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ANIMAL KINGDOM, an appellation given to that great division of natural bodies to which ANIMALS belong. Like the other kingdoms of nature, the mineral and the vegetable, it is divided into numerous sub-kingdoms, classes, orders, genera, and other subordinate groups, according to the properties and forms of the objects which it comprehends. As the primary grand divisions of the mineral kingdom are founded on the primitive forms of crystallization, and those of the vegetable kingdom on the endogenous and exogenous modes of growth, zoologists have endeavoured to find some common principle for their first divisions of the animal kingdom. The most common function in animals, and in all organized beings, is generation, and we find the animal kingdom divided into four distinct groups by the modifications of this function, viz., *fissipara*, *gemmipara*, *ovipara*, and *vivipara*. But as the fissiparous and gemmiparous modes of generation are effected without the presence of distinct permanent organs, as the fissiparous mode occurs in isolated species belonging to classes remote from each other in the scale, and as nearly all the classes of the animal kingdom belong to the oviparous division, the modifications of this system do not present the means of establishing primary divisions suitable for the purposes of zoology. Although the process of internal digestion is not so universal as the *function* of generation, the internal alimentary cavity is the most universal *organ* of animals, and its forms therefore merit a first consideration in the establishment of primary groups. It is found, however, that in animals whose general structure is nearly the same, the alimentary apparatus varies so much according to the nature of the food, as to render hopeless any attempt to subdivide the animal kingdom from its modifications; as from its having one or two apertures, from its being a simple sac or a lengthened intestine, from its having one, two, or more stomachs or glands developed in its course, or other modifications of this kind.

In the circulating system we are presented with better means for such divisions than in the digestive, for the radiated classes have only

vessels for their circulation, the articulated classes have a superadded ventricle, the molluscous classes and fishes a bilocular heart, amphibia and reptiles a trilocular heart, and the birds and mammalia have four cavities in that organ. The respiratory organs likewise afford the means of founding primary divisions, as into ciliated, branchiated, and pulmonated classes, in ascending from the lowest to the highest forms of that system.

The primary divisions of the animal kingdom adopted by Aristotle, viz., animals with red blood and animals without red blood, are obviously founded on a single principle of classification, and correspond with the more recent divisions of vertebrata and invertebrata; but from the number of distinct classes of animals now comprehended under each of these divisions, they are quite unsuitable as primary groups in the present advanced state of the science of zoology. Considering the functions of the nervous system or the intellectual conditions of animals as a means of classification, Lamarck proposed three great divisions, the lowest of which comprehended the animals regarded by him as *apathic* or automatic, the second the *sensitive*, and the highest the *intelligent*, which, however, are too hypothetical to answer the purposes of the zoologist. Without any fixed principle for the establishment of his primary groups, Cuvier divided the animal kingdom into the *radiated*, the *articulated*, the *molluscous*, and the *vertebrated* divisions, which have been generally adopted by naturalists. From the importance of the nervous system in the living economy of animals, some have sought in its modifications a means of establishing primary or grand divisions of the animal kingdom on principles more uniform and philosophical than those commonly employed. In the radiated or lowest classes of animals, wherever the nervous system is perceptible, as in actinia, medusa, beroe, asterias, echinus, holothuria, &c. it is found in the form of filaments disposed in a circular manner around the oral extremity of the body. This lowest form of the nervous system is expressed by the term *cyclo-neura*, and although, like the radiated and every other character assigned to these classes, it is of partial application, it marks the uniform condition of that system on which the manifestations of life are chiefly dependent, and which principally establishes the relations of animals to surrounding nature. A different form of the nervous system is found in the long cylindrical trunks of the helminthoid and entomoid classes, where we observe almost from the lowest entozoa to the highest crustacea, a double nervous chord or column extending along the whole of the ventral surface of the body. This form of the nervous system, common to the articulated classes of animals, is expressed by the term *diplo-neura*, and it is found to accompany an organization generally more complex than that of the cyclo-neurose classes, and inferior to that of most of the succeeding divisions or sub-kingdoms, especially in the organs of vegetative or organic life, as the vascular, the digestive, and the glandular apparatus. The nervous

system is more concentrated around the entrance to the alimentary canal in the molluscous classes, where it generally forms a transverse series of ganglia, disposed around the cesophagus, a character which is expressed by the term *cyclo-gangliata*. The dorsal position of the great ganglia and nervous columns of the cephalopods, and their partial protection by an organised osseous internal skeleton, leads to the condition of the nervous system presented by the vertebrated classes of animals, where its central parts are in the form of a lengthened dorsal nervous chord developed anteriorly into a brain, and protected by a vertebral column and cranium. The vertebrated classes are thus designated *spini-cerebrata*, from the form of the most influential part of their organization.

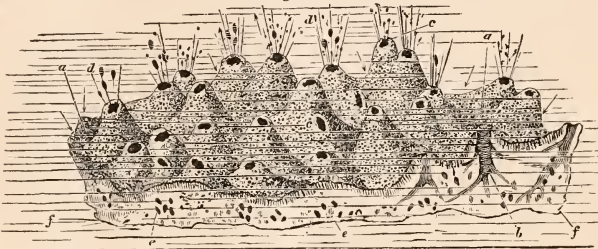
To the lowest sub-kingdom or cyclo-neurose division belong five classes of animals; viz.,

1. *Polygastrica*, microscopic, simple, transpa-

rent, soft, aquatic animals, in which no nervous filament has yet been detected, generally provided with eyes, with a circular exsertile dental apparatus around the mouth, and with vibratile cilia for respiration and progressive motion, and provided with numerous internal stomachs or cœca communicating with the alimentary cavity. (See *POLYGASTRICA*.)

2. *Porifera*, simple, aquatic, soft, animals, without perceptible nervous or muscular filaments or organs of sense, with a fibrous internal skeleton sometimes supported with silicious and sometimes with calcareous spicula, the body permeated with a soft gelatinous flesh, covered externally with minute absorbent pores, traversed by numerous ramified anastomosing canals, which commence from the pores and terminate in large open vents, as seen in the annexed figure of the *halina papillaris*, Gr. (*fig. 29*), which represents the animal as alive,

Fig. 29.



under water, with the usual currents passing inwards through its pores (*a a*), traversing its internal canals (*b*), and escaping by the larger vents (*c, d*). (See *PORIFERA*.)

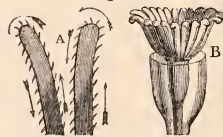
3. *Polypifera*, aquatic animals, of a plant-like form, generally fixed, of a simple internal structure, for the most part without perceptible nerves or muscles, or organs of sense, and nourished by superficial polypi, which are developed from the fleshy substance of the body, as in the *campanularia dichotoma*, (*fig. 30*), where the

Fig. 30.



irritable fleshy tubular portion of the animal is seen to occupy the interior of the base, the stem, and the branches, and to extend in the form of polypi from the open terminal cells. The polypi of most zoophytes are provided with tentacula around their orifice, as seen at *B*, (*fig. 31*), and the margins of these tentacula are generally furnished with numerous minute processes, termed *cilia*, (see *CILIA*.) by the rapid vibration of which, currents are produced in the surrounding water for the purpose

Fig. 31.



of attracting food and of aerating the surface and fluids of the body, as represented in *fig. 3, A*. (See *POLYPIFERA*.)

4. *Aculephæ*, soft aquatic free animals, of a simple structure, generally of a gelatinous and transparent texture, and emitting an acrid secretion which is capable of irritating and inflaming the skin like the stinging of a nettle, from which the name of the class is derived. They rarely possess a solid skeleton or a perceptible nervous system. They are all marine, often luminous, sometimes they possess eyes with a crystalline humour, they feed on minute floating animals, and swim by the contractions of a highly vascular and irritable mantle or by means of air-sacs, or by the rapid movement of

external vibratile cilia, as in the *berœ pileus* represented in fig. 32. This figure represents

Fig. 32.



one of the ciliograde acalephæ in which the mouth (*a*) is directed downwards, and leads, by a narrow œsophagus, to a wide stomach (*b*), and from this the intestine proceeds straight through the axis of the body to the anus (*c*) at the opposite pole. The longitudinal nerves (*g*), as in *holothuria*, proceed from a nervous ring around the œsophagus. The ovaries (*d*) extend along the sides of the intestine; the surface of the body is provided with eight longitudinal bands of pectinated broad vibratile cilia (*hh*), and two long ciliated tentacula (*ff*) extend from two curved lateral sheaths. (See ACALEPHÆ.)

5. *Echinoderma*, simple aquatic animals, for the most part provided with a calcified exterior skeleton or a coriaceous skin, the body for the most part radiated, globular, or cylindrical, often provided with a distinct nervous, muscular, respiratory, and vascular system. These animals have received the names of echinoderma, from the spines or tubercles which generally cover their exterior surface, as seen in the annexed figure of the *echinus esculentus* (fig. 33.) The mouth (*b*) is here in the centre

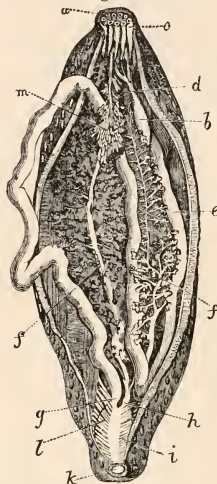
Fig. 33.



shell is seen to be provided with moveable cal-

careous spines. These animals are for the most part free, but some are fixed, as the crinoid echinoderma, the vascular system is unprovided with auricle or ventricle, and the digestive canal is seldom furnished with distinct glandular organs. There is sometimes a simple stomach with one aperture and numerous lateral cœca, and sometimes a lengthened intestine with two terminal openings. Some marine animals without an echinodermatous covering are placed in this class from the similarity of their structure in their more essential organs, as is the case with the *holothuria* represented in fig. 34. The mouth (*a*) is here surrounded with

Fig. 34.



ramose tentacula (*c*) and an osseous apparatus. The intestine is long, convoluted, vascular, supported by a mesentery, and terminates in a cloaca (*i*) at the opposite axis of the body. The ramified internal branchiæ (*ff*) open from the cloaca; the great systemic artery receives the aerated blood from the branchiæ, and the organs of generation (*m*) open near the anterior part of the body.

The irritable coriaceous skin is supported by five broad longitudinal subcutaneous muscular bands, and five crowded series of tubular muscular feet extend from its surface. (See ECHINODERMA.)

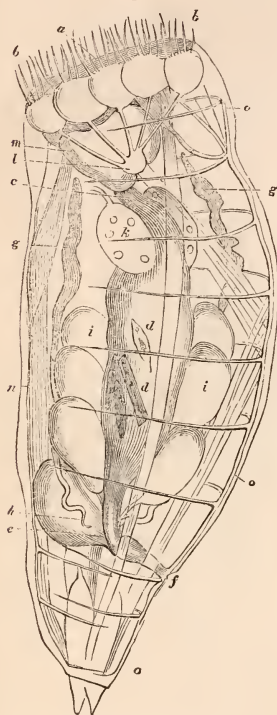
THE SECOND SUB-KINGDOM OF DIPLO-NEUROSE DIVISION comprehends four classes of helminthoid animals and the same number of entomoid classes, viz.

6. *Entozoa*, parasitic, simple, internal, or fixed animals, for the most part of a lengthened cylindrical form, without distinct organs of sense or any internal skeleton, the mouth or anterior part of the body generally provided with recurved sharp spines, the body generally covered with an elastic white transparent integument, the nervous system seldom distinct, the vascular system without auricle or ventricle, without respiratory organs, and with the sexes generally separate. (See ENTZOÏA.)

7. *Rotifera*, minute aquatic animals with distinct nervous and muscular systems, provided with eyes, lateral maxillæ, a dorsal vessel, an intestine with two apertures, and with vibratile cilia disposed generally in a circular form

around the anterior part of the body. They are termed rotifera from the appearance of revolving wheels produced by the rapid movement of the cilia disposed around the mouth.

Fig. 35.



One of these minute wheel-animalcules, the *hydatina senta*, is represented highly magnified in fig. 35, where the mouth (a) is surrounded with long vibratile cilia (b b). The œsophagus (c) leads to a capacious stomach (d), which becomes a narrow intestine below, opening into the cloaca (e), where the genital organs (i, i, g, g, h, h) also terminate. Several ganglia surround the œsophagus, and a dorsal vessel (o o) is seen extending along the middle of the back and sending out regular transverse branches. All the rotifera are free, most are naked, many are sheathed or loricated, they exhibit no branchial or pulmonary organs, they are remarkable for their fertility and their tenacity of life. (See ROTIFERA.)

8. *Cirrhopoda*, aquatic, articulated, diplo-neurose animals, with articulated cirrhi, and branchiæ for respiration, body covered with a fleshy mantle, and fixed in a multivalve shell. These animals are all marine, the branchiæ are fixed to the bases of the articu-

lated cirrhi, the mouth is provided with mandibles and maxillæ, there is a pulsating dorsal vessel, and a double longitudinal knotted sub-abdominal nervous chord. The cirrhopoda have been commonly placed among the molluscous classes from the form of their exterior coverings. (See CIRRHOPODA.)

9. *Annelida*, with a long cylindrical body generally divided into transverse segments, and covered with a soft skin; the head commonly provided with antennæ and numerous simple eyes, and the mouth with maxillæ; the organs of motion in the form of simple setæ or cirrhi extending from the sides of the body in a single or double row. The vascular system of the annelida consists of arteries and veins, without a distinct auricle or ventricle, and the blood is generally of a red colour. The respiratory organs are generally in form of external branchiæ, sometimes of internal air-sacs, and the alimentary canal passes straight through the body with two terminal openings, and with numerous lateral cœca developed in its course, as seen in that of the leech, *hirudo medicinalis*,

Fig. 36.

(fig. 36.) These lateral cœca (b, c, d, e, f, g, h, i, k, m,) increasing in length and size from before backwards, are often much more lengthened and divided, as in the *halithea*. Many of the red-blooded worms are fixed in calcareous, arenaceous, or other tubes, and many are free and naked. (See ANNELIDA.)

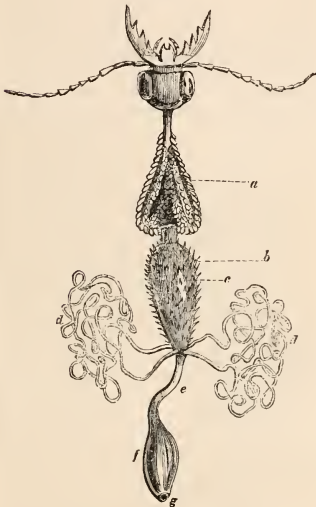


10. *Myriapoda*, with a lengthened articulated body equally developed throughout; the head provided with antennæ and simple eyes; the segments of the trunk free, without distinction of thorax and abdomen; the segments furnished with one or two pairs of articulated legs adapted for progressive motion on land; the respiration is aerial, and performed by tracheæ, which ramify from their commencement in stigmata which open along the whole extent of the body. They do not undergo metamorphosis, nor possess compound eyes nor wings, and they have always more than six pairs of feet. (See MYRIAPODA.)

11. *Insecta*, with six articulated legs extending from an articulated trunk, which is divided into a head, thorax, and abdomen; the head is provided with a labium, a labrum, mandibles, and maxillæ, with compound and often also with simple eyes, and a pair of antennæ and palpi; the thorax supports the six legs, and commonly one or two pairs of wings, and has attached to it the moveable segments of the abdomen, which embrace the principal organs of digestion, circulation, and generation. The respiration is effected by tracheæ, which form continuous lateral trunks before they ramify through the body. The circulation is aided by a pulsating dorsal vessel provided with numerous valves, and the alimentary canal is furnished with salivary and hepatic, and often with pancreatic glands. The sexes are sepa-

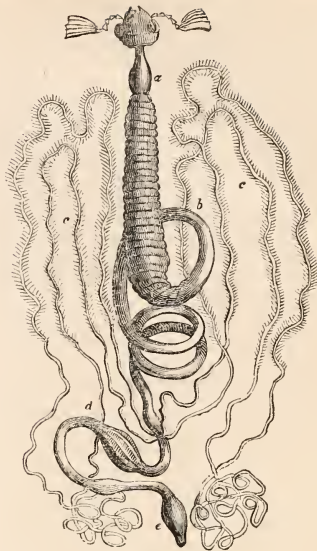
rate, and the genital organs, slow in their development, are highly complicated in the perfect state. These animals generally pass through a series of metamorphoses, and throw off their exuvial covering five or six times during their development. This class is the most numerous in the animal kingdom, comprehending about a hundred thousand species. The greater part of their life is spent in the larva state, during which they are generally most voracious, like the young of other classes. In the adult state the masticating organs and the digestive apparatus vary much according to the kind of food in the different species, as is seen in comparing the alimentary canal of a carnivorous *cicindela campestris* (fig. 37.) with

Fig. 37.



that of a phytophagous *melolontha vulgaris*, (fig. 38.) In the carnivorous insect (fig. 37.) the intestine passes nearly straight through the body with few enlargements in its course, and the glandular organs have a simpler structure. The œsophagus passes down narrow from the head, and dilates into a wide glandular crop (a), which is succeeded by a minute gizzard, and this is followed by the chylific stomach (b, c), which is covered like the crop with minute glandular cryptæ or follicles. At the pyloric extremity of the chylific stomach, the liver, in form of simple biliary ducts, pours its secretion into that cavity by two orifices on each side (d). The short small intestine (e) opens into a wide colon (f), which terminates in the anus (g). In the vegetable-eating insect, (fig. 38) the alimentary canal is more lengthened, convoluted, and capacious, with more numerous dilatations, and the glandular organs are more developed. The crop (a) of the *melolontha* is

Fig. 38.



succeeded by a minute rudimentary gizzard, and to this succeeds a long and sacculated glandular or chylific stomach, which becomes narrow and convoluted below, and terminates in a small pyloric dilatation, which receives the four terminations of the biliary organs. The succeeding part of the intestine is also convoluted, and has three enlargements in its course to the anus (e). The liver (c c) is here of great magnitude, and has its secreting surface much extended by the development of innumerable minute cœca from its primary ducts. Insects also often present distinct urinary organs, and numerous glands in both sexes connected with the organs of generation. (See INSECTA.)

12. *Arachnida*, with the head and thorax united, generally four pairs of legs; without antennæ, or compound eyes, or wings, or metamorphosis; the trunk divided into a cephalo-thorax and abdomen; the head is often provided with two pairs of chiliform manducatory organs; the eyes are simple. The respiration is aerial, sometimes performed by tracheæ, and sometimes by pectinated pulmonary sacs opening on the sides of the abdominal surface of the trunk. In their nervous, respiratory, and circulating systems they indicate a higher grade of development than insects, and like them are generally inhabitants of the land, attaining considerable size and strength, with cunning, cruel, carnivorous habits, and often provided with poisonous instruments. (See ARACHNIDA.)

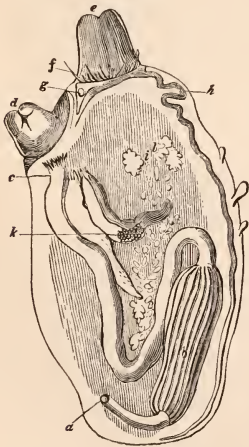
13. *Crustacea*, with the head and thorax generally united, two pairs of antennæ, two

compound eyes, more than four pairs of legs, the respiration effected by gills, and the shell generally hard and calcareous. These entomoid aquatic animals are generally carnivorous, and have a short and straight alimentary canal. Their circulating system is often aided by a muscular ventricle. The sexes are separate, and the organs of generation are double and symmetrical in both sexes. Their biliary organs have a conglomerate form, being composed of minute glandular follicles grouped together into lobules and larger lobes. Some of these animals are fixed and parasitic, and breathe by their general exterior surface; most are free, and respire by means of branchiæ placed under the sides of the carapace or exposed on the under-surface of the post-abdomen. (See CRUSTACEA.)

The THIRD, or CYCLO-GANGLIATED or MOLLUSCOUS DIVISION of the animal kingdom, comprehends five classes, viz. :—

14. *Tunicata*, soft, aquatic, acephalous animals, breathing by internal branchiæ, never in form of four pectinated laminae, and covered by a close external elastic tunic furnished with at least two apertures. The exterior tunic is lined by a muscular coat; sympathetic ganglia are observed in the abdominal cavity, and the respiratory organs are ciliated as in higher molluscan classes for the production of the respiratory currents. The mouth, unprovided with tentacula or other organs of sense, opens at the bottom of the abdominal cavity, as seen in the *Cynthia dione*. (Fig. 39. a.) The short œsopha-

Fig. 39.



gus leads to a capacious stomach (b), sometimes surrounded by the lobes of a small liver, which pours its secretion into that cavity as in higher mollusca. From the stomach a short wide convoluted intestine proceeds to near the ven-

tral orifice (d) of the sac, where it terminates in the anus (c). The thoracic orifice (e), or the entrance to the respiratory cavity, is generally provided with numerous delicate tentacula (f), and a nervous longitudinal filament (h) is generally observed to encompass that opening, and to terminate in a small ganglion (g). These animals are entirely marine, most are fixed, some are free; they are all female, like the conchifera; the circulation is aided by a muscular heart. Many are organically connected in groups, others are isolated, (See TUNICATA.)

15. *Conchifera*, acephalous, aquatic animals, covered with a solid calcareous shell, consisting of at least two pieces, and breathing by internal branchiæ in form of four pectinated laminae. These bivalved animals have the mouth, as in the former class, situated at the bottom of the respiratory or thoracic cavity; the stomach is surrounded and perforated by the lobes of the liver; the circulation is aided by a bifid or a divided auricle and by a muscular ventricle, which is generally perforated by the rectum, as seen in the annexed figure of the organs of the *spondylus*, (fig. 40.)

Fig. 40.

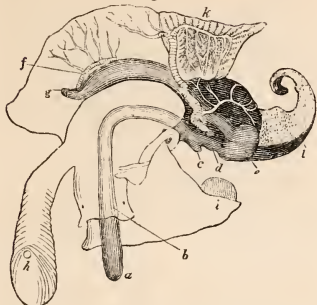


The two fimbriated lips (a) which surround the mouth are prolonged laterally into four tapering flat pectinated tentacular expansions (b). The stomach (c) and the intestine are surrounded by the large mass of the liver (i), and the rectum, near the adductor muscle (m), penetrates the ventricle of the heart (d), at some distance from the anus (e). The branchial veins (g, h) return the aerated blood to the two lateral divisions of the auricle, these pour it into the ventricle, by which it is propelled forwards and backwards through the system, so that the heart is here, as in other invertebrate classes, a systemic organ. (See CONCHIFERA.)

16. *Gasteropoda*, body invertebrate and inarticulate, provided with a head which for the most part supports tentacula and simple eyes, and furnished with a muscular foot, extended under the abdomen, and adapted for creeping. These animals are sometimes naked, more generally covered with a univalve, unilocular, solid, external shell. Some gasteropods breathe by a pulmonary cavity, most by branchiæ variously disposed on the surface or under an open mantle. Most are marine, many inhabit fresh waters, and some reside on land. The higher forms are mostly carnivorous, and the lower orders phytophagous, and this difference affects principally their alimentary apparatus,

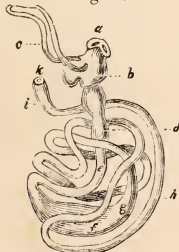
as seen by comparing that of the carnivorous *buccinum undatum*, (fig. 41,) with the same

Fig. 41.



apparatus in the phytophagous *patella vulgata*, (fig. 42.) Like most of the predaceous gastropods the *buccinum* is provided with a long muscular proboscis, (fig. 41, a, b,) capable of being extended to a distance from the mouth, and enclosing a bifid tongue covered with sharp recurved teeth. The oesophagus near the stomach dilates into a small crop (c), and to this succeeds a round membranous stomach (d, e). The whole remaining intestine is shorter than the oesophagus, and dilates into a wide colon (f) before terminating in the anus (g), on the right side of the body under the open mantle. The liver, of great size, and accompanying the testicle (i) in the turns of the spire, pours its secretion into the stomach as in the acephalous classes. The vas deferens following the right side of the body terminates at the end of the male organ (h) in a small tubular styliform duct. In the *patella*, (fig. 42,) however, which feeds on marine plants, the mouth (a) is provided with a long slender convoluted tongue covered with numerous rows of teeth like a long file. The wide and sacculated oesophagus (d) leads to a capacious and lengthened stomach (f, g), surrounded by the large liver, and the long convoluted intestinal canal (h) makes several turns imbedded in the mass of the liver before

Fig. 42.

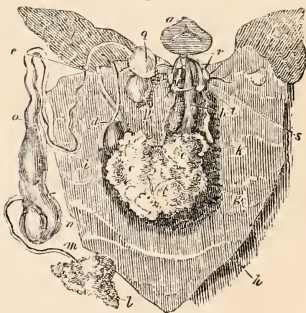


inferior orders are mostly male and female, but

in the higher forms the sexes are distinct. (See GASTEROPODA.)

17. *Pteropoda*, body organized for swimming, mantle closed above, branchiæ external, no muscular foot for creeping, shell, when present, always thin, pellucid, unilocular, and inoperculate. These soft, minute, floating animals are all marine, and are enabled to swim by means of two lateral musculo-cutaneous fin-like expansions, on the surface of which the respiratory branchiæ or vascular plexuses are placed. These lateral fins are never supported by rays. The head is generally provided with retractile or sheathed tentacula, seldom with eyes. The body is sometimes entirely naked, often protected by a delicate thin transparent shell, which encloses the abdomen and is covered with a fold of the skin. They appear to be most closely allied to the inferior testaceous cephalopods in the nature and form of their shells and in their locomotive powers, and also in the general simplicity of their internal structure, especially of their generative organs. The structure of one of the naked pteropods, *Clio borealis*, is represented in fig. 43, where the abdominal cavity is exposed by the mantle

Fig. 43.

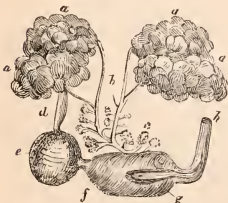


being opened from behind. The mouth (a) leads to a long oesophagus (b), which is surrounded by a circular series of nervous ganglia (t). The stomach (c c) is imbedded in the lobes of the liver (g), which open by numerous short ducts into its cavity. The oesophagus is accompanied by the two long simple salivary follicles (k), and at the left or pyloric extremity (d) of the stomach is placed the heart (i), enclosed in its pericardium, which receives the arterialized blood from the branchial veins, and sends it through the system. The bottom of the abdomen or cavity of the mantle (h) is occupied as in the cephalopods with the generative organs, which consist of an ovary (l) and long oviduct (m, o), into which a short wide cæcum (n), commonly considered as a testicle, pours its secretion. The oviduct terminates on the left side, near the anus (e), in a small glandular sac (g), beneath which is the renal sac (p). The pteropods are commonly found floating in immense numbers at the sur-

face of the water in still warm evenings in tropical seas; some, as the *clio borealis*, figured above, abound in the Arctic seas. (See PTEROPODA.)

18. *Cephalopoda*, free cyclo-gangliated or molluscous animals, with the feet disposed around the head, respiring by internal branchiæ, and with the abdominal cavity enveloped by a muscular mantle open anteriorly. The cephalopods are all marine animals capable of swimming by means of membranous or muscular expansions, which are never supported by rays. The surface of the body is often naked, sometimes covered with a shell, which is generally polythalamous, rarely monothalamous, and always inoperculate. There is often a concealed, loose, dorsal, calcareous or horny shell contained in a shut subcutaneous sac. The mouth is furnished with two horny or calcified mandibles, and the rudiments of an internal organized cartilaginous cranium and vertebral column are generally perceptible, together with some detached parts of the skeleton of vertebrata. The œsophagus is surrounded by a nervous collar, from which two supra-abdominal nervous columns generally extend along the middle of the back, and sympathetic ganglia are observed in the abdominal cavity as in the inferior molluscous classes. These are predaceous animals, and the alimentary canal, though generally furnished with three enlargements, forming a crop, a gizzard, and a spiral or proper chylic stomach, is always very short. There are two pairs of salivary glands; the liver is of great size, and pours its secretion, with that of the pancreatic follicles, into the stomach, as in the inferior classes. There is always a strong muscular systemic ventricle, and generally a divided auricle placed at the beginning of the branchial arteries. The common form of the chylipoietic organs is seen in those of the *loligopsis guttata*, (fig. 44.) where the liver

Fig. 44.



(*a a a a*) pours its secretion by ducts (*b*), which are surrounded and penetrated by the pancreatic follicles (*c c*), and which unite into a single canal before they open by a

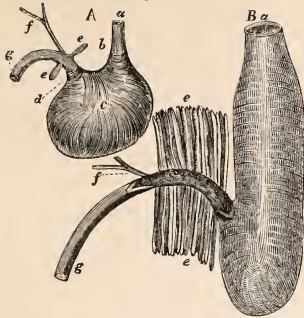
aperture into the third or chylic stomach (*f g*). The crop (*d*) ends in the strong muscular gizzard (*e*), and from the third stomach (*f g*) the short intestine (*h*) ascends in front of the liver to terminate by a valvular anus at the base of the funnel. The naked species have a glandular sac for secreting a black inky matter, which appears to be wanting in those protected by an external shell, excepting in the argonauta, where the shell is seen in the ovum, and where there is a slight membranous connexion be-

tween the animal and its thin delicate calcareous covering. The sexes are generally separate, but the lowest foraminiferous cephalopods appear to approach to the pteropods in the male and female character of the genital organs. (See CEPHALOPODA.)

The last or highest DIVISION of the animal kingdom, comprehending the vertebrated or red-blooded animals, or SPINI-CEREBRATA, consists of five distinct classes, characterised chiefly by their generative, their sanguiferous, and their tegumentary organs, viz.—

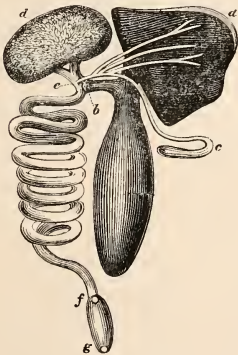
19. *Pisces*, cold and red-blooded oviparous vertebrated animals, with one auricle and one ventricle to the heart, breathing by permanent branchia, and with fins for progressive motion. They have a vertebral column and cranium, enclosing a spinal cord, and brain consisting of a medulla oblongata, optic lobes, cerebral hemispheres, olfactory tubercles, and a cerebellum. The hands and feet are always formed like fins for progressive motion in a watery element. The fins are supported by rays prolonged from the skeleton, the body is generally covered with scales, the trunk is organized for the lateral motion of the tail, there is no sacrum, and the pelvic arch is unconnected with the vertebral column. The bones are elastic or cartilaginous, and the centres of ossification for the most part remain permanently detached. The bodies of the vertebrata terminate in two cup-like cavities, they move on elastic tense intervertebral sacs, and the transverse processes are directed vertically downwards in the coccygeal region of the skeleton to facilitate the lateral motion of the trunk. The muscles, of a white colour, are disposed in oblique strata on the sides of the trunk for the movement of the elastic vertebral column. The mouth, destitute of salivary glands, is generally furnished with numerous unequal, irregular, fangless, osseous teeth, and the wide œsophagus, short like the neck, leads to a capacious stomach, from which the intestine, shorter than in the higher classes, and nearly equal throughout, proceeds, without cœcal enlargement, to terminate in a cloacal sac on the inferior surface of the trunk. The liver is large, and pours its secretion generally by a single duct into the duodenum, near the pyloric extremity of the stomach and close to the opening of the pancreatic duct, as shown in the annexed figures of these parts in the frog-fish (fig. 45, A) and the cod (fig. 45, B). The œsophagus (*a*) of the frog-fish (fig. 45, A) leads to a large globular stomach (*c*) with a strong muscular cardiac sphincter (*b*). The pyloric extremity is also surrounded with strong muscular bands (*d*), and beyond its pyloric valve two pancreatic simple glandular follicles (*e e*) open into the duodenum (*g*) close to the opening of the ductus communis chole-dochus (*f'*). In the cod (fig. 45, B) the wide œsophagus (*a*) leads to a long and capacious muscular stomach shut below, and immediately beyond the pyloric valve, formed by a circular fold of the mucous coat, open the ducts of numerous straight and simple pancreatic folli-

Fig. 45.



cles (*cc*) along with the ductus communis choledochus (*f*). The cartilaginous plagiostome fishes, the most complicated of this class, have a conglomerate form of the pancreas opening in the same situation. In the sturgeon and in the sword-fish an intermediate form is seen between the simple pancreatic follicles of the invertebrated classes and the more complicated conglomerate organ in the higher vertebrata. This is shown in the annexed figure of the chylopoietic viscera as I found them in the *xiphias gladius* (fig. 46), where the liver (*a*) is raised up to show

Fig. 46.



the three hepatic ducts uniting with the cystic from the curved gall-bladder (*c*) to form a very short ductus communis choledochus. The pancreas (*d*) forms a large reniform mass composed of numerous straight follicles produced by the successive divisions of the great terminal duct (*e*) of this organ. This large intermediate organ is surrounded with a distinct muscular tunic to force its contents into the duodenum immediately beyond the pyloric valve (*b*). The tortuous small intestine ends by a valvular orifice (*f*) in a very short but distinct colon, which presents no cæcum in its course to the anus (*g*). The bilocular heart

of fishes is entirely branchial; it is often preceded by a *sinus venosus*, and is always succeeded by a *bulbus arteriosus*, which often presents numerous internal valves in its course. The venous blood is entirely sent through the gills, and the branchial veins, after giving branches to the anterior parts, unite to form the aorta which sends the arterialised blood through the rest of the system without the aid of a systemic heart. The respiration is effected by the transmission of water through the mouth or through distinct spiracula, and over the surface of the branchiæ, which are internal in the adult, and are often preceded by external branchiæ in the young. The lungs are always rudimentary, when present, sometimes in form of a shut single air-bag, sometimes divided or ramified, and most generally communicating by a *ductus pneumaticus* with the intestine or stomach, or œsophagus, but seldom employed for respiration. Fishes are oviparous and have the sexes separate; the ovaries are continuous with the oviducts in osseous fishes, and detached from them in the plagiostome chondropterygii, and impregnation sometimes takes place internally and sometimes after the ova are separated from the body. (See PISCES.)

20. *Amphibia*, cold and red-blooded, vertebrated, oviparous animals, with three cavities of the heart, with a naked skin, and breathing, in the young state, by gills. These animals commence their career like fishes with one auricle and one ventricle, which send the whole of the blood through the branchiæ, and they have at this period also double concave bodies of the vertebræ, as in fishes. Many retain the gills through life, accompanied with pulmonic cavities, from which the arterialised blood is sent to a small left auricle. These animals are termed *amphibia* from the metamorphosis to a terrestrial from an aquatic life seen in most of the species. Their skeleton is imperfectly consolidated, their ribs very short or wanting, their pelvic arch free or nearly so, and their atlantal and sacral extremities often very imperfectly developed or partly deficient. Their toes are destitute of claws, as their skin is of scales, and the respiration through their naked, highly sensitive, and secreting surface compensates for the imperfect development or limited use of their lungs, especially during submersion or hibernation. Some reside constantly in the water, others occasionally, and others continue on land. The male organ of intromission is rarely developed, and impregnation of the ova is generally effected externally. The genital organs are double and symmetrically developed in both sexes. The perennibranchiate amphibia, especially the axolotl, have been shown by Weber to possess a double auricle like the caducibranchiate species. (See AMPHIBIA.)

21. *Reptilia*, cold and red-blooded, oviparous, vertebrated animals, with two auricles and one ventricle, not breathing by gills in their young state, covered with scales, and with the means of internal impregnation. These animals, whether aquatic or terrestrial, breathe only by means of lungs, and their pulmonic respiration and the left auricle of the heart are

greater than in the amphibia. Their bones are more consolidated than in the lower vertebrata, their pelvic arch, when developed, is more firmly attached to the vertebral column, the centres of ossification, especially of the cranial bones, generally remain detached, the extremities are for the most part more completely developed, and the toes are generally provided with claws. Their cerebellum is remarkably small, their muscular irritability languid, and they have great tenacity of life. This ventricle, which receives both the venous and arterialised blood, is more or less divided by an ascending imperfect septum. The thoracic and abdominal cavities are not separated by a muscular diaphragm, and the lungs extend backwards over the abdominal viscera. Their organs of generation are double in both sexes, and symmetrically developed on the two sides of the body. The two portions of the corpus cavernosum are often detached and bifid; the chorion of the ova is generally thin or coriaceous, seldom calcified or hard, and the instincts of the parent generally extend to the protection of the young. (See REPTILIA.)

22. *Aves*, warm and red-blooded, oviparous, vertebrated animals, with four cavities of the heart, covered with feathers, and with their arms organized for flight. Their bones are the most compact and dense in texture, the most extensively ankylosed, and generally contain air admitted from the cells of the lungs. Their tympanic bone is moveable, they have horny mandibles in place of teeth, their coracoid bones reach the sternum, the sternal ribs are ossified, and they want the tarsal bones. Their diaphragm never forms a complete partition between the thoracic and abdominal cavities. The hemispheres of the brain are without convolutions, the optic lobes are large and hollow, the cerebellum is large and sulcated, and the posterior enlargement of the spinal chord of great size. The great irritability of their muscular system corresponds with the great extent of their respiration, the high development of their nervous system, the rapidity of their circulation, and the increased energy of all their functions. Their alimentary canal is furnished with a crop, a glandular infundibulum, a gizzard, and generally with two cœca-coli, as seen in the annexed diagram (*fig. 47*), showing the

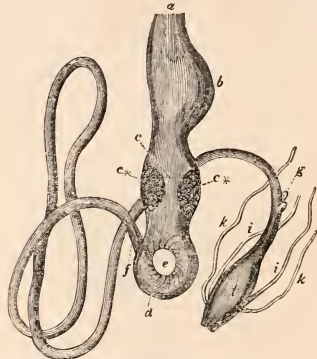
Fig. 47.



common form of these parts in a gallinaceous bird. In these gallinaceous birds the œsophagus (*a*) sends out at a right angle with its course a large crop (*b*), with a contracted neck, and supplied with glandular follicles. Beneath this is the infundibulum or glandular stomach (*c*), with numerous large follicles placed between the mucous and muscular coats, and this opens into the large muscular gizzard (*d*), provided externally with two strong digastric muscles (*e*). The cardiac and pyloric orifices of the gizzard are close to each other (*f*), and towards the lower part of the small intestine a minute cœcum often indicates the original entrance of the yolk-bag. The two long cœca-coli (*g*) commence by narrow entrances (*h*), and the short colon ends in a common cloaca (*l*) for the genital and urinary secretions.

In the predaceous birds, as the eagles (*fig. 48*), the œsophagus (*a*), the crop (*b*), the infundibulum (*c*), and the gizzard (*d*), are capacious, thin,

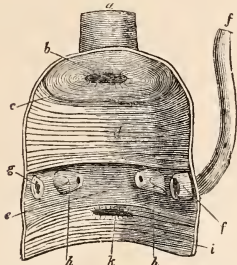
Fig. 48.



and membranous, and form a continuous cavity for the prey, from which the indigestible parts can be thrown out in a bolus. In these birds the cœca-coli (*g*) are very small, sometimes unequal, or wanting. The urinary (*ii*) and genital organs (*kk*) enter the cloaca (*l*) near the anus. The right ventricle of birds has the tricuspid valve in form of a thick strong muscular fold, and the aorta descends on the right side. The lungs form two undivided, light-coloured lobes, fixed by pleuræ to the back part of the trunk, the last rings of the trachea form an inferior larynx, the bronchi pass in a membranous form through the lungs, and the lungs open into large membranous abdominal air-cells, which communicate with the interior of the bones. This extensive aeration of their systemic as well as their pulmonic vessels gives energy to their muscles for their aerial life and their distant migrations, and a high temperature to their body for the incubation of the egg. Their plumage and their downy covering are the best suited for their aerial life and their high internal heat. Their organs of generation are double and symmetrical in the male, and

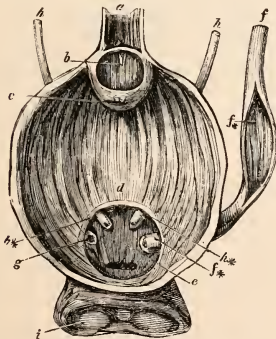
generally unsymmetrical in their development in the female. The testes are internal, and the vasa deferentia terminate in the cloaca, where there is sometimes a grooved organ of intromission. In the female the left ovary and oviduct are developed, the right for the most part atrophied and useless. The cavity of the cloaca in most birds, as seen in that of the great condor of the Andes (fig. 49), receives the end of the rectum (a), which forms a wide

Fig. 49.



rectal vestibule (b): beneath this lies the part analogous to the urinary bladder (c d). Lower than the urinary sac are found the two openings of the ureters (h h*), with the pervious oviduct on the left side (f), and the remains of the impervious oviduct (g) on the right side. The bursa Fabricii and the clitoris (when present) are placed more posteriorly in the preputial cavity. The most distinct forms of these generative and urinary parts, and the nearest approach to the mammalia are seen in the cloaca of the ostrich (fig. 50), where the rectum (a) opens into a wide and distinct rectal vestibule (b), which extends into a large urinary bladder (d). Beneath the urinary bladder is the urethro-sexual canal (c), into which the two ureters

Fig. 50.



(h h* h*) and the oviducts (f, f* f* g) open towards the dorsal and lateral part. The preputial cavity (i) is the terminal portion in which the distinct clitoris is here lodged. The ova

are impregnated internally, their chorion is calcified, and their development is effected by incubation. (See AVES.)

23. *Mammalia*, warm and red-blooded vertebrata, having four cavities of the heart, with a viviparous mode of generation, and possessing mammary glands; with the lungs free in a distinct thoracic cavity, and generally having the body more or less covered with hair. The bodies of their vertebræ unite by flat surfaces, the tympanic bone is fixed, the jaws are generally furnished with teeth lodged in deep alveoli, the coracoid bone rarely reaches the sternum, and the posterior extremities, when present, are always attached by the pelvic arch to a solid sacrum. The thoracic and abdominal cavities are separated by a muscular diaphragm. The hemispheres of the brain contain large ventricles, and rarely want convolutions, the optic lobes are small, concealed, solid, and divided by a transverse sulcus, the commissures of the brain and cerebellum, and the hemispheres of the cerebellum are large. The alimentary canal is of great length, the colon long and wide, with a single cæcum, and sometimes with a vermiform appendix, and the anal opening is generally distinct from the urinary and genital passages. The tricuspid valve is thin and membranous, the aorta descends on the left side, there is no inferior larynx, the epiglottis is distinct, and the bronchi continue cartilaginous into their ramifications in the lungs. The lungs, generally divided into lobes, move freely in a distinct thoracic cavity, and have no abdominal cells or perforations on their surface, as in birds. There is always a urinary bladder, and the urethra in the male passes through a tubular penis. The organs of generation are double in both sexes, symmetrical in the male, and rarely unsymmetrical in the female. The oviducts commonly unite at their lower part to form a uterus, in which the ovum becomes again connected with the parent, and is hatched. There are mammary glands opening externally for lactation during the helpless condition of the young. (See MAMMALIA.)

These are the PRIMARY and SECONDARY DIVISIONS of the ANIMAL KINGDOM, the structure, classification, and history of which it is proposed to consider in this Cyclopædia, under the heads of the several classes as enumerated in the subjoined table.

ANIMALIA.

I. Sub-regnum, Cyclo-neura vel Radiata.

- Classis 1. Polygastrica.
2. Porifera.
3. Polypifera.
4. Acalephæ.
5. Echinoderma.

II. Sub-regnum, Diplo-neura vel Articulata.

- Classis 6. Entozoa.
7. Rotifera.
8. Cirrihopoda.
9. Annelida.
10. Myriapoda.
11. Insecta.
12. Arachnida.
13. Crustacea.

III. Sub-regnum Cyclo-gangliata vel Mollusca.

Classis 14. Tunicata.

15. Conchifera.
16. Gasteropoda.
17. Pteropoda.
18. Cephalopoda.

IV. Sub-regnum Spini-cerebrata vel Vertebrata.

Classis 19. Pisces.

20. Amphibia.
21. Reptilia.
22. Aves.
23. Mammalia.

For the BIBLIOGRAPHY of this article see that appended to each of the articles on the classes of animals and COMPARATIVE ANATOMY (*Introduction*.)

(R. E. Grant.)

ANIMAL (from *anima*, breath, the living principle. Lat. *animal*. Gr. *ζῷον*. Fr. *animal*. Germ. *Thier*. Ital. *animale*). The objects of the material universe were long considered as arranging themselves naturally into three grand divisions, or *kingdoms*, as they were called: the animal, the vegetable, and the mineral. Closer attention, however, and a more careful study of the qualities and actions of the various bodies composing these kingdoms, lead to the conclusion that two of them have much in common, and consequently that a two-fold division suffices to comprehend the whole of the objects in nature,—these are the inorganic, or lifeless, and the organic, or living; the first embracing minerals, fluids, gases, or the various forms in which simple brute matter presents itself to our observation; the second including vegetables and animals.

As the subject ANIMAL may be regarded in the light of the very kernel and epitome of the entire matter treated in the pages of our Cyclopædia, we shall give such extension to this head as its importance seems to demand, studying brevity nevertheless, and embracing in general views the particular points which will be illustrated in detail in the different articles on anatomy and physiology, human and comparative.

COMPARISON OF THE ORGANIC AND INORGANIC WORLDS.

Physical qualities and elementary composition of unorganized and organized bodies.—The organic and inorganic kingdoms of nature are distinguished from one another by many strong features of difference,—first, in reference to their general physical qualities, external form, volume, and elementary composition; and second, in regard to their capacities of action.

The *forms* of the objects composing the inorganic world, indeterminate when they are considered in their masses, are reducible to a very few simple crystalline shapes when they are regarded in their parts. The cube, the hexahedron, the rhomb, the prism, &c. are the elementary forms of the inorganic world: plane surfaces and straight lines uniting under different inclinations, and originating angles that measure certain determinate numbers of de-

grees are the *accidents*, which give them their characteristic and individual shapes.

But the inorganic world has not absolutely even this limited perfection of form, if the expression may be allowed. In order that the objects which compose it may exhibit themselves under the form of crystals, solution of some kind, rest, time, and space are required; and these or any of these being denied, the objects of the unorganized world present themselves or exist as simple aggregates of molecules, shapeless in their component parts as in their masses. And further, even when the objects of the inorganic world do present themselves under definite forms, these are not necessary and invariable. Carbonate of lime, to take a single instance, occurs crystallized not only in rhombs, but in hexahedral prisms, in dodecahedrons, the several faces of which are pentagons, in solids terminated by twelve triangles with unequal sides, &c. In their material composition, too, unorganized bodies are essentially homogeneous: one part of a mineral does not differ from another.

This is very different from what occurs in the world of organization. From the lowest to the highest of living beings the shape is determinate for the individual, not only as a whole, but even as each of its component parts is concerned. Instead of being circumscribed within angles and right lines like the objects of the inorganic kingdom, those of the organic are mostly rounded in their forms, or they are branched, or articulated and made up of several parts, which present varieties of conformation in harmony with the kinds of offices they have to perform, or the conditions surrounded by which the beings thus fashioned exist. Neither do they consist of homogeneous particles like minerals, but are made up in general of heterogeneous parts: in plants we have roots, leaves, branches, flowers, &c.; in animals muscles, nerves, bones, and a great number of organs besides, each itself reducible to a variety of simpler parts or elements, entitled tissues.

The organic world also presents an immeasurably greater variety of forms than the inorganic: the myriads of animals and vegetables that people and possess the earth differ to infinity from each other in their forms and physiognomies.

Size.—Neither is there less discrepancy between the inorganic and the organic world in the quality of size, which, in the first, is perfectly indeterminate, being greater or less, simply as the constituent molecules happen to be aggregated in larger or in smaller numbers. The volume of organized bodies, on the contrary, is determinate; every animal, every vegetable, has a particular stature, a certain bulk, which is that of its species also, and is within narrow limits alike in regard to all the individuals composing the kind.

Composition.—Contrasted in their chemical nature, organized and unorganized bodies present numerous and striking points of dissimilarity. Modern chemistry enumerates no fewer than fifty-two elementary or simple sub-