summits into wide plates which articulate by suture with each other and with similarly expanded ribs, to form the carapace.

In Serpents and Iguanas we have a special mode of vertebral interarticulation, over and above that formed by the zygapophyses. The neural arch develops a median anterior prominence with two articular surfaces called the zygosphene, and this fits into a corresponding median posterior recess called the zygantrum.

The maximum of complication as regards the interarticulation of dorsal vertebræ is found in the last dorsal of the Great Anteater. There each posterior zygapophysis develops two additional articular surfaces, one on each side of a notch which receives a process from the anterior side of the neural arch of the succeeding vertebra, which process is furnished with two corresponding surfaces. More or less distinct traces of certain additional processes, called metapophyses and anapophyses, are sometimes present, but these it will be better to notice when describing the lumbar vertebræ, wherein they are more developed.

We find in some Serpents peculiar processes which project downwards and forwards from the base of the inner side of the transverse processes. We may also find present a long median inferior process extending vertically from the ventral surface of the centrum and as long as, or longer than, the neural spine of the same vertebra. Such processes are present in many Serpents—especially the poisonous ones—and in such Birds as the Penguin and Cormorant.

Lumbar Vertebræ.—These are vertebræ interposed between the dorsal vertebræ and the sacrum; they are generally the largest vertebræ of each vertebral column, but sometimes (as in Bats and Pterodactyles) the cervical vertebræ are yet larger. Lumbar vertebræ are generally to be distinguished in Mammals, in Crocodiles, and in certain Lizards, but not in any Ichthyopsidan.

In Birds lumbar vertebræ are present, but are disguised and hidden by the extent to which the sacral ossification extends forwards.

There are five lumbar vertebræ in Man, but the number in him is below the average of his class, though some Apes have but four. The Slow Lemur may have nine, the Two-toed Sloth has but three, and the Monotremes but two. These vertebræ are very numerous in the *Cetacea*, but the hinder limit of the lumbar region is more or less difficult to determine in these animals. The transverse processes are generally much longer than those of the dorsal vertebræ, and do not bear either capitular or tubercular articular surfaces.

The processes already spoken of as metapophyses and anapophyses are generally much more developed in the lumbar than in the dorsal vertebræ. The former project forwards from the vicinity of the anterior zygapophyses, and the latter project backwards at a lower level. Both processes are to be detected in the last dorsal and first lumbar vertebræ of Man, but are at their maximum in the Armadillos. In addition, also, to the complexity of articulation before described as existing on the last dorsal vertebra of the Great Anteater, we find in that animal's lumbar region an additional articular surface on each side of each transverse process.

The lumbar vertebræ may be anchylosed together and to other parts of the skeleton, as is the case in Birds.

Sacral Vertebræ.—These are distinguished from others, not only by their connexion with the skeleton of the pelvic limbs, but also by their coalescence and a certain degradation in their structure as compared with the trunk and cervical vertebræ. In Man five vertebræ thus coalesce to form the more or less triangular single bone known as the sacrum, but which always shows plain traces of its composite nature. Such coalescence and degradation generally exist in Vertebrates above the *Ichthyopsida*, which possess fully developed limbs. The coalescence of vertebræ is generally less extensive than in Man, though sometimes—as in Birds, some Edentates, and some Reptiles—it is much greater. The sacrum may be composed of as many as ten vertebræ (as in some Armadillos) or of twenty (as in the Ostrich), and the lumbar or caudal vertebræ or both contribute to its formation.

In most if not all Mammals the sacral vertebræ—or the more anterior of them—have what are at first distinctly ossified elements in their transverse processes, which elements (like parts before noticed in the cervical vertebræ) are costal in their nature, *i.e.*, represent rudimentary ribs, and in Crocodiles and Tailed Amphibians the sacral vertebræ have a distinct rudimentary rib attached to each transverse process. In Birds, however, the vertebræ of the sacrum, which have expanded transverse processes, do not develop these from distinct ossifications.

As regards the extent of connexion between the sacrum and the hip bones, union is more extensive in Man than in most Beasts, or in animals below Birds. Often in Mammals and almost always in Tailed Batrachians it may be confined to a single vertebra; but ten vertebræ may be involved in this union in Mammals and twenty in Birds.

That the development of the sacrum is not always in proportion to that of the pelvic limbs is proved by the little Lizard *Seps*, in which, in spite of the rudimentary condition of the limbs, there are true sacral vertebræ.

No Fishes have a true sacrum, though, very rarely, as in the Turbot, we meet with a kind of false sacrum, formed by the anchylosis of the bodies and ventral spines of the first two caudal vertebræ.

Caudal Vertebræ.—The vertebræ of the tail may be as many as 270, as in some Sharks. Amongst Mammals 48 (*Microgale longicaudata*) is the highest number. Man has usually rudimentary caudal vertebræ, completely or partially united so as to form a small conical bone called the coccyx. Its proximal end articulates with the sacrum by its centrum and two small zygapophyses. It has besides two rudimentary transverse processes and two processes representing piers of the absent neural arch. The other vertebræ are destitute of processes and consist but of smaller and smaller vertebral centra. Thus the last vertebra is the very opposite of the first (or atlas), being all centrum, while the atlas has no centrum at all. The coccyx usually becomes anchylosed to the sacrum about or after the middle of life. The caudal region is still more reduced in some Bats, where there may be but two such vertebræ.

In animals provided with numerous coccygeal vertebræ, such vertebræ may be provided with processes and articulations as complex as those of other spinal regions. Transverse processes may be largely developed at the tail root, but almost always thence backwards diminish in extent; sometimes, however, as in the Armadillo (*Chlamydophorus*), they may increase in size backwards from the tail root. Rarely (as, *e.g.*, in *Menobranchus*) caudal vertebræ may be furnished with two ribs supported by both tubercular and capitular processes. Inferior arches may exist in the form of detached "chevron bows" placed beneath the intervals of successive caudal vertebræ, especially towards the tail root. They may be represented by processes or by continuously ossified inferior arches, which may, as in the Flat Fishes, be very prolonged, extending downwards from each centrum as much as the neural arch and spine extend upwards from it.

Birds have generally six or eight, but may have ten, caudal vertebræ, at the end of which is a so-called "ploughshare-bone," consisting of two or more vertebræ anchylosed together.

The caudal region of the Frog is formed in a very peculiar way. It never consists of distinct vertebræ at any time of life, but is formed by the ossification of the membrane which surrounds the notochord, to which two small neural arches become attached. This structure is called the urostyle.

In Fishes (as in the Perch and Stickleback) there may be a urostyle continuous with the centrum of the last vertebra. Such a urostyle, unlike that of the Frog, is very sharply bent upwards. It is very small and inconspicuous. In other Fishes the hinder part of the notochord may (as in the Salmon) remain unossified and only protected by lateral bony plates, but it is still sharply bent upwards. In a few Fishes (as, *e.g.*, *Polypterus*) the hinder end of the spinal column is not bent upwards. In other Fishes again (as in the Sturgeon and many Sharks) the hinder end of the vertebral column gradually tapers and gradually (not suddenly as in the Perch and Salmon) inclines upwards. In the forms in which the hinder end of the vertebral column bends upwards—whether gradually or suddenly—the arches and processes beneath its hinder end exceed in size those on the dorsal side of it, as also do the fin-rays attached to them. Thus it happens that the part of the caudal fin which is on the ventral side of the gradually or suddenly bent-up part of the spinal column more or less greatly exceeds in size the part on the dorsal side. In those Sea Fishes (*e.g.*, the Sturgeon and many Sharks) in which the upward flexion is gradual and manifest, the ventral part of the caudal fin is evidently the larger, and such a tail is called *heterocercal*. In Fishes in which the hinder end of the spinal column is suddenly bent up and of minute size, so that its real condition is disguised, the caudal fin appears symmetrical and as if the parts dorsal and ventral to the end of the spinal column were equal. Such a condition has been named *homocercal*. Those Fishes in which the spinal column ends without turning upwards, and in which the parts of the caudal fin dorsal and ventral to it are really and not only apparently symmetrical, are said to be *diphycercal*.

Sternum.—The breastbone or sternum extends more or less along the middle line of the ventral region of the anterior part of the trunk in all Vertebrates above Fishes, except Serpents and a few other Reptiles.

Almost always it is connected with the more anterior ribs. Its anterior end is distinguished as the manubrium or presternum, and its hinder is called the xiphoid process or xiphisternum—the middle part being the "body" or mesosternum. A sternum may exist without ribs, or without forming any cartilaginous or osseous connexion with ribs, as in the *Amphibia*. The plastron of Chelonians might well be supposed to be a great sternum, more especially as the plate-like ribs are connected with it. It appears, however, that this great complex plate does not really include a sternum.

The before-mentioned threefold division of the sternum is normal in Mammals, and also exists, though more obscurely, in Birds and Reptiles. Even in Mammals it is not universal; the manubrium only may be present, as in the Greenland Whale, or the manubrium and xiphisternum without any mesosternum, as in the Dugong.

In Tailed Amphibians and the Slow-Worm (*Anguis*) we have a single sternum, which may be mesosternum only, while in many Frogs and Toads we have only the latter and the xiphisternum. The manubrium may develop a median keel, as in Bats, the Mole, and Armadillos; or the mesosternum, as in the Tamandua; or the mesosternum and xiphisternum, as in most Birds.

The xiphisternum may assume various forms, but attains its maximum development in Birds, where it forms the part of the sternum posterior to the attachment of the ribs, and may consist of a median and four lateral processes, as in the Fowl. It bears the greater part of the keel.

In the Monotremes there is a median ossicle in front of the manubrium, which is often called the episternum. It is really a part of the appendicular skeleton.

Ribs.—Mammals possess a greater or less number of ribs, which are mostly long, slender, curved bones, extending downwards from the transverse processes or bodies of the vertebræ, the more anterior of them forming a junction with the sternum. The part of the skeleton formed by the rib-bearing vertebræ, the ribs, and the sternum is called the thorax. In Man (see ANATOMY) there are twelve ribs (on each side of the body), whereof the first seven join the sternum by the intervention of cartilages, and are called "true ribs." The other five, which do not join the sternum, are called "false ribs." Each rib (except the last two on each side) has a double attachment to the spinal column. At its proximal end it has a rounded "head" or "capitulum," which articulates with the capitular surface of a dorsal vertebra. At a little distance from the capitulum is another rounded articular prominence called the "tubercle" or "tuberculum," which joins a vertebral tubercular surface. The part of the rib between the head and the tubercle is called the "neck." At its distal end each rib has attached to it an elongated cartilage called "costal." Those costal cartilages which do not join the sternum either end freely or blend with the costal cartilage next in advance.

Frogs and Toads have no ribs, nor can they be said to exist in some Fishes (*e.g.*, the Chimæra, the Seahorse, the Lamprey and its allies); but in the immense majority of Vertebrates there are cartilaginous or osseous ribs, attached by their proximal ends to the vertebral column, and tending to surround the trunk.

All rib-bearing animals have both "true" and "false" ribs, save Serpents, Fishes, and Chelonians, which can have no true ribs since they have no sternum, and Tailed Amphibians, in which, though there is a sternum, no ribs join it. There may, however, be but a single pair of true ribs—as in the Whalebone Whales. The ribs are exceptionally broad in the Two-toed Anteater, where they overlap one another. The number of ribs has already been indicated under the head of "dorsal vertebræ," though in Birds we may have short ribs attached to the cervical vertebræ, and others coming from vertebræ which are generally counted as "sacral." There may be as few as five or six pairs, as in *Amphiuma*; or the numbers may reach 320, as in some Pythons. In many Reptiles, as in the Crocodiles, there may be cervical ribs; and there may even be caudal ribs, as in *Menobranchus*.

The function of aiding respiration is one which the ribs possess in the higher *Vertebrata*, but quite other purposes may be subserved by them in addition to, or instead of, respiratory action—namely, locomotion, change of form, or bodily protection as armour. Thus the ribs may form a solid case for the safe keeping of the parts within, co-operating in this office with other skeletal structures so as to form the "carapace" of Tortoises already noticed. Ribs may be the main agents in locomotion, as in Snakes, which glide along by the successive application to the ground of the edges of their ventral scales, which is brought about by the motions of the ribs, the ends of which are connected with the inner surface of such scales. In the little flying Lizard *Draco* certain much elongated ribs serve to support a parachute-like flying membrane, and in the Cobra it is certain ribs which sustain its "hood" when distended.

The presence of a distinct "head" and "tubercle" is a general but not constant character, and the head of the ribs may be connected with two vertebræ or only with one vertebra. The ribs may bifurcate proximally into two equal diverging branches, one representing the "head" and the other the "tubercle." A small backwardly-projecting structure termed an "uncinate process" may be given off from the ribs and may ossify as a distinct bone, as in most Birds and in the Crocodile.

Sometimes (as in Monotremes and many Lizards) a third segment may be intercalated between a rib and its sternal cartilage, and sternal cartilages may be represented by bones, as in Birds and Armadillos. In some Lizards the sternal cartilages of opposite ribs are continuous in the mid ventral line. There may be no representative of a sternal rib, as in Fishes and Batrachians.

Rarely, as in the Crocodile, there may be ventral rib-like structures in the wall of the abdomen, which meet and are attached ventrally, but are "free" at their dorsal ends. These cannot, however, be counted as true ribs. Fishes have often two series of ribs on each side of the body, and in *Polypterus* some vertebræ may have four ribs on either side. In Fishes the ribs may also be in part attached to the neural spines above or to the hæmal spines below the vertebræ.

Cranial Skeleton.

By the cranial skeleton we mean the skull, or that part of the axial skeleton which serves to shelter the brain (or anterior expanded end of the central part of the nervous system), together with solid structures continuous or more or less directly connected therewith. Such a structure exists in every Vertebrate animal, except the *Amphioxus*, which has no brain. Nothing of the kind is known to exist in any Ascidian or in any Invertebrate animal,—unless that cartilage of Cuttlefishes which serves as an investment of the nerve centres and a support for the optic and auditory organs may be deemed a true cranial skeleton, since its portions just enumerated make it, as we shall shortly see, very analogous to a true skull.

The cranial skeleton is, of course, at first composed entirely of soft mesoblastic tissue, parts of which always become cartilaginous and generally also osseous, while more or less of its structure may remain in the condition of mere membrane. The bones which generally, as just said, enter into its framework may arise directly in the membrane or may be preceded by cartilage which ossifies, a circumstance which divides the cranial bones into two categories—"membrane bones" and "cartilage bones."

The cranial skeleton of Vertebrates is made up of three sets of parts:—(1) parts devoted to enclosing and protecting the brain; this is the cranium proper; (2) parts sheltering the organs of sense situated in the head—namely the optic, auditory, and olfactory capsules; these skeletal parts consist of the bones, cartilages, and membranes of the orbit, the internal ear, and the nose respectively, or the perioptic, periotic, and perirhinal bones and cartilages; (3) parts continuous or more or less directly

connected with the cranium, and applied to aid nutrition in the form of deglutition or respiration; such skeletal parts are the jaws and arches (or parts of such) behind the jaws known as the hyoidean and branchial arches.

1. *The Cartilaginous Cranial Skeleton.*—This is formed "by a differentiation within the membranous cranium,"[1] and consists of two plates (parachordals) placed one on each side of the anterior part of the notochord, and forming with the latter the floor of the hinder part of the cranium, which part is known as the basilar plate. The cartilaginous auditory capsules are closely united to the outer sides of the basilar plate. From the anterior margin of that plate two bars, called the "trabeculæ," diverge forwards from the anterior end of the notochord, and then approximate, so as to enclose what is known as the pituitary space, and also the floor of the anterior part of the cranium. Thence they advance (generally united) into the nasal or ethmoidal region of the skull, forming a median nasal septum, having a cartilaginous olfactory capsule on each side of it, and developing lateral processes in front of and behind those capsules. Only in the *Cyclostomata* is there a single olfactory capsule instead of a pair. The nature of the parachordals and trabeculæ is disputed, but opinion inclines to regard them as corresponding to the neural arches of the spinal skeleton,—except the part around the notochord, which corresponds with centra in an unsegmented condition.

Upgrowths arise on the outer side of each parachordal, and these meet above and thus form a complete dorsal arch in the hinder or occipital region of the skull. The posterior aperture of this arch is called the occipital foramen, and through it the spinal cord enters the cranium, there to expand and become the brain. Lateral plates arise on each side farther forwards, in the anterior or sphenoidal region of the cranium. But these do not generally ascend enough to unite together dorsally, at least they almost always form but an imperfect roof to the cranial cavity. This cranial aperture may be related to a median, dorsally placed, eye, which probably once existed in all Vertebrates, and still exists in a rudimentary condition in many Lizards.[2] The lateral plates grow together medianly in front, and more or less completely separate the cranial cavity from the ethmoidal region in front of it. Openings are left here and there in the cartilages of the cranial walls for the passage outwards of nerves from the central part of the nervous system; but these openings or foramina will be noticed in describing the osseous cranial skeleton. On each side of the sphenoidal region are the optic cartilaginous capsules, which, however, never become united (as do the others) with the cranium, and therefore are not generally reckoned as parts of the skull. A special median cartilaginous vertical upgrowth from the trabeculæ between these capsules may (as in Teleostean Fishes, Lizards, and Birds) form an interorbital plate beneath the most anterior part of the cranial cavity.

The third category of cranial skeletal parts is generally represented by a series of descending cartilaginous bars (or visceral arcs) on each side of the alimentary canal, running forwards beneath the cranium to terminate at the mouth.

As this lateral region of the head corresponds with the body wall behind it, and shows transitory indications of division (like the body wall behind it) into an inner part or splanchnopleure and an outer part or somatopleure, it is obvious that skeletal structures formed in its inner or outer part may be taken as belonging to different categories. In the *Cyclostomata*, as in the Lamprey, we find cartilaginous bars placed in the somatic division exclusively,—bars which support and externally protect the series of gill-pouches on each side; and parts probably homologous with these somatic bars of the Lamprey are found also in some Sharks.

The Cyclostomes also possess complex labial cartilages which support the lips of their suctorial mouths. Representatives of these cartilages are also to be found about the mouths of many Fishes, as well as in the temporary suctorial mouth of the Tadpole; and they still persist in connexion with the olfactory capsules, though in a reduced form, in higher animals.[3] The most important members of the third category of cranial skeletal parts are—(1) the series of cartilaginous arches lying in the splanchnic or inner region of the lateral wall of the head, which arches support the gill-pouches on their inner sides and are known as the branchial arches, and (2) the arches seemingly in series with them, which are more anteriorly placed, and which are known as the hyoidean arches and the jaws.

One or other, or both, of these two sets of arches are well developed in all craniate Vertebrates, except the Cyclostomes, in which there are no true branchial arches, but only a hyoidean and a rudimentary jaw arch. There may be as many as seven branchial arches (*e.g.*, in *Notidanus*), but five are usually present in water-breathing Vertebrates. The hyoidean arch becomes segmented into two noteworthy portions, the upper of which is known as the hyomandibular portion.

The most anterior, or mandibular arch, also becomes segmented into an upper or metapterygoid portion, an inferior or Meckelian portion, and a median or pterygoquadrate portion, which grows forwards in front of the metapterygoid portion, and forms the foundation of the upper jaw against which the lower jaw (formed from the Meckelian portion) bites.

The thus formed upper and lower jaws may come to be suspended from the cranium in one of three ways. (1) They may depend from the cranium directly, that is, without the intervention of the hyoidean arch; this arrangement is known as autostylic,[4] and exists in all Vertebrates above Fishes, as well as in certain of the latter (*Chimæra* and the *Dipnoi*). (2) They may be suspended by the co-operation of the hyomandibular portion of the hyoidean arch with their own metapterygoid portion; this arrangement is known as amphistylic, and is found in *Notidanus*, *Hexanchus*, and *Ostracion*.[5] (3) They may be suspended exclusively by the hyomandibular portion of the hyoidean arch (to the exclusion of their more proximal portion), as in most Fishes and the Skates—an arrangement known as hyostylic.

2. *The Osseous Cranium.*—The bony skull is formed partly by ossifications of the cartilage of the cartilaginous skull and partly by ossifications of the membranes investing or completing it. The cartilaginous cranium may, as in Elasmobranchs, be covered by a thin calcified layer without becoming ossified. It may, as in the Selachian Ganoids, remain itself quite unossified, and yet become enveloped by membrane bones. In most cases, however, the investment of the cartilaginous cranium by membrane bones is accompanied by a more or less complete ossification of the cartilage itself. In the *Amphibia* the cartilaginous cranium is to a not inconsiderable extent ossified, but the membrane bones which invest it are nevertheless easily separable from it. The most constant ossifications of the cartilaginous cranium are in the occipital region. In the Lepidosiren these are the only ones, a bone being thus formed on each side of the occipital foramen, which bones are known as the exoccipitals.

[1] Balfour, ii. p. 466.
[2] See *Nature* of May 13, 1886, p. 33.
[3] Balfour, *loc. cit.*, p. 490.
[4] These terms were proposed by Professor Huxley.
[5] Balfour, *loc. cit.*, p. 475.

Many disputes have taken place as to what cranial bones (both cartilage and membrane bones) of one group of animals correspond with those of other groups. Such disputes still exist in certain cases, and it would be unwise to positively assert more than the existence of a general correspondence between the cranial bones of widely different Vertebrates—such, for example, as between Teleostean Fishes and Reptiles or Mammals.

Beneath the occipital foramen the basioccipital bone arises, and it may, as in Birds and Reptiles, develop a posterior prominence which joins with contiguous prominences of the exoccipitals to form a single "condyle" for articulation with the spine. On the other hand, there may be, as in Mammals and Amphibians, two lateral exoccipital condyles unaccompanied by any median basioccipital prominence. In most Fishes we find only a concave articular surface behind the basioccipital, which thus resembles in form the vertebral centra, the anterior posterior surfaces of which are concave. A fourth bone, the supraoccipital, generally bounds the occipital foramen above.

In front of this occipital segment the auditory capsule, on each side, generally ossifies from three centres of ossification, which form the prootic, opisthotic, and epiotic bones respectively. Of these the first is the most constant, and is the only one which ossifies in the Frog. When all three are present, the prootic is anterior in position, the opisthotic inferior and posterior, and the epiotic posterior and superior. Sometimes, as in Fishes, two other superoexternal bones may be formed in the auditory capsule, the more anterior of which is the sphenotic and the more posterior the pterotic.

The base of the cranium, in front of the basioccipital, generally ossifies as the basisphenoid, and a depression on its upper surface is known as the sella turcica or pituitary fossa. In front of the basisphenoid there may be, as in Mammals, another azygous bone, the presphenoid. The skull's lateral walls (in front of the auditory capsule) ossify as the alisphenoid and orbitosphenoid on each side, the latter forming the antero-lateral wall of the cranium. The optic capsule or sclerotic may be merely membranous, as in Mammals, or may ossify, as in Birds, but it never forms any solid connexion with the cranial walls.

The olfactory region very often ossifies as a median vertical bone (the mesethmoid) and two lateral ones (the lateral ethmoids or prefrontals). These ethmoidal ossifications may close the cranial cavity anteriorly, or may be altogether anterior to it. The olfactory and presphenoidal region may ossify very exceptionally as one bone. Such a condition we find in the Frog and its allies. These bones vary greatly in different classes of Vertebrates as to the degrees in which they anchylose together or remain distinct, and also as to the order in which those unite which ultimately coalesce. Similar differences occur with respect to the remaining skull bones. Speaking generally, we find the greatest amount of distinctness in the Osseous Fishes, and the greatest amount of coalescence in the class of Birds.

The membrane bones of the cranium are most conspicuous and constant on its roof. In Fishes we find every grade of transition between simple dermal scutes and true subdermal bones of the internal skeleton. Well-developed dermal cranial scutes are to be found in the Sturgeon and some Siluroids. Where the membrane bones still retain the character of dermal plates, those on the dorsal surface of the cranium are usually arranged in a series of longitudinal rows, continuing in the region of the head the rows of dermal scutes of the trunk. The dorsal cranial dermal bones differ in different Fishes as regards arrangement and number as well as size. Owing, however, to their linear arrangements, they usually receive corresponding names, though it is very doubtful whether they can be considered as truly homologous.[1] In most Bony Fishes, as in higher animals, we may generally distinguish in the cranial roof one or two parietals, with an interparietal or upper (or upper part of a) supraoccipital behind the parietals, and a frontal or pair of frontals in front of them. A bone called the squamosal may also form part of the cranial roof, as in Mammals, and may send forwards and outwards a process which unites with another form, a preorbital bone, to form a zygomatic arch. In front, above, behind, and beneath the orbit (in which lies the sclerotic) bones may arise termed malars and lachrymals, supraorbitals, and post-frontals respectively, and the zygomatic process of the squamosal may unite with a corresponding process from the malar or the post-frontal. The malar bone, or (as it is often called) the jugal, rather belongs, however, to the third category of cranial skeletal parts. The olfactory or ethmoidal region becomes roofed over in part by the frontals, in part by the lateral bones (belonging to the third category of cranial parts to be presently noticed) called the maxillæ, but it is mainly roofed over by two bones (sometimes one bone) called nasals, which bound the posterior surface of the external nasal opening on each side of the skull. In Bony Fishes, Amphibians, and Serpents almost the whole cranium is invested below by a large membrane bone called the parasphenoid.

The nervous centres within the cranial cavity send forth nerves through certain definite small apertures or foramina, which show much constancy of position. As a rule, and in the highest class of Vertebrates, the olfactory nerves pass out medianly in front to the ethmoids, between the orbitosphenoids or the membranous parts which may represent them. The optic nerves perforate the orbitosphenoids, but may pass out behind them. In Lizards (*e.g.*, *Hatteria*, *Anguis*, and many others) an aperture is left in the roof of the skull which is called the "parietal foramen." It serves for the reception of a third and rudimentary eye, the existence of which in Lizards was before referred to in noticing the cartilaginous cranium. It is a structure of great morphological interest. The nerves of the muscles of the eye, as well as the first of the three divisions of the fifth nerve, pass out in the interval between the orbito- and ali-sphenoids. The two other divisions of the fifth, as a rule, perforate the alisphenoid, the third the more constantly, the aperture for it being known as the foramen ovale, the less constant aperture for the second branch being called the foramen rotundum. The auditory nerve enters the auditory capsule (whether ossified or not) on its inner side, and does not pass out from it, but the facial nerve both perforates and traverses it. The glossopharyngeal, pneumogastric, and spinal accessory nerves pass out between the auditory capsule and the exoccipital, which latter bone is perforated and traversed by the hypoglossal nerve.

Thus the osseous cranium (apart from the sense-capsules) consists of three arched segments: of these the hindmost is formed by the basi-, ex-, and supra-occipitals, the median by the basisphenoid, alisphenoids, and parietals, and the anterior by the presphenoid, the orbitosphenoid, and the frontals. These have been called "cranial vertebræ," and certainly if the essence of vertebræ consists in their being a series of solid rings, fitted together and enclosing a tract of the nervous centres, then it must be admitted that the cranium—of the highest class of animals at least—is made up of three such vertebræ. Their development, however, is altogether different from that of true vertebræ, and no such resemblance to vertebræ

[1] Balfour, *loc. cit.*, p. 486.