

tary larynx is continued directly into the membranous bronchi. In the Salamanders a short membranous trachea exists, and in some genera of Batrachia, as in *Pipa*, more or less perfect cartilaginous leaflets and rings appear upon it. In the Ophidia also, as in *Coluber* and *Vipera*, the trachea is often membranous at its commencement, but provided further down with cartilaginous rings, which are frequently osseous, *e. g.*, in *Crótalus* and *Python*, where their number is very considerable, amounting to 300 rings and upward. The rings are continued also over the single, or, where two lungs are present, double bronchi. In the Sauria, the trachea varies in length, being short with only 20—30 rings in the Chameleon, while in the Crocodile upward of 80 occur. In the Chelonia, as in *Testudo græca*, the trachea is divided deeply and higher up, and is furnished with strongly developed rings, which are continued throughout the bronchi into the lungs.

The Lungs exhibit remarkable diversities of form and structure. Thus, in the Ichthyodea, as in the *Proteus*, the lungs form a pair of very long narrow tubes which terminate inferiorly in a slightly-expanded pyriform bladder. In the *Triton* they present the appearance of elongated sacs, of tolerably uniform width throughout, and terminating in a point, while in the Frogs they are much shorter and broader. When the lungs have been fully expanded, they extend through the greater part of the abdominal cavity. In many Sauria the lungs present similar characters, and are both of equal size, *e. g.*, *Scincus*. In the Apodal Sauria, as *Anguis*, *Pseudopus*, and also in *Chirotes*, only one lung, and that usually the right, is present, but in those Sauria with very short or only a single pair of feet, as *Zeps* and *Bipes*, the left also exists, but is one third or more shorter than that of the right side. In the Ophidia, as *Boa* and *Python*, the length of the left lung is generally less by a third or half than that of the opposite side, but in *Coluber*, *Crotalus*, and others, it is much smaller, and quite rudimentary, appearing as an almost obliterated appendage. The genera *Cæcilia* and *Amphisbæna* appear on the contrary to have the left pulmonary organ developed, and the right shortened, this arrangement probably varying according to the species. In the *Viper* and other Serpents there is only a single lung, which on that account is always very long. The lungs are flat and short in the Crocodile, but largest and most perfectly formed in the Chelonia, where they extend beneath the carapace as far as the pelvis. Here and there, as in *Polychrus* and *Gecko*, and es-

pecially in the Chameleon, hollow cæcal diverticula are given off from the lungs.

The internal structure of the lungs differs in the several orders and genera of Reptiles, the respiratory surface being very much increased in the *Squamigera* by the development internally of cells, while in the lowest orders, the lungs are simply hollow bags. In the Ichthyodea and Tailed Batrachia their condition is of the simplest kind, as in *Proteus* and *Triton*, where they form, as already stated, simple bladder-like sacs, directly continued from the membranous larynx. In the Salamander the lungs begin to assume an uneven appearance from the occurrence of small inversions. In the Anurous Batrachia their respiratory surface is increased by membranous cells which project into them internally, and form with the lateral walls open rhomboidal, or more or less hexagonal or polyhedral spaces, upon which lesser cells again rest, these last opening in the inward direction into the common cavity of the lung. The lungs are more perfectly formed in the Chelonia and Sauria, although several genera of the latter frequently retain the simple character of membranous sacs, with an areolar tissue developed upon the internal surface of their walls, but no internal dissepiments. In both orders the cartilaginous rings of the bronchi becoming more imperfect are continued as strips, which, cartilaginous at first, are next converted into tendon, and form rounded or angular meshes which rest partly upon the walls of the lung, and enclose lesser meshes or air-cells, or are united together internally so as to form numerous dissepiments; thus the whole lung is filled more or less by a coarser or finer areolar tissue, and presents a number of cellular portions which can be all inflated from any one point. The middle areolar tissue is usually absent in the upper and lower (or only in the latter) parts of the lung, and the cells are then merely parietal, and leave cavities of considerable size in the interior of the organ. The lungs of the Crocodile and Monitor are the most completely made up of cells. In the Serpents it is commonly only the commencement of the one developed lung that is replete with cells and areolar tissue, its posterior extremity being in the condition of a thin walled and very extensible bladder. The size of the cells varies, but they are always larger than in Birds.

In the Amphibia, which present the lowest forms of air-breathing animals in the class Vertebrata, the study of the structure of the *Larynx* as an instrument of voice is one indeed of particular interest.

Its simplest structure is exhibited by some Ichthyodea, *e. g.*, *Pro-*



teus, in which it forms a cylindrical cavity, which is narrow superiorly toward the glottidean fissure, and beneath the latter is continued through the intervention of two sacs into the lungs. Within this rudimentary larynx are situated several strips of cartilage, corresponding to the *pars arytenoidea* and *laryngo-trachealis*. In the Tritons and Salamanders, where the sacs or rudimental indications of the bronchi are absent, the laryngeal or vocal box, compressed from before backward, is supported by a *superior arytenoid*, and an *inferior lateral or laryngo-tracheal cartilage*. The structure is similar in one family of Ichthyodea, comprising the Menopome, Amphiume and Axolotl, as also in Cæcilia, where several tracheal rings are already met with.

Resembling more nearly the larynx of the higher animals, but with diverse modifications, we come now to consider the structure of the laryngeal cavity in the Anourous Batrachia; a subject of special interest from the differences which it presents in the two sexes of these Amphibia. This latter circumstance is very strikingly exemplified by its conditions in the males of the genus *Pipa*. The *arytenoid cartilages* are here of considerable size, triangular in form, and articulate with the lateral or *laryngo-tracheal cartilages* situated beneath them, and here united into a single body; this, which corresponds to the thyroid cartilage, forms at the same time the upper part of the trachea, and diminishes greatly in size opposite to the arytenoid cartilages. The glottidean fissure is situated quite close to the root of the tongue, and there are always found in this situation, with but few exceptions, as in *Pipa* and *Dactylethra*, a pair of vocal chords, that correspond to the *ligamenta inferiora* of the Mammalia, and are attached before and behind to the arytenoid cartilages. Beneath the vocal chords are situated a pair of cavities analogous to the *ventricles of Morgagni*. A pair also of inferior vocal ligaments, narrower than the true ones, and formed by simple folds of mucous membrane, frequently occur.

In the Squamigerous Reptiles, the separation of the larynx from the trachea is more distinctly shown. The arytenoid and thyroid cartilages in the Serpents are frequently blended together. In the Crocodiles and Tortoises, and in many of the Sauria, the thyroid cartilage is very developed, isolated from the rest, and being provided with special processes, resembles that in the larynx of Man. Frequently there is developed from it in the direction upward a fold of mucous membrane or a *processus epiglotticus*, which as in the Chameleon, may be viewed as a rudiment of the laryngeal valve.

A true cartilaginous epiglottis is found to be present either as a narrow papilla, or broader lobule, in different Serpents and Sauria. The vocal ligaments are not nearly so generally present among the Squamigera, as the Anourous Batrachia. They are wanting in all the Serpents, the hissing sounds of these animals being produced like the act of whistling in the human subject, by the edges of the narrow laryngeal outlet performing friction against the air in expiration. The Lizards possess a pair of narrow vocal chords. A thick fold of mucous membrane with a subjacent pouch is all that is to be remarked in the Crocodile.

A peculiar structure in the genus *Chameleo*, reminding us of the laryngeal pouches in many Apes, is well deserving of notice. Between the larynx and first tracheal ring is found an opening which leads into a membranous sac that can be distended with air.

As concerns the *Laryngeal muscles*, an expander of the glottis (*m. dilatator aditus laryngis* Henle) is found, very generally in the Batrachia, and arises either from the vertebral column and the skull, or from the lingual bone (this being the case in all the Anoura), and is inserted into the edge of the vocal fissure, or into the *cartilago lateralis* of its corresponding side. Besides this muscle, in examples of a more perfect structure, we may distinguish three others, a dilator of the laryngeal inlet, with a contractor and a compressor of the cavity of the larynx, all of which exhibit manifold diversities. Among the Squamigera an elevator and a depressor of the larynx are found in the Serpents, as a pair of long muscles, that are absent in the higher orders of the sub-class, but a *compressor* and *dilatator aditus laryngis* are universally present.

In some of the Anourous Batrachia, *e. g.*, in the Tree and Meadow Frogs (*Hyla* and *Rana esculenta*), but not in *R.*, *temporaria*, accessory organs are associated with the vocal apparatus. They consist of a pair of thin-walled, very dilatable bladders, situated by the articulating surface of the inferior maxilla, and which open always into the cavity of the mouth below the Eustachian tubes; they contribute to strengthen the voice, by serving as an apparatus of resonance.

Between the carotid arteries and resting upon the trachea, a small vascular gland, which may be viewed as the analogue of the *Thyroid gland*, is found in several Squamigerous Reptiles, as in the Tortoises, Crocodiles, and also in the Serpents.



## URINARY ORGANS.

ALL Reptiles are provided with *Kidneys*, which are commonly situated far backward and deeply within the pelvis. In the Anourous Batrachia, however, and especially in the Ophidia, they are placed far forward, and in the latter order the right kidney lies asymmetrically in relation to the left, being placed higher up and in advance thereof. The size of these organs varies in the several orders, but is generally very considerable; they are very narrow, elongated, and run to a point anteriorly in the Ichthyodea and Tailed Batrachia; of an elongato-oval form with slight incisures in the Lizards and Anourous Batrachia; in the Ophidia they are for the most part very elongated and flat, and divided into round lobules, while in others, *e. g.*, Boa, they are portioned out into narrow plates lying one upon the other; in the Crocodiles and Chelonia they are broader, and frequently, especially upon the posterior part, provided with indentations. Occasionally, as in the Rattle-Snakes, each kidney is completely divided into an upper and under piece. In rare cases both kidneys, as in *Lacerta ocellata*, appear to coalesce inferiorly into one entire mass, a structure of which we are reminded in several Fishes and Birds, and occasionally in its very interesting occurrence as abnormal in Man, where it is due to an arrest of development. As regards the more minute structure of the kidneys, we may perceive in their early conditions in the Batrachia and Ichthyodea, narrow cæcal canals supported upon the extremity of the ureter, and in the Ophidia these, which are much longer and more contorted, unite together in a racemiform manner, and give off at intervals small trunks into the ureter; even in the more compact substance of the kidneys in the Chelonia and Sauria, the blindly terminating cæcal canals are found to be continuous from the peripheral to the middle part of the organ, with ramifications of the ureter. The kidneys, as has been already stated, have a special portal system. The afferent veins form, *e. g.*, in the Frog, a couple of small trunks which enter the kidney inferiorly and externally, and are distributed upon its posterior surface. The efferent veins take their origin by radicles from the anterior surface, and pass to the inferior vena cava. The ureters are mostly short and delicate, situated usually upon the internal inferior edge of the kidney, and in the Ophidia attain no inconsiderable length; they perforate the walls of the posterior region of the cloaca, discharging

into that cavity in the Squamigerous, a constantly firm chalk-like and crystalline urinary secretion, but which is on the contrary in the Naked Reptiles in a fluid state. There arises usually from the anterior walls of the cloaca (with however it would appear the exception of the Ophidia) a bladder which is usually small and rounded in the Sauria, elongated but simple in the Sirens, in the Chelonia mostly slit into two round lobules, and frequently, as in the Batrachia, fissured and developed to a very great degree; this is filled usually with a large quantity of colorless fluid, and has been viewed as an urinary bladder. Its walls are very thin and membranous, traversed by vessels, and the fluid contained therein consists of real urine and uric acid.

The *Renal Capsules* are found in all the Squamigera, and may be distinctly demonstrated in all the larger Serpents, Lizards, and Tortoises; they are mostly of a yellowish color, elongated in form, and are usually situated above the kidneys, either within the folds of the peritoneum, or more freely near to the sexual organs; internally they rest upon the vena cava, to which they are united by vessels. Besides the Ichthyodea, they are wanting also in the Batrachia, but in the Anoura, we meet with large, yellow-colored lobes of fat divided in a digitate manner, and placed upon the anterior extremities of the kidneys, while delicate streaks of granular fat course over the anterior surface of those organs.

## PARTICULAR ORGANS OF SECRETION.

In the order Amphibia the tegumentary follicles are occasionally, as in the Toads and Salamanders, developed to a very considerable degree, being in part distributed in small groups over a great extent of the body, and forming, *e. g.*, in Bufo and Salamandra, a protuberant conglomerate mass upon either side the head behind the ears. In the Salamanders and some Tritons they are situated chiefly in rows along the back; these follicles, as well as the crural glands of the Lizards, have been described in treating of the tegumentary system. Each aperture leads into a pouch, the commencement of which is slit into small blind pockets or cæca. In some Sauria an aperture is constantly found behind the anus, which conducts into a small pouch secreting a substance of a peculiar odor. The analogous follicles in many of the Ophidia, as in the common Snake (*Coluber natrix*), male as well as female, are very long and distinct. They are situated below the vertebral column near to the penis and behind the anus, upon the verge of which they



open. They are lined internally by a mucous membrane, which is covered with a net-work of flat cells and depressions; that secrete a fetid kind of grease. An epithelium provided with the same cellular surface rests quite freely upon the mucous membrane of these *Anal sacs*. The *Chelonia* possess similar but more rounded anal sacs. The *Crocodyles* have a thicker walled pouch situated beneath the integument upon the middle of the lower jaw, and which is called the musk gland, from its secreting a dark-colored grease smelling like musk.

The most remarkable peculiarity in the secretory organs of the present class is afforded by the *Poison glands*, which occur, however, only in the order *Ophidia*.

The *Poison-gland* corresponds in some measure with the parotid salivary gland, and agrees most strikingly in situation with the latter in the *Venomous Serpents*, having posterior venom-teeth, *e. g.* *Dipsas*, *Homalopsis*, where it lies more freely, not invested by any fibrous tunic, and has a short excretory canal. In the typical *Venomous Serpents*, as *Vipera*, *Naja*, *Crotalus*, *Trigonocephalus*, the poison-gland is situated more behind and beneath the eye, consisting of short tubes in *Naja*, or of hollowed ramified lobules (*Trigonocephalus*) and is surrounded by a dense, mostly double fibrous sheath, this again being covered by a layer of muscular fibres, which proceed partly from the temporal muscle, and serve to compress the gland and force its contained secretion into the excretory ducts; the latter courses along the external surface of the superior maxillary bone, and enters an opening placed at the root of the poison-tooth. The situation and structure of the poison-gland are similar in the *Aquatic Serpents* (*Hydrus* and *Hydrophis*). This gland occurs in an unusual situation in *Causus rhombeatus*, being ensiform, situated in a channel-like cavity, and extending to the 18th or 19th vertebra, so that it reaches over more than a seventh part of the whole length of the body; its excretory duct extends from the poison-tooth to behind the quadrate bone. The ejection of the poison into a living animal is accompanied by peculiar and frequently fatal effects.

#### ORGANS OF GENERATION.

REPTILES, like all the *Vertebrata*, have two distinct sexes, which exist in tolerably equal numerical proportion to each other, though with some preponderance upon the part of the female. The germ-preparing sexual organs are always situated within the abdomen,

and usually in front of the kidneys. The ovaria and testes are usually placed symmetrically upon the two sides, and are of equal size; it is rare for the testis or ovarium of the right side to be situated higher up than the left, as in the *Ophidia* and *Blindworms* (*Anguis*), where their asymmetrical arrangement reminds us of that of the lungs and kidneys of the same side.

In all the naked *Amphibia* and among the *Squamigera*, as the *Ophidia* and *Sauria*, the *Ovaria* are in the form of simple sacs or bags, mostly of a rounded shape, *e. g.*, *Ichthyodea*, *Tritons*, *Salamanders*, and *Ophidia*, or of a more elongated form, *e. g.*, *Sauria*, lined internally with a smooth mucous membrane, beneath which the ova are developed, and externally invested by peritoneum. Occasionally, as in the *Anourous Batrachia*, the ovaria are divided into lobes; and partitions projecting into their interior, form there cells within which the ova are found. In the direction forward, each sacciform ovarium is provided with a round or sometimes tubular aperture for the exit of the ova; within the smallest and most primitive ova a chorion, vitellus, and germinal vesicle may be clearly distinguished, the latter being in the *Naked Amphibia* provided with numerous small germinal spots. In the *Squamigera* the germinal spot is always single. In the *Chelonia* each ovarium, as in *Birds* and *Cartilaginous Fishes*, consists of a stroma, upon the free surface of which, namely, that turned to the ventral side, the ova are developed.

The *Oviducts* are two long membranous, frequently multi-contorted tubes, which are kept in their place by folds of mesentery, and are provided in the direction forward in some *Reptiles*, as in the *Chelonia*, with an infundibuliform abdominal ostium, into which the ova, after being detached from the ovarium, are received. In the *Batrachia* the opening of the oviducts is placed at a great distance from the ovarium, in the proximity of the heart. Strong and even muscular fibres lie between the external peritoneal and internal mucous membrane, and by means of these the oviducts are capable of exercising considerable peristaltic movements like the intestines. Their internal mucous membrane exhibits, chiefly in their lower or posterior part, strong longitudinal folds or villi, upon which the albumen is secreted, being the first investment which is here obtained by the ova. The oviduct is usually more widely dilated in the posterior part. Both oviducts open into the cloaca separately. A clitoris has been found hitherto only in the *Chelonia* and *Crocodyles*.

The *Testes* are of an elongated form in the *Ichthyodea* and *Ophidia*, or rounded, as in the *Frogs*, *Sauria* and *Chelonia*, and frequent-



ly divided by constrictions into several portions. A single testicle is most commonly found upon either side; occasionally, however, we meet with two and even several testes united one behind the other merely by the seminal vessels, as is the case in the Salamanders, where three to four such testes occur. The testes are invested externally by a thick fibrous coat, and consist internally of long or short and narrow cœca. The open extremities of these cœca pour the seminal fluid into several ducts, which unite to form a straight or contorted vas deferens, running down in front of the kidneys. Both vasa deferentia open into the cloaca. Upon the testes, as also upon the ovaria, there are appended occasionally in front, large yellow-colored lobes of fat divided in a digitate form, *e. g.*, in the Tailed Batrachia, while on the Anoura the adipose lobes are elongated, undivided, and attached by mesentery to the internal side of the sexual organs, or that turned toward the vertebral column.

The *Spermatozoa* contained in the semen of the Reptilia exhibit very numerous diversities. Those of the Squamigera, however, present the greatest degree of uniformity. They have, in general, in the common Snake for example, like those of Mammalia, an elongated body pointed anteriorly, and a very fine filamentary tail. In the Naked Amphibia greater varieties occur, while in the Frogs their body is elongated and narrow, but not very long; the spermatozoa of the Tritons and Salamanders are slender and circularly contorted, attain a very remarkable length, and exhibit very peculiar movements; other anomalous and singular forms occur, *e. g.*, in Bombinator. The spermatozoa are probably of largest size in the Proteus, thus exhibiting an interesting analogy with the blood corpuscles.

A proper external organ of copulation or sexual excitement, namely, a *Penis*, is absent as a rule in all the Naked Amphibia, Batrachia as well as Ichthyodea. Still however in the Tritons, and in some also, perhaps all the Ichthyodea, there is developed, at least during the period of the coitus, an organ which may be viewed as a rudiment of a penis. It consists of an acuminate papilla of considerable size, situated within the cloaca, and continued posteriorly into two short thick crura, which form a groove with the posterior wall of the cloaca, into which the semen is conveyed as it issues from the adjacent mouths of the vasa deferentia. This papilla is imperforate, but, though very irritable, is incapable of erection. This structure resembles much the rudiment of the penis that occurs in the male Ray-fish. Accessory glands occur in the Ichthyodea and Tailed Batrachia. They consist of a very dense

glandular layer, which surrounds the cloaca, and forms a protuberance around the anus, which consists of several layers of cœca, and projects very much at the time of the coitus.

The Lizards and Serpents possess a double penis capable of being everted; these two intromittent organs are in the Serpents often very long, slender and pointed, and are here, frequently like other organs, *e. g.*, *Coluber natrix*, asymmetrically developed, the left being the longest. They lie extended beneath the integument in a cavity behind the anus at the commencement of the tail, and can be everted from the cloaca, as in the Ducks and Geese, by a pair of special muscles; they are devoid, however, of elastic tissue and a fibrous body. At the season of the coitus they form, when everted, a double tube, which serves for the exit of the semen. Frequently, as in the Vipers and Rattlesnakes, and also in Python, each of the two penes is bifurcated at the extremity.

The penis is single in the Tortoises and Crocodiles, and resembles more that of the Two-toed Ostrich among Birds; it consists of a fibrous body, and has a groove upon its upper and anterior surface, which is imbedded in cavernous tissue, and into which the seminal fluid is received from the seminal ducts. In front we find a glans of varied form, infundibuliform in the Crocodiles, and very largely developed in the Tortoises; the whole of it consists, as in Man and Mammalia, of cavernous tissue. A muscle serves to draw the penis out of the cloaca. It is peculiar to all Reptiles, that the urogenital orifice lies invariably, as in the higher Vertebrata, in front of the anus.

In the males and females of the Tortoises and Crocodiles, there is found what are called the *Peritoneal canals*, which conduct as membranous tubes or slits from the peritoneal cavity into the cloaca, and are continued upon the penis as far as the glans, and there terminate blindly; in the female they are to be traced to the root of the clitoris; in both sexes they remind us of the vaginal canals of the Mammalia (see p. 54), and are probably the remnant of a foetal structure, viz., the excretory ducts of what are called the false kidneys or Wolffian bodies.

The two sub-classes of Reptiles, differing, as we have already seen, in so many important particulars from each other, are also developed from the ovum in an entirely different manner. The Naked Amphibia agree with Fishes in having neither amnion nor allantois, both of which foetal structures occur, however, in the Squamigera, of whom many have proposed, to form a distinct class, limit-