoring glancing blows; (3) the mobility of the head on the spinal column; (4) the mobility and density of the scalp.

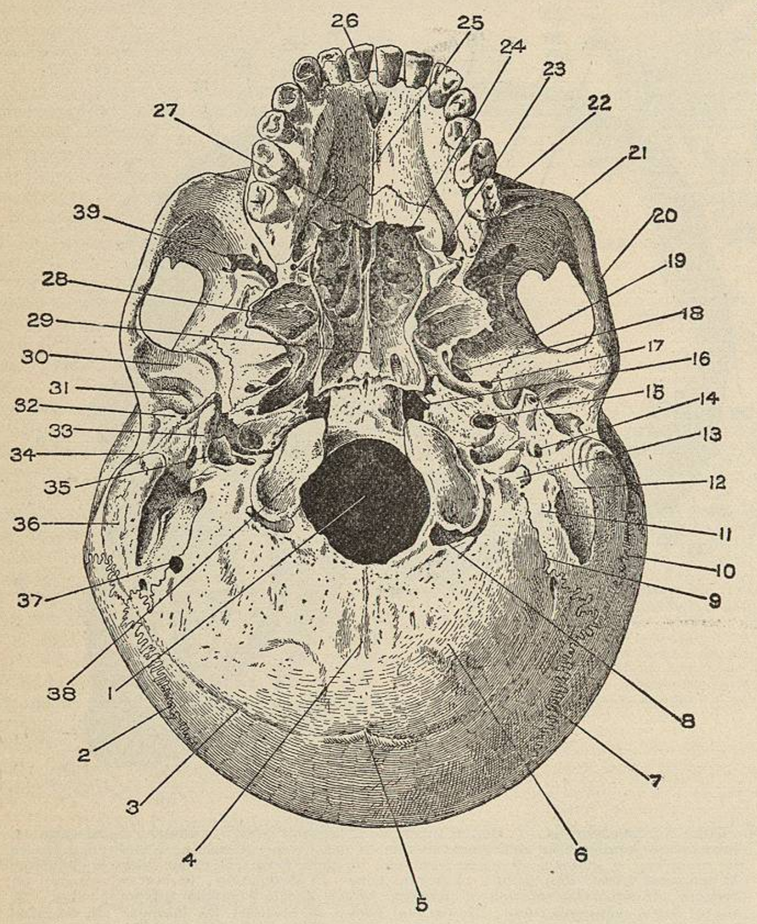

FIG. 4305.—Norma Basilaris. 1, Foramen magnum; 2, lambdoid suture; 3, superior curved line of the occipital bone; 4, external occipital crest; 5, inion; 6, site of inferior curved line; 7, lambdoid suture; 8, posterior condyloid foramen; 9, occipito-mastoid suture; 10, parieto-mastoid suture; 11, groove for occipital artery; 12, digastric fossa; 13, jugular process of occipital bone; 14, stylo-mastoid foramen; 15, carotid canal; 16, foramen lacerum medium; 17, foramen spinosum; 18, foramen ovale; 19, sphenosquamous suture; 20, zygoma; 21, malar; 22, superior maxilla; 23, posterior palatine canal; 24, lateral mass of ethmoid in nasal fossa; 25, intermaxillary suture between the palate processes of the superior maxillæ; 26, anterior palatine canal or fossa; 27, posterior nasal spine on palate bones; 28, pterygoid fossa; 29, part of nasal septum (vomer); 30, eminentia articularis (anterior root of zygoma): 31, glenoid fossa; 32, auditory process flooring the external auditory canal; 33, styloid process; 34, supramastoid crest (posterior root of zygoma); 35, jugular foramen; 36, mastoid process; 37, mastoid foramen; 38, condyle of occipital bone; 39, sphenomaxillary fissure.

From the fact that there is much membrane and cartilage between the bones the skull of the infant is much more elastic than that of the adult. The yielding character of the infant's skull is shown during delivery, when frequently the parietal bone may be flattened by pressure against the sacral promontory or by the forceps without producing fracture.

A COMPARISON OF THE HUMAN AND ANTHROPOID SKULLS.—The principal difference between the skull of man and that of the anthropoid apes is in the excessive development of the brain cavity (Fig. 4308, *A* and *B*). The average weight of a man's brain in European races is 1,360 gm. These figures may fall to 1,025 gm. or rise to 1,675 gm. Brains weighing less than 1,000 gm. are pathological. On the other hand, the brains of the anthropoid apes have an average weight of 360 gm. In a few isolated cases this weight may rise to, but never exceed, 420 gm. The excessive development of the cranial cavity induced by the enlarged brain has been the main factor, according to Prof. J. Ranke, in determining the change in attitude of our anthropoid progenitors from the semi-erect to the erect posture. Several peculiarities in the anatomical structure of man compared with those of the anthropoid apes give this theory an air of plausibility. In the majority of mammals very powerful *cervical ligaments* maintain the equilibrium of the head. In the anthropoids *very strong muscles* extend from the occiput to the spinous processes (twice as long as those of man) of the cervical vertebræ, thus preventing the massive muzzle from falling upon the chest and pressing on the organs of respiration. In man those structures are very feebly developed. In him the very voluminous brain case suffices to counterbalance the weight of the much reduced face, thus permitting the head to be balanced on the spinal column. But in connection with this point it should be remembered that Broca and other anthropologists teach that the assumption of the erect attitude was one of the conditions of the development of the brain and its large cranial cavity, since this attitude alone permits the free use of the hands and an extended range of vision.

In order to convince ourselves that the excessive development of the human brain and its enclosing cranial cavity are correlative with the reduction of the facial part of the skull, we have only to compare the human skull with that of an anthropoid, placing both in the same horizontal plane and approximately parallel to the line of vision.

As a rule the bony structure of the human skull, when viewed from the norma verticalis, leaves nothing of its facial part to be seen; at the very most, in rare instances, may be observed the alveolar segment of the upper jaw, or the lower portion of the nasal bones. In the anthropoids almost all of the facial part of the skull is observed.

On comparing the profiles (norma lateralis) of the human and anthropoid skulls it is noted in the latter that the facial portion forms a bestial and massive muzzle in advance of the cranium, while in the former the much-reduced face is placed below the anterior portion of the cranium. The mastoid processes in the anthropoid are relatively much smaller than in man. In the anthropoid the facial part of the malar bone is greatly developed in comparison with its temporal portion. The contrary obtains in man.

The skulls, when viewed from the norma occipitalis, reveal plainly the foramen magnum in the monkeys, while the foramen is not seen at all in man.

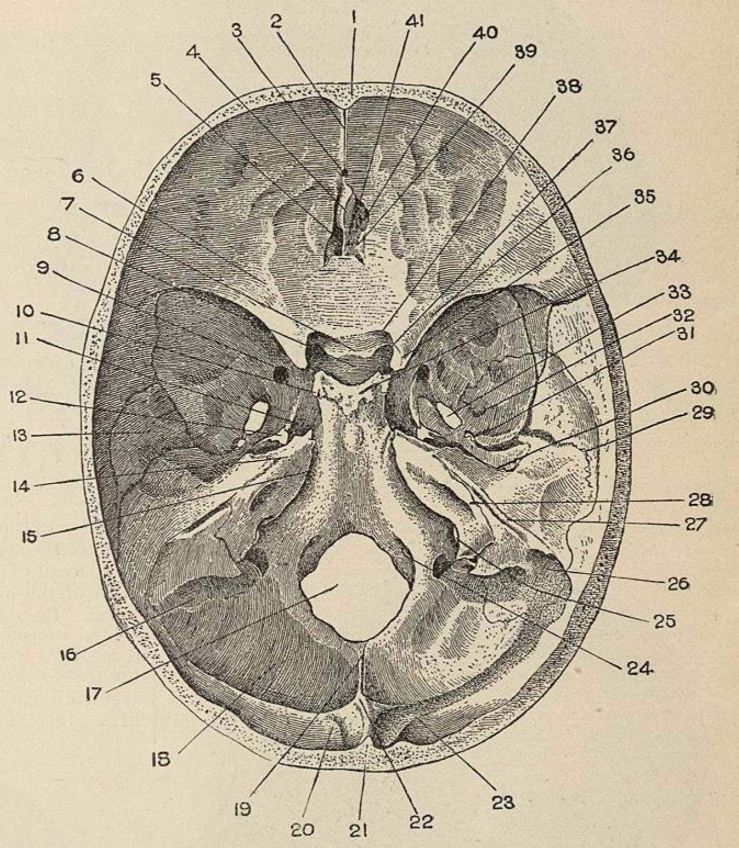

FIG. 4307.—Floor of the Cranial Cavity. 1, Diploë of frontal bone; 2, crest of attachment of the falx cerebri; 3, foramen cæcum; 4, crista galli of ethmoid; 5, cribriform plate of ethmoid; 6, anterior cranial fossa for lodgment of frontal lobe of cerebrum; 7, olivary eminence (optic groove immediately in front of it); 8, pituitary fossa; 9, foramen rotundum; 10, posterior clinoid process; 11, cavernous groove; 12, foramen lacerum medium; 13, middle cranial fossa for lodgment of temporal lobe of cerebrum; 14, depression for the ganglion of Gasser; 15, groove along the petro-occipital suture for the inferior petrosal sinus; 16, groove for lateral (sigmoid) sinus terminating at jugular foramen; 17, foramen magnum; 18, fossa (posterior cranial) for lodgment of left cerebellar hemisphere; 19, internal occipital crest for attachment of falx cerebelli; 20, fossa for lodgment of occipital lobe of cerebrum; 21, crest for attachment of falx cerebri; 22, internal occipital protuberance; 23, groove for lateral sinus continued from that for the superior longitudinal sinus; 24, anterior condyloid foramen; 25, jugular foramen; 26, groove for sigmoid part of the lateral sinus; 27, groove for the superior petrosal sinus; 28, internal auditory canal; 29, petrosquamous suture; 30, hiatus Fallopii; 31, foramen spinosum; 33, foramen ovale; 34, dorsum sellæ; 35, anterior clinoid process; 36, lesser wing of sphenoid; 37, cavernous groove; 38, optic foramen; 39, 40, cribriform plate of ethmoid; 41, slit for nasal nerve.

Viewed from the front, or norma frontalis, the human skull shows that the top of the nasal opening is always situated higher than the lowest point of the infra-orbital margin; in the anthropoid apes it is always observed below this point.

All the other characteristics which distinguish the human from the anthropoid skull are the direct results of the excessive development of the human brain case at the expense of the face, and the assumption of the erect attitude and biped progression.