the dorsal vertebræ, and are more numerous than those of the caudal vertebræ. In the true Serpents, there are always above 100 vertebræ, usually above 200, or 300, as in the great Boas, while the Python presents even 400 and upward, of which the caudal make up only a fourth to a seventh part of the whole series. No traces of a sternum are met with in the Ophidia.

In the true Sauria the number of the vertebræ and ribs is also considerable, being greatest in the elongated serpent-like forms of that order, as Anguis, Pseudopus, Chirotes, Amphisbœna, where they amount from 30—60 or 100, while that of the caudal vertebræ, which at the extremity of the tail become very small and rudimentary, frequently exceeds 100, as in Lacerta, Monitor, &c. The bodies of the vertebræ, like those of the Ophidia, are generally concave anteriorly, and provided with a hemispherical head posteriorly. The cervical vertebræ, of which the second has an odontoid process, are few in number, and generally devoid of ribs, but occasionally support them; to these succeed numerous dorsal vertebræ, and more rarely behind them some lumbar vertebræ, *e. g.*, in Monitor, Lacerta, Chameleon, Draco; lastly, a sacrum may be distinguished, usually consisting of two vertebræ, with long transverse processes that unite it to the iliac bones; to the sacrum follow next the numerous caudal vertebræ, frequently provided at their commencement with superior and inferior spinous processes. Superior spinous processes are usually found upon the cervical and caudal vertebræ, and upon the latter, inferior processes also, forming at their root a hemispherical canal, within which the aorta passes. Transverse and oblique processes are likewise met with. The ribs are numerous, and there are several anterior and posterior ones, as in the Lizards, which are not connected to the sternum. In the Chameleon, the broad body part of the sternum is merely cartilaginous, and the costal cartilages, corresponding with the sternal ribs, coalesce together in the middle line, so as to form so many intersecting bands. In the Flying Dragon (Draco viridis), the anterior ribs alone are united with the sternum; the posterior, especially the three middle ones, are very long and straight to support a membranous expansion, which serves the animal as a parachute, to sail through the air with from tree to tree. Nearly all the Saurians, with very few exceptions, such as Amphisbœna, possess a sternum, which occurs, however, in a rudimentary condition in the other serpentoid genera. It consists, as is well exemplified by the genera Lacerta, Monitor, &c., of an anterior slender T-shaped or cruciform bone, which

corresponds to the manubrium, and behind this of a very broad, flat, cartilaginous piece representing the body of the sternum, whereunto are appended posteriorly two small elongated pieces, parallel with each other, which, but for their receiving some of the costal cartilages, might be regarded as analogous to the ensiform cartilage of the Mammalia. The sternum becomes smaller, and more rudimentary in Chirotes, where the ensiform cartilage is formed by the uni-perforate plate of the body of the bone. In Anguis, even this is wanting, and there is only left a thin cartilaginous plate behind the clavicles; while in Pseudopus, the T-shaped manubrium is present along with it, though furnished with shorter processes.

The Crocodiles exhibit in the conditions of their skeleton, as in other general points of structure, various departures from the type of the remaining Sauria. The relative number of the vertebræ, with the exception of the caudal, agrees with that of the human subject, there being seven cervical, twelve dorsal, and five lumbar. The atlas is remarkable for consisting of four pieces, and supporting, as does also the second cervical vertebra, a moveable bone or rib of considerable size. The five succeeding vertebræ of the neck, like the twelve dorsal vertebræ, have their laminæ united by suture to the vertebral bodies, and support also short rib-like appendages, which are attached, like true ribs, by two crura, or in a furcate manner to the double (superior and inferior) transverse processes, and terminate externally by a hammer-shaped head, the anterior and posterior ends of which lie in such a way upon those of the adjoining vertebræ, as to limit the movements of the vertebræ in the lateral direction. This structure explains the fact, why one can easily escape when pursued, from a Crocodile, by moving in a circle. The sternum is broad anteriorly, and there projects into a pointed and free median process, while posteriorly it extends by means of two long slender pieces (sternal ribs), as far as the pubis. The part opposite to the lumbar vertebræ supports five pairs of free costal cartilages, without any vertebral ribs. There are only two sacral vertebræ, as in the rest of the Sauria, and about forty caudal vertebræ.

It is in the Chelonia unquestionably that the vertebræ, ribs, and sternum, present the most abnormal structure, for it is in them that a coalescence of some of the tegumentary bones takes place with those of the true skeleton, so as to form the dorsal shield, or carapace, and the ventral or plastron. The cervical vertebræ, eight in

number, are always freely moveable, and to such a degree in the Land and Fresh-water Tortoises, that the neck can be retracted beneath the carapace. They are similar to those of the Lizards, and provided with long but very depressed superior and inferior spinous processes. The odontoid process of the second cervical vertebra is constituted by a distinct bone. The two sacral, as also the caudal vertebræ, few in number, are provided with strong transverse processes. The bodies of the dorsal vertebræ are of very peculiar construction, being very long and narrow, and anchylosed to the dorsal shield, and hollowed out superiorly for the lodgement of the spinal cord. By making a perpendicular section of young specimens, the bodies may be readily perceived with the arches alternating with them. A distinct series of bones of a flattened form may at the same time be seen in the upper part of the section, to be situated upon the spinous processes; they form the middle row of dorsal scutes, and are partially anchylosed together, and with the ribs, by suture. They belong to the dermoskeleton, and in adult animals coalesce completely with the spinous processes. The lateral parts of the carapace also consist of anchylosed ribs and dermal bones. In young specimens the ribs are seen to be narrow, and are plainly distinguishable from the dermal bones. The origin of the rib, or its narrow neck, may be also detected, and the mode by which the head uniting with the bodies of two vertebræ, and also with their arches, forms the *tuberculum costæ*. In adult specimens of the Land Tortoises, the tegumentary bones are so strongly anchylosed together, that the two ribs which were originally distinct, become completely absorbed, and even the costal necks and heads are represented by only thin bony fibres. Externally the carapace is surrounded by a circle of quadrangular, or elongated bony scutes, which belong entirely to the tegumentary skeleton, and replace as it were, the costal-cartilages, while they are in part firmly united to the plastron. This union is effected moreover by means of a sternum, and several dermal bones anchylosed to it, as may be also seen in young specimens. The plastron consists of eight pieces united by suture, or by fibro-cartilage, and of a single piece intercalated between the four anterior ones, and which may be regarded as a kind of manubrium sterni. In the Land and River Tortoises, at least in Emys, this piece consists of a large and entire plate; in Trionyx, and the Marine Tortoises (*e. g.* Chelonia), it is perforated by irregular apertures, and the anterior pieces concur to form a T-shaped bone, which reminds us of the structure of

this part of the sternal apparatus in the Lizards. In Trionyx and Chelonia, the apices of the ribs are free, and abut against marginal scutes, which never become anchylosed to them. In Testudo and Emys the dorsal scutes are most perfectly developed, but they are all blended together, and united by suture.

The typical structure of the *Scapula* and *Clavicle* is best exemplified in the Tailless Batrachia, or the Frogs, whence we will pass to consider its modifications in the other orders. The Scapula consists in the Frogs of two bony plates, the superior one of which rests upon the transverse processes of the anterior vertebra, the inferior narrower helps to form, along with the two succeeding bones, the articulating surface for the humerus. The clavicles are two in number upon either side; the anterior one is narrow, and flattened like a scale, the posterior is broader; they both diverge from each other in front, and come in contact in the middle line with their fellows of the opposite side, so that the anterior coalesces with the anterior, the posterior with the corresponding piece of the sternum.

Next in order to the above, we have to consider the structure of these parts in the Chelonia. The Scapula is in them a longer and narrower bone, slightly and loosely connected superiorly by ligamentous bands with the first cervical vertebra, while inferiorly it is continuous directly with the anterior and also narrow clavicle, so that the two bones are anchylosed into a single one. The posterior clavicle is mostly broader, and expanded in the form of a shovel at its free extremity, which is directed backward, while in front it unites with the two former bones by means of synchondrosis, to form the articulating cavity for the humerus. The whole of this osseous girdle is completely covered by the carapace and plastron, and is therefore not visible externally.

In most of the Sauria, the scapula, as in the Frogs, is formed of two pieces. The posterior clavicle is very broad, projects into several points, which abut against a cartilaginous piece that is united to the sternum, and a corresponding cartilaginous piece of the other side. The anterior clavicle is rib-shaped, and does not contribute in any way to the formation of the shoulder joint. Both the anterior clavicles abut against each other in the middle line, and together form a narrow arch in front of the T-shaped portion of the sternum. The above arrangement of parts is principally displayed by the Lacertæ, and other closely-allied genera. The Crocodiles have a single elongated scapula, and also a single, tolerably broad and flat

clavicular bone, forming, with the preceding, the articulating cavity for the humerus; the two clavicles rest upon the supra-lateral border of the broad sternum. The structure is in a like degree simple in Chameleon, and also in Chirotes. In Anguis and Pseudopus there is found beneath the skin a bony girdle, without any further development of extremities; in this the anterior flattened clavicles which converge and come in contact with each other, are distinct, and in a less degree, may the rudimentary scapula, and still less the posterior clavicle, be distinguished. In Amphisbœna, at least in Trogonophis Wiegmanni, only a rudiment of the anterior clavicle is present, so that this animal exhibits the greatest amount of imperfection, and, as it were, the last link in the interesting metamorphoses of the anterior extremities in the Sauria. While, however, these subcutaneous rudiments of bones occur in the serpent-like Sauria, it would appear, at least according to present researches, that in the Ophidia every trace of anterior extremities has disappeared. In the Tailed Batrachia, as the Salamanders and Tritons, the structure is more simple. The scapulæ continue in a more cartilaginous condition, and instead of the clavicles, there is found anteriorly, a broad, partly cartilaginous plate, which comes in contact with that of the opposite side. The structure of these parts is similar in the Icthyic Reptilia; in Siren, and Proteus, the scapula is at least osseous inferiorly, but in Amphiuma is reduced to a mere cartilaginous plate. Every trace of extremities appears to be wanting in Cœcilia.

In the disposition of their *Anterior Extremities*, the Reptilia approximate the Mammalia. The humerus is of moderate length, and in the Chelonia very much bent, and twisted in such a manner in relation to the axilla, that the arched surface looks in the direction backward; two bones are generally met with in the fore-arm, whereof the radius is usually placed anteriorly, but in the Chelonia, internally and posteriorly; it is only the Tailless Batrachia who have a single bone to their fore-arm, but even this presents a double groove indicative of its division into two bones, and possesses internally a double medullary canal. In many Reptiles a peculiar ossicle is developed in the extensor tendon of the humerus, above the projection of the olecranon, and, from its resemblance to the patella, has been called the patella brachialis. It occurs in many Batrachia and Sauria, more rarely in the Tortoises, but is wanting in many genera, and in the Crocodiles. In all Reptiles, the carpus is composed of a double, more rarely a single or triple, series of small ossicles, which

vary in number, and present a merely cartilaginous condition in the Sirens. To these succeed the metacarpal and phalangeal bones of the fingers, the latter differing in number and proportion, three in a row being the usual quantity, though in the Sauria there are from four to five phalanges upon some of the digits. The Ichthyic Reptilia have a few somewhat cartilaginous carpal bones. The Land Tortoises appear to have no metacarpal bones; the phalanges are here very short, but in the Marine Tortoises very long, and well developed to sustain the swimming paddles. In the Frogs, and Salamanders, there are found from 5—7, and in the Chelonia and Sauria mostly 9—10 phalanges. The two latter orders have mostly five, the Batrachia four fingers. There is frequently found however in the males of the Tailless Batrachia, a special rudimentary bone, or thumb. In the Sauria the third digit has four, the fourth five joints, and both of them are very long. The Proteus and Amphiuma tridactylum, as the name of the latter implies, possess only three digits, while there are only two in A. didactylum, and one in Chœmasaura.

The greatest resemblance to the Mammalian type, and consequently the most perfect condition of the bones of the *Pelvis*, is manifested by the Sauria and Chelonia; for it is here that we constantly find an ilium united to the sacrum, as well as a pubis and ischium, all these three bones remaining permanently separated, and meeting in the acetabulum; in both orders the ischiac unite in front, like the pubic bones, thus giving rise to a symphysis, as in the latter; in the Chelonia these two symphyses approximate, so as to leave an intervening obturator foramen. In the Anourous Batrachia the pelvis has a V-shaped form; the two iliac bones are very long and narrow, form the branches of the letter, and coalesce within such a narrow space behind with the very small pubic and ischiac bones, as to leave a bony disc, perforated by the two closely adjacent acetabula. In the Tailed Batrachia, and the Ichthyic Reptiles (though in some of the latter, as in Siren, it is wanting), the ilium is a narrower bone, united by ligament with the vertebral column; the pubis and ischium are blended together so as to form a single plate of considerable size, loosely connected to that of the other side, and for a great extent cartilaginous, especially in the Sirens. The rudiments of the pelvis are still further diminished in the Apodal Sauria, wherein a single bone is all that is invariably found, situated as in many Ophidia beneath the skin, behind the rib-bearing vertebræ, and nearest to the anus; it actually supports

in several species small osseous rudiments of feet. The structure of the posterior extremities in Pseudopus, Anguis, and Acontias, is very interesting, as exhibiting an advanced condition, for here indeed the single elongated pelvic bones are attached by ligament to the transverse processes of the last dorsal vertebra; in Eryx, Boa, Typhlops, Amphisbœna, &c., a pair of very elongated bones, consisting occasionally of several pieces, lie always free, and at a distance from the vertebral column, in a parallel position with the rectum. The Amphisbœnas, such as Trogonophis, exhibit the simplest form of pelvis, since it consists in them of a very small flattened bone, lying posteriorly beneath the integument, and near to the vertebral column; it may be regarded as a rudiment of the ilium. This structure is rather more complete in Ophisaurus.

The *Femur* is of large size, and strongly curved in the Chelonia; the tibia and fibula are generally met with, with the exception of the Anourous Batrachia, where only a single bone is found, as in the fore-arm, presenting marks of division. There is frequently developed in the extensor tendon of the femoral muscles, in many Sauria, a patella, and in several Batrachia, as in Pipa, a second patella occurs, situated behind, between the tibia and tarsal bones. These last, disposed in three rows, continue partly cartilaginous in the Tailed Batrachia, and present themselves under similar conditions in the Ichthyic Reptiles; on the contrary in the Anourous Batrachia the two tarsal bones, corresponding to the os calcis and astragalus, are constructed after the type of the crural bones, being of an elongated form, while in front of them is situated a row of lesser tarsal ossicles; in the Chelonia, and Sauria, the small tarsal bones are disposed in two rows. The metatarsal bones correspond completely in the several orders with the metacarpals. The number and form also of the phalanges of the toes correspond, with some exception, to those of the fingers. The last toe but one is usually the longest. Several Ophidia, and Apodal Sauria, possess the rudiment of a single toe, which is even provided with a nail, as in Pseudopus, where the rudiment is very small, and turned in the direction upward. It is more developed in the true Serpents, but it is only in some genera, as Tortrix, Boa, Python, and also Eryx, in which this rudiment of a toe supports a strong pointed claw. The poisonous Snakes, Natterers, &c., appear to be destitute of these structures. In Siren, and Cœcilia, all trace of posterior extremities is likewise wanting.

MUSCULAR SYSTEM.

The two sub-classes of Reptilia exhibit, even in the structure and arrangement of their muscles, certain constant differences.

The muscles of the Squamigerous Reptiles who rank nearest to Birds and Mammalia, are of a redder color, more isolated and separated from each other into several bundles, and generally possess greater energy of action, although those of the Frogs, which are white, are endowed also with remarkable strength. In the Sirens, and also in the Tailed Batrachia, the mode of arrangement of the muscles is analogous to that of Fishes, their body, as in them, being adapted for swimming. The distinctness and degree of separation of the muscles increase as we approach the Sauria, in which the muscles are most readily referred for comparison to those of the human subject. In other respects such great diversities occur throughout the class, that it were difficult to give a general description, without entering into more tedious detail than would be compatible with the nature and extent of this work, and we must therefore refer the student to the list of books and illustrations given at the end of the class, for further information upon this subject.

The *Tegumentary muscles* are not always so developed in Reptiles, as in Mammalia and Birds, and are completely wanting, for example, upon the trunk of the Chelonia. Powerful and distinct muscles of this kind are found, however, in the Serpents, upon the ventral scutes, to the number of six pairs to each of the latter, which by means of their action can be slid one within the other; tegumentary muscles occur also in the Batrachia.

The Ichthyic Reptilia, the Water-Newts, and the Tadpoles or larvæ of the Raniform Amphibia, which progress in the water by inflecting trunk and tail, possess large laternal masses of muscle similar to those of Fishes, which cover the whole back, and are continued directly into the ventral muscles. The large lateral muscle always arises from the occipital and temporal bone, and from the arches and transverse processes of the vertebræ, and is continued to the end of the caudal portion of the column. It is usually intersected transversely by as many tendons as there are vertebræ present. A superior and inferior layer of muscles may be distinguished, which correspond to the *m. sacro-lumbaris*, and *longissimus dorsi*. Besides the two oblique muscles of the abdomen, a

rectus may be distinguished, provided with many transverse tendinous bands. The muscles of the extremities are more analogous to those of the higher Reptilia.

In the Frogs the muscles of the back, are much shorter, and the parallel tendinous intersections are limited, as in man, merely to the abdominal muscles. The dorsal region in the Frog, particularly behind the head, is covered chiefly by the powerful muscles of the scapula, and the very small latissimus dorsi. The temporal muscle is very developed, and in like manner the strong muscles of the lower law. The *pectoralis major* is of very remarkable strength, and gives off narrow strips in the direction forward and backward, and is also divided into several stout bellies; beneath it lies the small pectoral, also of considerable size. The extensors of the humerus and fore-arm (*m. m. deltoideus* and *triceps brachii*) consist of very short, but uncommonly fleshy and strong muscular bellies. The flexor and extensor muscles of the hand present a similar character, so that in this respect the organ obtains a form analogous to that of the human subject. Upon the posterior extremities, on the contrary, the large glutæi are very different from those of Man, appearing as short, narrow, and but slightly developed muscles, adapted to the elongated form of the iliac bones, to which they are attached. The muscles of the legs, from the hinder extremities being adapted by their length for leaping and swimming, exhibit forms more analogous to the human structures, this holding good, both with the extensor and flexor muscles, as the *m. sartorius, adductor magnus, semitendinosus* and *membranosus*, and the strong muscles of the fibula, the *gastrocnemii*. The strong tendo-Achillis is continued into the *plantar aponeurosis*, and the patella-like bone already alluded to, as placed between the tibia and tarsal ossicles, serves it as a pulley over which to play. The muscles of the feet are greatly subdivided, and their short bellies pass into delicate tendons.

The slightest or most rudimentary degree to which the muscles of the trunk, including those of the back and ribs, are developed, is met with in the Chelonia, by reason of the peculiar manner in which their tegumentary is anchylosed to the true skeleton. The muscles of the face are equally rudimentary, and upon removing the hard closely overlying integument, we perceive only the temporal and palpebral muscles. The muscles of the neck, and its nape, are, on the contrary, well developed, particularly the *m. spinalis cervicis*, which divides into single detached bundles, and is inserted

into the carapace, beneath which it serves, together with the *retrahentes capitis et colli*, to retract the head of the animal. The oblique and transverse muscles of the abdomen are of considerable size, being important agents in the movements of respiration, and there is found in this region of the body, as in Birds, a rudimentary form of diaphragm, which arises as a broader thinner muscle than in them, from the vertebral column and carapace, and is interposed between the peritoneum and pleura, without, however, meeting its fellow in the middle line from the opposite side. Beneath the plastron lie the great pectoral muscles, which, like the large glutæi, are strongly developed, this being the case also with the muscles of the extremities, among which the flexor muscles of the leg, the *biceps femoris* and *semi-tendinosus*, are remarkable for their length.

In the Ophidia the cranial and maxillary muscles, especially those of the lower jaw, are distinguished by their great development; for instance, the temporal, from which a layer is given off over the poison-sac of the Venomous species, and acts upon it as a compressor. The muscles of the trunk, however, by which locomotion is effected, are the most remarkable in the Serpents. It is here chiefly the *intercostales*, as well as the *spinales, semi-spinales, interspinales* and *inter-transversales* muscles that act upon the very moveably united vertebræ and the free extremities of the ribs. Of the intercostals, some pass directly from one to the next adjoining rib, while others pass over several of these bones. Even the pelvis and rudimental feet of many Serpents (the osteological relations of which have been described above) are provided with muscles that bend the extremities as far as their ungual phalanx, and extend or draw them in different directions.

NERVOUS SYSTEM.

The *Brain* of the Amphibia ranks greatly inferior to that of Birds in the relative proportional size which it bears to the bulk of the body, though it fills up tolerably the cranial cavity, and is surrounded by the usual membranes. What is remarkable, it exhibits no very important differences in the several orders, though in this respect we are confessedly still in want of more accurate investigations.

The *Spinal Cord* is prolonged into the caudal vertebræ, and is generally furnished with two swellings corresponding with the