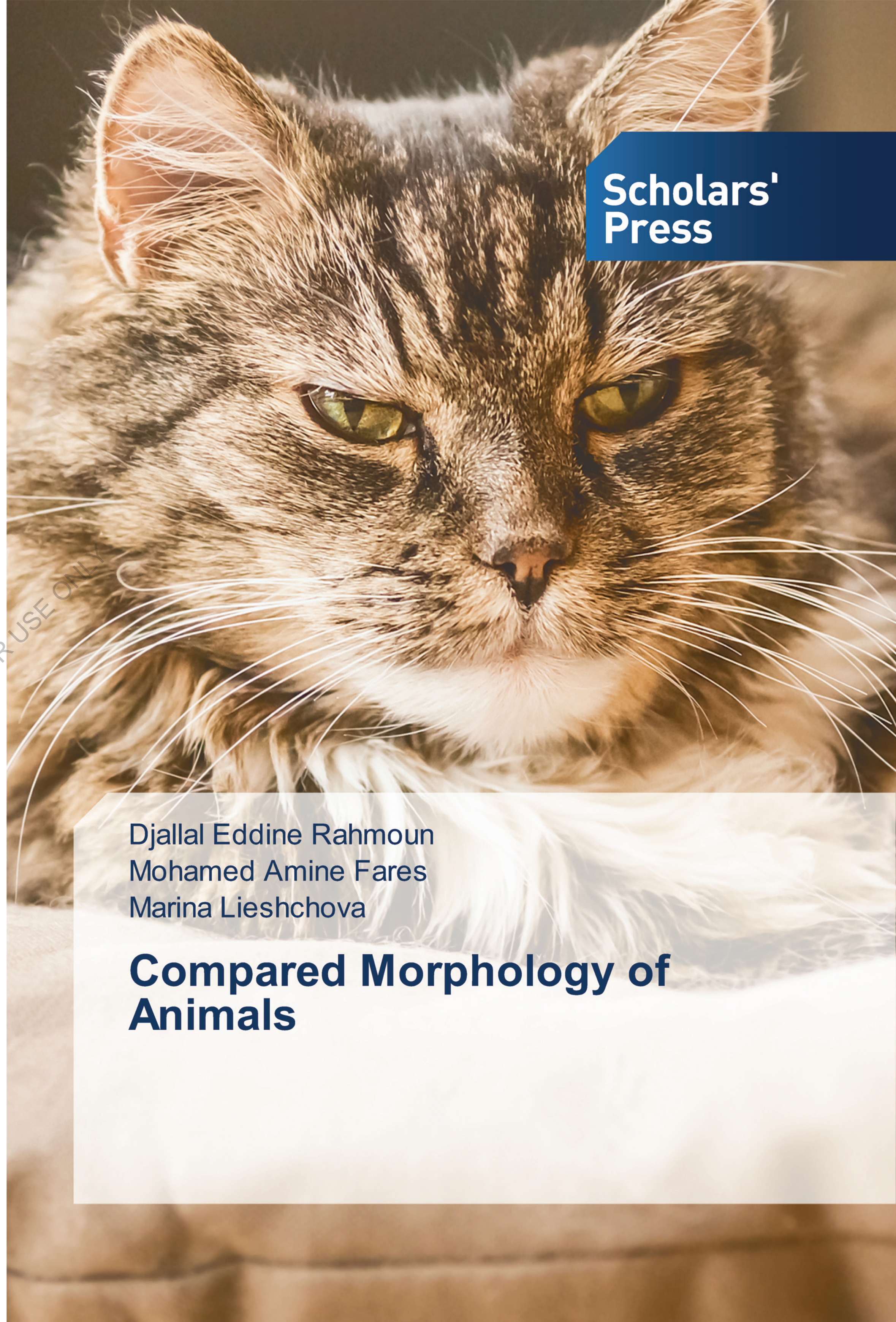
Compared Morphology of Animals

Comparative morphology forces us to examine organized beings from a multitude of points of view, and must go hand in hand with the study of man. The structure known as anatomy and physiology of the animal's body have been singularly advanced by the discoveries that have been made on animals. Nature has endowed animals with various qualities by their destination and each presents a distinct character with organization which is simple and reduced. The analogy between animals and animals is such proof that it has been universally recognized. Under a small volume, a structure of different complicated system and important organs will be illustrated in this area of morphology.

Rahmoun Djallal Eddine: PhD Animal morphology, oncology and pathology, Master in medical biochemistry.
Fares Mohamed Amine: Student in Taoura Institute of Agronomic and Veterinary Sciences, University of Souk Ahras.

9 786138 938736



Scholars' Press

Djallal Eddine Rahmoun
Mohamed Amine Fares
Marina Lieshchova

Compared Morphology of Animals

Djallal Eddine Rahmoun
Mohamed Amine Fares
Marina Lieshchova

Compared Morphology of Animals

Djallal Eddine Rahmoun
Mohamed Amine Fares
Marina Lieshchova

Compared Morphology of Animals

Scholars' Press

Imprint

Cover image: www.ingimage.com

Publisher:
Scholars' Press
is a trademark of
International Book Market Service Ltd., member of OmniScriptum Publishing Group
17 Meldrum Street, Beau Bassin 71504, Mauritius
Printed at: see last page
ISBN: 978-613-8-93873-6

COMPARED MORPHOLOGY OF ANIMALS

Rahmoun Djallal Eddine
Fares Mohamed Amine

TABLE OF CONTENTS

COMPARATIVE ANATOMY 01
PRINCIPLES OF COMPARATIVE ANATOMY 03
CLASSIFICATION OF ANIMALS 04
TEN PHYSIOLOGICAL BODY SYSTEMS 07
SKIN AND DERIVATIVES 07
SKELETON SYSTEM 11
MUSCLE SYSTEM 15
THE NERVOUS SYSTEM 17
DIGESTIVE SYSTEM 21
VASCULAR SYSTEM 27
RESPIRATORY SYSTEM 31
EXCRETION SYSTEM 33
REPRODUCTION SYSTEM 35
ENDOCRINE GLANDS 36

Abstract

Abstract

Comparative morphology forces us to examine organized beings from a multitude of points of view, and must go hand in hand with the study of man. The structure known as anatomy and physiology of the animal's body have been singularly advanced by the discoveries that have been made on animals. Nature has endowed animals with various qualities by their destination and each presents a distinct character with organization which is simple and reduced. The analogy between animals and animals is such proof that it has been universally recognized. Under a small volume, a structure of different complicated system and important organs will be illustrated in this area of morphology.

Keywords: anatomy, animal, comparative morphology, organs, physiology, structure.

COMPARATIVE ANATOMY

Also called comparative morphology, is the study of the laws of the structure and development of organs by comparing different types of living things. Comparative anatomy data is the traditional basis for biological classification. By morphology is meant both the structure of organisms and their science. We are talking about external signs, but much more interesting and important internal characteristics. The internal structures are more numerous and their functions and relationships are more substantial and diversified. The word "anatomy" of Greek origin: the prefixeana with the racinetom means "to cut". Initially, this term was used only in relation to the human body, but now it is understood as a section of morphology that deals with the study of any organism at the level of organs and their systems.

All organisms form natural groups with anatomical characteristics similar to their constituent individuals. Large groups are systematically divided into smaller ones, whose representatives have an increasing number of common characteristics. It has long been known that organisms of similar anatomical structure are similar in their embryonic development. However, sometimes even significantly different species, such as turtles and birds, are almost indistinguishable in the early stages of individual development. The embryology and anatomy of organisms are so closely correlated that taxonomists (classification specialists) use the data from these two sciences to develop models for the distribution of species between orders and families. Such a correlation is not surprising, since the anatomical structure is the end result of embryonic development.

Comparative anatomy and embryology also serve as the basis for the study of evolutionary pedigrees. The organisms which descend from a common ancestor are not only similar in embryonic development, but they also pass through stages which repeat, although not with absolute precision, but in general anatomical characteristics, the development of this ancestor. As a result, comparative anatomy is crucial to understanding evolution and embryology. Comparative physiology also has its roots in and is closely linked to comparative anatomy. Physiology is the study of the functions of anatomical structures; the stronger their similarity, the closer they are to their physiology. Anatomy is generally understood as the study of sufficiently large structures visible to the naked eye. Microscopic anatomy is called histology - it is the study of tissues and their microstructures, Comparative anatomy requires the dissection (preparation) of organisms and deals mainly with their macroscopic structure. Although it studies structures, physiological data is used to understand the relationships between them. Thus, in higher animals, there are ten physiological systems, whose activity depends on each of one or more organs. Below, these systems are considered sequentially for animals from different groups. First of all, the external characteristics are compared, namely the skin and its formation. Leather is a kind of "jack of all trades" which fulfills a wide variety of functions; moreover, it forms the external surface of the body, so it is in many respects accessible to observation without opening up. The next system is the skeleton. In molluscs, arthropods and certain armored vertebrates, it can be both external and internal. The third system is the musculature, which ensures the movement of the skeleton. The nervous system occupies the fourth place, because it is precisely this system which controls the functioning of the muscles. The following three systems are digestive, cardiovascular and respiratory. All of them are located in the body cavity and are so closely interconnected that some organs work simultaneously in two or even all of them. The vertebrate excretory and reproductive systems also use certain common structures; they are placed in 8th and 9th places. Finally, a comparative analysis of the endocrine glands forming the endocrine system is given. The comparison of other glands, such as the skin, is done when examining the organs on which they are located. because it is she who controls the work of the muscles. The following three systems are digestive, cardiovascular and respiratory. All of them are located in the body cavity and are so closely interconnected that some organs work simultaneously in two or even all of them. The vertebrate excretory and reproductive systems also use certain common structures; they are placed in 8th and 9th places. Finally, a comparative analysis of the endocrine glands forming the endocrine system is given. The comparison of other glands, such as the skin, is done when examining the organs on which they are located. because it is she who controls the work of the muscles. The following three systems are digestive, cardiovascular and respiratory. All of them are located in the body cavity and are so closely interconnected that some organs work simultaneously in two or even all of them. The vertebrate excretory and reproductive systems also use certain common structures; they are placed in 8th and 9th places. Finally, a comparative analysis of the endocrine glands forming the endocrine system is given. The comparison of other glands, such as the skin, is done when examining the organs on which they are located. that certain organs function simultaneously in two of them, even in all three.

The vertebrate excretory and reproductive systems also use certain common structures; they are placed in 8th and 9th places. Finally, a comparative analysis of the endocrine glands forming the endocrine system is given. The comparison of other glands, such as the skin, is done when examining the organs on which they are located. that certain organs function simultaneously in two of them, even in all three. The vertebrate excretory and reproductive systems also use certain common structures; they are placed in 8th and 9th places. Finally, a comparative analysis of the endocrine glands forming the endocrine system is given. Comparison of other glands, such as the skin, is done when examining the organs in which they are found.

PRINCIPLES OF COMPARATIVE ANATOMY

When comparing animal structures, it is useful to consider some general principles of anatomy. Among them, the following are considered particularly important: symmetry, cephalization, segmentation, homology and analogy.

Symmetry refers to the peculiarities of the location of body parts relative to any point or axis. In biology, two main types of symmetry are distinguished - radial and bilateral (bilateral). In animals with radial symmetry, for example the intestines and echinoderms, similar parts of the body are located around the center, like spokes in a wheel. These organisms are inactive or generally attached to the bottom and feed on food objects suspended in water.

With bilateral symmetry, its plane passes along the body and divides it into right and left parts in the shape of a mirror. The dorsal (upper or dorsal) and ventral (lower or abdominal) sides of an animal with bilateral symmetry are always clearly distinguished (however, the same is true for forms with radial symmetry).

Cephalization is the dominance of the head of the body over the tail. The head is usually thickened, located in front of a moving animal and often determines the direction of its movement. The latter is facilitated by the sensory organs almost always present on the head: eyes, tentacles, ears, etc. The brain, the opening of the mouth and often the inherent means of attack and defense are also associated with it (bees are a well-known exception). In addition, physiological processes (metabolism) have been shown to be more intense here than in other parts of the body. As a rule, the isolation of the head is accompanied by the presence of a tail at the opposite end of the body. In vertebrates, the tail was originally an organ of movement in water, but during its evolution it began to be used in different ways.

Segmentation is characteristic of three types of animals: annelids, arthropods and chordates. In principle, the bodies of these bilaterally symmetrical animals are made up of a number of parts similar to each other - segments or somites. However, although the individual earthworm rings are almost identical to each other, there are even differences between them. The segmentation can be not only external, but also internal. In this case, the organ systems inside the body are divided into similar parts located in rows according to the visible external boundaries between the somites. The segmentation of chordates is apparently not genetically linked to that observed in worms and arthropods, but has occurred independently during evolution. Bilateral symmetry, cephalization and segmentation are characteristic of animals that move quickly in water, on land and in the air.

Homology and analogy. The homologous organs of animals have the same evolutionary origin, whatever the function exercised in a given species. They are, for example, human hands and wings of birds or tails of fish and monkeys, which are of the same origin, but used in different ways.

Similar structures have a similar function, but have different evolutionary origins. This, for example, the wings of insects and birds or the legs of spiders and horses. Organs can be homologous and similar at the same time, if they have the same genetic sources and similar functions, but they are located in different segments. Such are, for example, various pairs of legs of insects and crustaceans. In these cases, they speak of serial (homodynamic) homology, since similar structures form series (series).

When similar organs, developed from dissimilar anterior structures, reveal a noticeable proximity to the structure, they speak of their parallel or convergent development. The law of convergence stipulates that the organs performing the same functions and used in the same way become morphologically similar during evolution, no matter how different they may be at the start. One of the most remarkable examples of convergence is the eyes of squid and octopus, on the one hand, and vertebrates, on the other. These organs came from completely different rudiments, but acquired significant similarity due to the identity of the function.

CLASSIFICATION OF ANIMALS

Before presenting the results of an anatomical comparison of organ systems, it is useful to briefly characterize the main groups of animals, emphasizing the differences between them. These groups are called types; the evolutionary series from the most primitive to the most evolved can be represented as follows: Porifera, Mesozoa, Cnidaria (Coelenterata), Ctenophora, Platyhelminthes, Nemertinea, Acanthocephala, Aschelminthes, Entoprocta, Bryozoa, Phoronidea, Brachioda, Arthropata Chordata.

When examining comparative anatomy, it is not necessary or even desirable to compare the structure of all types of representatives. It is necessary to consider only the types that have the most important anatomical characteristics to understand evolution. Since vertebrates are traditionally the first among objects of comparative anatomy, all of its classes will be briefly described as belonging to this group. See also ANIMAL SYSTEM.

Sponges (Porifera) are considered to be the most primitive among multicellular animals and are divided into 3 classes according to the particularities of the material forming their skeleton. In calcareous sponges, they are spicules of calcium carbonate; in ordinary sponges - elastic and flexible fibers of sponge, whose chemical composition is close to the horn; glass sponges have a thin network of glass-like flint needles.

Intestinal or cirrus (coelenterate, or Cnidarians) include water polyps, jellyfish, sea anemones and corals. The body of these predominantly marine animals consists of only two layers of cells, the ectoderm (outer leaf) and the endoderm (inner leaf) surrounding the body cavity, which is called the intestine, with a single mouth opening . An important characteristic of the group is the radial symmetry.

Marine animals, somewhat reminiscent of jellyfish. Their significance for comparative anatomy is low, with the exception of the fact that it is the most primitive group which has a true third germinal leaf (medium) - the mesoderm. Thus, all animals above the level of coelenterates go through the stage of three embryonic leaves in their embryonic development.

The type of flatworm (Plathelminthes) includes planaria, trematodes, tapeworms, etc. All, in fact, have a flat body and, like the intestinal cavities, are devoid of anus: undigested food residues "scorch" through mouth. In these animals, the beginning of brain formation (cephalization) is already perceptible.

Primary cavity worms are worm-shaped with a body cavity called a pseudo-target. They have both a mouth and an anus, connected by a simple rectum. Among them, many parasites. Some zoologists consider the classes listed below as independent types: rotifers, gastrocnemians, priapulids and nematodes.

The type of mollusk includes snails, bivalves, squid and other so-called soft-bodied animals. Usually they are protected by a shell secreted by the layer of ectodermal tissue. All of these animals are equipped with a full set of organ systems listed above and are characterized by a very high level of organization.

Ringed worms include segmented worm-like shapes. The type of arthropod includes animals with an external skeleton and joint members, including crustaceans, millipedes, insects and arachnids. These two types are very organized and are largely comparable to vertebrates.

Hemichordates, sometimes considered a subtype of chordates - worm-like animals that live on the seabed.

The type of chordate consists of the following subtypes: larval chordates, cephalocordates and vertebrates. The type as a whole has three main characteristics: the presence, at least in the larvae, of a cartilaginous rod extending along the dorsal surface of the body and called the cord; the central tubular nervous system located above and, finally, the gill slits connecting the pharynx to the left and right surfaces of the body behind the head. In vertebrates, the accord is replaced by a spine made up of cartilage in the lower fish and bones in more advanced evolutionary groups.

Chorda larvae are also called shells. This subtype brings together several hundred species - ascidians attached at the bottom to appendages and freely floating salps.

The cephalic, or cranial chordates, are represented mainly by the genus Amphioxus, that is to say lancelet, so named because their body is pointed at the head and the tail. They have numerous gill slits, a cord and a hollow spinal cord located above. The three characteristic features of chordates are expressed here in the most primitive form, and lancets are generally considered to be close to the ancestors of this whole group of animals.

Vertebrates include the corymb, maxilla, cyclostomes, lamellar skin, fish, amphibians, reptiles, birds and mammals. Skull skins and plaques have long since disappeared. They were heavy creatures resembling shell-shaped fish that inhabited the ancient seas. Cyclostas, which are now represented by lampreys and hagfish, are progressive (simplified) parasites of fish.

To consider the comparative anatomy of fish, it should be divided into 3 groups: cartilaginous, lobed muscle and bones. The former are represented mainly by sharks and sting rays. They have dense skin with placoid scales, which differ fundamentally from the scales of other fish. Cartilage skeleton; the gill slits open outward; the mouth is located on the underside of the head; the tail has a non-equipolar fin. In their internal anatomy, cartilaginous fish are primitive and not specialized; they have neither lungs nor swim bladder.

Bone fish are extremely diverse and numerous; they include over 90% of all modern fish species. Typically, they have a swim bladder and the skeleton contains a lot of bone tissue. Usually the body is covered with scales, but many exceptions are known. African feathers, sturgeon-shaped silt fish and armored pike are the surviving representatives of the primitive groups. They are interesting in that the characteristics of their anatomy allow modern fish to be linked to the old ones.

Amphibians, or amphibians, are salamanders, newts, toads, frogs and legless forms, the so-called worms. Typically, their larvae live in water and breathe with gills, such as fish, and adults go to land and breathe with their lungs and skin, although many exceptions are known. The wet skin of amphibians is devoid of scales, feathers and hair, only small scales of worms are immersed in worms.

Reptiles or reptiles - these are crocodiles, turtles, lizards and snakes. Their bodies are covered with scales. It is the remains of a group of animals that dominated in Antiquity, some of them reached very large sizes. Subsequently, the reptiles gave way to more active mammals.

Birds are very close to reptiles. Certainly all are characterized by feathers, a constant body temperature, excellent lungs and a heart to 4 bedrooms, and most birds can fly. However, their anatomy still reveals many ancestral reptilian characteristics.

Mammals, or animals, are covered with hair and feed the young with milk, which is secreted by special glands. They are descended from reptiles, but like birds, they are warm-blooded and have a 4-chamber heart. Their limbs are deployed forward and brought under the body for more efficient locomotion. All mammals, with the exception of three oviparous births, reproduce their offspring by live births. People belong to this class, which increases interest in its study.

TEN PHYSIOLOGICAL BODY SYSTEMS

SKIN AND DERIVATIVES

The external tissues of any animal can be called skin, but, according to the ideas of comparative anatomy, real skin is characteristic only of chordates. It consists of two tissues, the epidermis on the outside and the dermis (actually the skin, the cutis or the corium) below.

The epidermis is a derivative of ectoderm, one of the three original germ layers. In vertebrates, it is always multilayered; in the depths is the germ layer, and outside is the horny layer. The latter consists of flat dead cells that have lost their nuclei. It is constantly peeling - either in the form of dandruff, as in higher vertebrates, or in a continuous layer, as in amphibians and reptiles. The cells of the stratum corneum are rich in protein keratin, which also forms the nails and hair. It prevents the evaporation of moisture through the skin and, thanks to its strength, protects it from damage; The reptile blankets are particularly rich. The germinated layer, or malpigius, is made up of multiplying living cells. As their number increases, they are pushed to the surface and become part of the stratum corneum.

In mammals, two others are distinguished between the germinated and horny layers - grainy and shiny. Granular adjacent to the shoot and consists of dying cells with pigment granules. The shiny layer is under the stratum corneum and contains dead cells with transparent inclusions. Thus, in mammals, the epidermis is four layers: one layer is alive, one is dying and two are dead.

The dermis is the thick, relatively soft internal tissue of the skin. It is formed from the middle germinal leaf, the mesoderm, provides nutrition to the epidermis, contains nerve endings, blood vessels and is often rich in fatty deposits. The bases of the hair and feathers, as well as the glands, which are the swelling of the epidermis, are also found here.

Typically, the skin adapts more or less freely to the body and is separated from the underlying structures by a layer of loose connective tissue - subcutaneous tissue containing many intercellular spaces.

Arthropods have an external skeleton formed by ectoderm cells. Its outer layer is periodically discharged due to the growth of the body. In molluscs, a soft and often ciliated ectoderm generally secretes a protective limestone shell. The first animal in the evolutionary series with real skin is the lancet. Its epidermis is formed of a single layer of densely packed cubic cells; however, the cells of the dermis degenerate and fuse, so that it appears unstructured, and the skin as a whole is monolayer.

Fish . The skin of the fish contains many mucous glands and is usually covered with many scales. Several types are known. Shark scales and close forms develop depending on the type of teeth and are called placoids. The scales of modern bone fish are formed from the inner layer of the skin and are ctenoids (toothed, comb-shaped) or cycloid (round).

The scales embryo is a lime deposit in the dermis layer. As it grows, its edge comes out through the epidermis, so that the scales overlap like tiles. In some fish, for example American pike, the scales do not overlap, but cover the body like tiles. They are called ganoids and increase as the fish grow. At the cycloid and ganoid scales, the intensive growing seasons leave layers resembling tree rings.

Amphibians. The skin of these animals is an additional respiratory organ: it is soft, moist and has a dense network of blood vessels. It contains a large number of mucous and toxic glands; local accumulations of pigment are characteristic, creating a camouflage color. All growing amphibians spill the outer layer of the skin in a single layer. At least in the very early stages of development of aquatic amphibian larvae, their ectodermal cells carry eyelashes that promote locomotion and respiration. In the outermost layer of the skin, keratin is deposited for the first time, preventing loss of moisture by evaporation. However, amphibians have not yet made significant progress towards protection against desiccation and inhabit more or less humid places. The skin of some ancient amphibians contained large bony plaques.

Reptiles. The main property of their skin is the ability to resist drying out. It is completely covered with scales, hard and dry, which is associated with adaptation to life on earth, but it is also flexible, for example, in lizards and snakes. In addition, it can contain bony plaques, forming a shell like on turtles or on the back and head of crocodiles. Snakes and lizards deposit the outer layer of the skin in a single layer and, in turtles, it comes off in separate flaps.

Reptiles have few skin glands. The scent glands are found in some turtles on the chin and along the edges of the shell, in alligators and crocodiles - on the back of the thighs and around the cloaca, in a number of snakes - next to the opening of the cesspool.

Finger claws first appear in some amphibians, but they do not play an important role. All reptiles with limbs, with the exception of sea turtles, have well-developed claws.

The birds . The skin of birds cannot be described as strong or dense, but it is rich in fat. There are few skin glands, but almost always there is a large sebaceous gland (coccygeal) above the base of the tail. The sulfur glands can be located near the opening of the outer ear. The legs of birds are covered with the same scales as in reptiles. The claws are of similar origin.

Beak. The corneal covers of the jaws of turtles and birds are formed by a modified outer layer of the epidermis. A similar beak was characteristic of some extinct dinosaurs of the reptile class. In birds, toucans lose their superficial horny layers, like reptiles which lose their skin. The beaks of birds are of various shapes and sizes, which is associated with an adaptation to a particular feeding mode. The forelimbs of birds are adapted for flight, so that the tasks usually carried out by brushes in other animals are transferred to the beak. In addition, animals with a beak are devoid of teeth. It can be used as a weapon to clean plumage, climbing, courtship, nest building, etc.

Feathers are a derivative of reptile scales and a feature of the skin of birds. Like the scales, the feather begins to develop in the form of a protrusion of the connective tissue (papilla) of the corium. However, it does not flatten, but extends into a cylinder which, rising above the epidermis, divides on one side and turns, forming along the free edges of the beard.

There are three main types of feathers: outline, down and threadlike. The outline feathers cover the whole body and reach the largest size on the wings and tail. The down protects the chicks and, in adult birds, forms a heat-insulating layer under the outline. Powder fluff, characteristic of herons and a number of other birds, is characterized by fragile beards, which disperse in the powder used to clean the plumage. Threaded feathers are located with downy feathers below the outline and can protrude from the surface near the corners of the mouth, forming sensitive hairs. For example, the fringed turkey beard is made up of mustache feathers.

A typical contour feather consists of 6 components: an ochin, which is immersed in the skin and fixes the feather there; a rod representing a continuation of the center and the main axis of the pen; flat range of connected beards; accessory pen extending near the junction of the rod with the ocher; lower navel - a hole in the base of ocher; upper navel - the second hole at the base of the accessory pen, allowing air to enter and exit the hollow stem.

Mammals. In mammals, the skin is generally fairly weakly bound to the body by a thick, elastic layer of subcutaneous tissue. It contains many glands, such as mammary, sebaceous, perspiring and odorous. The glands of the last three categories can be very numerous.

The mammary glands, characteristic of mammals, are large structures essential for feeding calves. Usually they are located in two rows on the sides of the lower side of the trunk, but can be grouped between the hind limbs, such as, for example, in cows, horses and many other herbivorous animals, or placed in front, at the level of the chest, as in elephants, monkeys and humans.

Hair is the second unique characteristic of mammalian skin. Hair is only absent in some of its aquatic forms, for example whales and mermaids (the latter have facial hair). A number of animals, such as elephants and pangolins, have very sparse hair; Depending on the species, their thickness varies - from the delicate fur of the beaver to the long needles of the porcupine. Hair is used for thermal insulation and protection against damage. In addition, hair can be specialized to perform special functions; for example, when faced with many animals, there are tactile hairs ("whiskers"), called whiskers. Horns. In giraffes, deer and horned horns, they are bony growths on the frontal bones of the skull, covered with skin or its derivatives. In giraffes, they are constantly clothed in skin and in deer, they branch out as they grow and eventually lose their skin membrane. Rhino horns and pangolin scales are formed by a mass of fused hair. In canids, for example cows and antelopes, as well as in the American pronghorn, the horns are covered with keratin (horn), derived from the stratum corneum of the epidermis. In the pronghorn, these covers and in the deer, the horns are completely rejected each year and grow back.

Claws. In mammals, the claws reach the peak of their development and diversity. The nails of monkeys and humans and the hooves of large herbivorous animals are modified claws.

SKELETON SYSTEM

The skeleton supports, protects and connects the body parts of the animal. It is of different types and is made of various materials.

Invertebrates. The simplest radiolaria have a complex and geometrically regular flint skeleton, and the foraminifera are protected by special limestone shells.

Sponge skeletons can be constructed from three different materials: lime, horny spongin protein and silica. Lime and sponges are sometimes combined, but in glass sponges, the skeleton is purely flint. In the intestinal cavities, the skeleton is rare, except for corals, in which it is formed of external and internal calcareous structures. Calcareous coral reefs are mainly deposits of skeletons of dead corals. In all primitive groups, the skeleton plays a supporting and protective role, but is not used for locomotion. Flat and round worms do not. Some annelids live in limestone tubes formed by their own secretions. In worms of different types, there are hairs, which are considered to be skeletal structures. The lime shells of molluscs are mainly external formations; the exception is the inner cuttlefish shell. Skeleton slugs and octopuses are private.

Arthropods are characterized by a composite skeleton covering the outside of their entire body, including the antennae (antennae) and the legs. It is made up of chitin carbs, and in shellfish it can contain large amounts of calcium. The chitin shell that develops during embryogenesis at from the ectoderm is a dead formation and can not grow, therefore, by increasing in size, all arthropods periodically reject the outer layer of the skeleton (fade). Roundworms, as they grow, also repeatedly change their hard outer covering, called the cuticle.

Vertebrates. The vertebral skeleton is not only made of bone: it includes cartilage and connective tissue, and sometimes various skin formations are included in its structure.

In vertebrates, it is customary to distinguish the axial skeleton (skull, rope, spine, ribs) and the skeleton of the limbs, including their belts (shoulder and pelvic) and free sections. The lancet has a chord, but neither the vertebrae nor the limbs. Snakes, footless lizards and worms do not have the skeletons of their members, although some species in the first two groups retain their remains. In eels, the abdominal fins corresponding to the hind limbs have disappeared. In whales and mermaids, there were no external signs of hind legs either.

Skull. There are three categories of skull bones by origin: replacement of cartilage, integumentary (integumentary or cutaneous) and visceral. Invertebrates have no structure comparable to that of a vertebrate skull. There are no signs of a skull in the hemichordate, tuniculus, and cephalic chordates. Cyclostomes have a cartilage skull. Sharks and their relatives may have had bones in them once, but now its box is a unique monolith of cartilage seamlessly between the elements. The skull bones have more different bones than representatives of any other class of vertebrates. In them, as in all the higher groups, the central bones of the head are deposited in the cartilage and replace it, and are therefore homologous to the cartilaginous skull of sharks.

The integumentary bones are in the form of calcareous deposits in the dermal layer of the skin. In some ancient fish, they were patches of a shell protecting the brain, cranial nerves and sensory organs located on the head. In all the higher forms, these plaques have migrated deeply, incorporated into the original cartilage skull and formed new bones, closely associated with the replacements. Almost all of the outer bones of the skull come from the skin layer of the skin.

The visceral elements of the skull are derivatives of cartilaginous branchial arches that appear in the walls of the pharynx during the development of the vertebral gills. In fish, the first two arches have mutated and transformed into jaw and hyoid apparatus. In typical cases, they keep 5 other branchial arches, but in some genera their number has decreased. In a primitive modern henna shark (Heptanchus) behind the maxillary and hyoid arches of the gill arches up to seven. In bony fish, the cartilage of the jaw is lined with numerous integumentary bones; these also form gill covers protecting the delicate gill lobes. During the evolution of vertebrates, the original cartilage of the jaws decreased regularly until they disappeared completely. If in crocodiles, the balance of the original cartilage in the lower jaw is lined with 5 paired integumentary bones, then in mammals only one remains - the tooth, which completely forms the skeleton of the lower jaw .

The skulls of ancient amphibians contained heavy cover plates and were similar in this respect to the skull typical of clyster fish. In modern amphibians, the scythes and the replacement bones are considerably reduced. In the skull of frogs and salamanders there are fewer than in other vertebrates with bony skeletons, and in the last group many elements remain cartilaginous. In turtles and crocodiles, the bones of the skull are numerous and closely spliced together. In lizards and snakes, they are relatively small and the external elements are separated by large gaps, as in frogs or toads. In snakes, the right and left branches of the lower jaw are fairly freely connected to each other and to the skull by elastic ligaments, which allows these reptiles to swallow relatively large prey. In birds, the skull bones are fine but very hard; in adults, they have grown together so completely that a few points have disappeared. The orbits are very large; the relatively huge brain roof is formed by thin integumentary bones; light jaws covered with horns. In mammals, the skull is heavy and includes powerful jaws with teeth. The remains of the cartilaginous jaws moved to the middle ear and formed its bones - a malleus and an anvil.

In birds and reptiles, the skull is attached to the spine using one of its condyles (joint tubercle). In modern amphibians and all mammals, two condyles are used for this, located on the sides of the spinal cord.

The spine, or spine, is in all chordates, except the cranial and the shell. In embryonic development, it is always preceded by an agreement, which persists for life in the lancet and the cyclostomes. In fish, it is surrounded by vertebrae (in sharks and their closest relatives, it is cartilaginous) and appears distinct. At the mammals, only the rudiments of the agreement in the intervertebral discs are preserved. The chord is not converted into vertebrae, but is replaced by them. They arise during embryonic development in the form of curved plates which progressively surround the rope with rings and, as they grow, move it almost completely.

In a typical spine, 5 departments are distinguished: cervical, thoracic (corresponding to the chest), lumbar, sacral and caudal.

The number of cervical vertebrae varies considerably depending on the group of animals. Modern amphibians have only one of these vertebrae. Small vertebrate birds can only have 5 and swans up to 25. The Mesozoic reptile plesiosaurus had 72 cervical vertebrae. In mammals, there are almost always 7; the exception is the lazy (6 to 9). In cetaceans and manatees, the cervical vertebrae are partially fused and shortened depending on the shortening of the neck (according to some experts, there are only 6 manatees). The first cervical vertebra is called the atlas. Mammals and amphibians have two joint surfaces, which include the occipital condyles. In mammals, the second cervical vertebra (epistrophy) forms the axis on which the atlas and the skull rotate.

The ribs are usually attached to the thoracic vertebrae. In birds, there are about five, in mammals 12 or 13; snakes have a lot. The bodies of these vertebrae are generally small and the spinous processes of their upper arches are long and tilted backwards.

Lumbar vertebrae generally from 5 to 8; in most reptiles and all birds and mammals, they do not have ribs. The spinous and transverse processes of the lumbar vertebrae are very powerful and, as a rule, directed forward. In snakes and many fish, the ribs are attached to all the vertebrae of the trunk, and it is difficult to draw the line between the thoracic and lumbar regions. In birds, the lumbar vertebrae are fused with the sacral ones, forming a complex sacrum, which makes their backs more rigid than other vertebrates, with the exception of turtles, in which the thoracic, lumbar and sacral parts are connected to the shell.

The number of sacred vertebrae varies from 1 in amphibians to 13 in birds.

The structure of the rear section is also very diverse; in frogs, birds, anthropoid monkeys and humans it contains only a few partially or fully fused vertebrae, and in some sharks, up to two hundred. Towards the end of the tail, the vertebrae lose arches and are represented by single bodies.

The ribs first appear in sharks in the form of small cartilaginous processes in the connective tissue between the muscle segments. In bony fish, they are bony and homologous to the hemal arches located under the caudal vertebrae. In four-legged animals, such “fish” ribs, called inferior, are replaced by superior ones and are used for breathing. They are placed in the same partitions of connective tissue between muscle blocks as in fish, but are located in the body wall above.

The skeleton of the limbs. The ends of the tetrapods developed from the paired fins of the carp-fin fish, in the skeleton of which there were elements homologous to the shoulder bones and pelvic belts, as well as to the front and rear legs.

Initially there were at least five distinct ossifications in the shoulder girdle, but in modern animals there are usually only three: the scapula, the clavicle and the coracoid. In almost all mammals, the coracoid is reduced, attached to the scapula, or completely absent. In some animals, the scapula remains the only functional element of the shoulder girdle.

The pelvic girdle includes three bones: iliac, sciatic and pubic. In birds and mammals, they have completely merged with each other, in the latter case forming what is called unnamed bones. In fish, snakes, whales and mermaids, the pelvic girdle is not attached to the spine, which therefore does not have typical sacral vertebrae. In some animals, the shoulder and pelvic belts include additional bones.

The bones of the anterior free limb in tetrapods are, in principle, the same as in the hind leg, but are called differently. In the forelimb, if you count from the body, comes first the humerus, followed by the radius and the ulna, then the carpus, metacarpal and phalanxes of the fingers. In the hind limb, they correspond to the femur, then to the tibia, tarsus, tarsus, metatarsals and phalanxes of the fingers. The initial number of fingers is 5 on each member. Amphibians only have 4 fingers on their forelegs. In birds, the forelimbs turn into wings; wrist bones, metacarpals and fingers are reduced in number and partially fused, the fifth finger is lost on the legs. The horses had only the middle finger. Cows and their closest relatives rest on the third and fourth fingers, while the rest are lost or reduced. The ungulates move at the tip of their fingers and are called phalanx walk. Cats and many other animals, when walking, rest on the entire surface of the fingers and are of the finger type. Bears and humans, when moving, press the entire sole to the ground and are called motion stop.

The external skeleton. In vertebrates of all classes, in one way or another, the external skeleton is presented. The head plates of the corymb (without an extinct jaw), ancient fish and amphibians, as well as the scales, feathers and hair of the upper tetrapods, are skin formations. The shell of turtles is also of similar origin - a highly specialized skeletal formation. Their dermal bone plates (osteoderms) approached and fused with the vertebrae and ribs. It should be noted that the shoulder and parallel pelvic belts have moved into the chest. In the crest at the back of the crocodiles and the armor of armadillos are bony plates of the same origin as the carapace of turtles.

MUSCLE SYSTEM

The main function of the muscular system is to set parts of the skeleton in motion; the corresponding muscles are called skeletons. However, there are other types and functions. During contraction, the muscles create a pulling force, they cannot push. At the same time, they become thicker and shorter, but their volume does not change significantly. Muscle function is controlled by the nervous system and can be arbitrary or involuntary. Skeletal muscle is an arbitrary type.

Muscle types. In vertebrates, there are three categories of muscle tissue: striated, cardiac, and smooth.

The striated muscles which form the main body mass of the body act arbitrarily.

They are associated with the skeleton, contract with great speed and force, but with prolonged work, they always get tired and need rest. By their nature, they are segmental and colored, they can be red, like beef, or light ("white"), as in fish and in the "breast" of chickens. Their fibers are multi-core and grouped in bundles surrounded by a film of connective tissue called perimisium.

The smooth muscles are not attached to the skeleton; they are located in the walls of blood vessels, the digestive tract and in the dermal layer of the skin. These muscles are devoid of transverse stripes, contract involuntarily, slowly and weakly, but they do not experience fatigue. Their cells are mononuclear and are not grouped in bundles surrounded by perimeter. In this respect, they resemble the muscle cells of the lower invertebrates.

The heart muscle (myocardium) is formed by cells growing from the same embryonic tissue as smooth muscle cells in blood vessels, but here they are multinuclear, red in color, and can contract quickly and considerably. In lower vertebrates, they are somewhat elongated, while in higher vertebrates, they are large and connected by jumpers in a tight loop network.

Invertebrates. It is difficult to say when the muscles appeared during the evolution of the animal kingdom. Contractile fibers are found in protozoa, sponges, and intestinal cells, but specialized muscle cells only appear in tapeworms and roundworms. In all invertebrates down to the level of molluscs, they lack transverse striation and resemble the smooth muscle cells of vertebrates. They do not shrink much and always relatively slowly. The exception here is molluscs: muscle closures in bivalves can be considered skeletal. Developed muscles are inherent in annelids, especially earthworms. In the wall of their body are annular muscles, which reduce its diameter, and longitudinal, shorten it. There are also microscopic muscles (in each segment of the body, there are 4 pairs) which move the hairs and are able to stick them in the ground. An earthworm typically slips for him due to the contractions of the three categories of muscles - annular, longitudinal and microscopic.

An excellent striated muscle capable of rapid and powerful contraction is characteristic of arthropods. The flying muscles of some insects are the fastest of all: in this sense they even exceed the muscles of similar hummingbirds. It is interesting to note that the skeletal muscle of the arthropod controls the movements of the external skeleton, being inside, under its protection.

Vertebrates. The vertebral muscles can be divided into five groups according to the embryonic origin: segmental (skeletal), visceral, ophthalmic, cutaneous and muscular of the branchiomers.

The segmental muscles never cross the midline of the abdomen; they are located overlapping on the sides of the body in accordance with the initial segments, or somites, of the embryo. From these axial blocks, the muscles of the limbs develop.

In lancets, cyclostomes and fish, the segmental muscles remain in their original and most basic state. In the fins of fish, they are simply arranged and consist mainly of hoists and lowerers. At the ends of the tetrapods, they are numerous and diverse in their function. The segmental muscles attach to the bones of the skeleton either directly or using tendons (cords of connective tissue).

Visceral muscles, acting spontaneously and devoid of transverse bands, located mainly in the walls of the digestive tract. They are responsible for the peristaltic movements that push food into the digestive tract.

In the pharynx area in fish, their unsegmented blocks attach to the gill arches and transform into striated muscles of the branchiodeles. In higher vertebrates, they penetrate the surface of the head, becoming arbitrary facial and maxillary. It is a wonderful example of the convergent transformation of involuntary smooth muscles into voluntary striated muscles in the process of adapting to the role of skeletal muscle.

Eye muscles. The mobility of the eyeballs is ensured by the fact that six fine muscles are attached to it. In all vertebrates, they come from three paired somites in the head of the embryo. By their origin, the eye muscles are linked to segments, but are generally considered separately because of their uniqueness. Their work is controlled by the third, fourth and sixth cranial nerves.

Muscle skin of very specific origin. When the segmental muscles originate from the middle germinal leaf, the free cells of the mesoderm are separated from its outer edge, which lose their segmented distribution. They form an indistinctly limited layer of tissue called a dermatome, which completely surrounds the developing body of the embryo, adhering from the inside to the ectoderm. Corium is formed with the muscles there. They should not be confused with those that cause, for example, the flapping of skin flies on the horse's shoulders: such skin movements cause voluntary muscles - derived from skeletal muscles, and the skin muscles themselves are involuntary. In birds, they attach to the base of the feathers and lift them when cut. Similar muscles put the "hairs" on the animals' bodies. So-called buttons

THE NERVOUS SYSTEM

Evolutionary advanced animals have a highly specialized nervous system to regulate and coordinate the activities of all parts of the body. In less organized forms, its structure is relatively simple.

Invertebrates. In sponges, the sensory ("sensitive") mechanisms are not localized in strictly defined cells of the body, that is, they have no real nervous system. Specialized nerve cells (neurons) appear in the intestinal cavity. In the hydra, they form a homogeneous network serving all parts of the body. In starfish, the mouth is surrounded by a nerve ring, from which the nerve trunks of ectodermal origin extend into each of the five arms. In flat and annular worms of the head, there is an accumulation of nerve cells in pairs called the ganglion (nerve node) and serves as the primitive brain. From it along the lower side of the body also extends the paired nerve trunk. In an earthworm, its branches are combined and form the abdominal nerve chain with the nodes. In arthropods, the nervous system is basically the same, the brain is enlarged and divided into lobes, the abdominal trunk is shortened,

Vertebrates differ from invertebrates in three important characteristics of the central nervous system: it occupies a dorsal position, develops from the spinal ectoderm of the embryo and is represented by a tube. It is laid as a longitudinal groove along the center line of the back. Later, the edges of the groove are lifted, bent towards each other and connected to the neural tube. At the head, it swells and forms protrusions, which turn into different parts of the brain.

The structural basis of the nervous system is the neuron. It consists of a compact cell body and the sensory and motor processes that arise from it. Sensory processes, called dendrites, branch out strongly and drive nerve impulses in the body of the neuron. On the motor fibers, the axons, the impulses go from the body of a neuron to another cell.

The nervous system of vertebrates is generally divided into two parts - central and peripheral. The first includes the brain and spinal cord; the second - cranial nerves (cranial), spinal nerves and the autonomic nervous system.

The brain . In the lancet, only the cavity at the anterior end of the neural tube is enlarged, and the brain as such is not. In all vertebrates, it is divided into 5 sections: final, intermediate, middle, posterior and oblong medulla. The main components of the final brain are the olfactory lobes, responsible for the corresponding "sensation", and the cerebral hemispheres, the main center of nerve coordination. The diencephalon connects the terminal brain to the middle. The parietal organ (parietal eye) and the pineal gland (pineal gland) extend from its dorsal surface, and the optic nerves cross under it. The main parts of the midbrain are paired visual lobes, particularly important for the lower vertebrates. The posterior brain forms the cerebellum on the dorsal side of the elongated cord, which is responsible for coordinating movement. After the fourth, all the cranial nerves extend along the sides of the oblong cord in front of the place of its transition in the spinal cord.

The brain of the Squalus shark is elongated and its olfactory and visual lobes are clearly distinguished. The cerebral hemispheres are small, which indicates a weak development of "intelligence"; the hollow cerebellum inside is relatively large. In all actively swimming (pelagic) fish, the visual lobes and cerebellum are large, as these animals require good vision and good movement coordination. The same goes for birds. In amphibians, the cerebellum is very poorly developed. In salamanders, the visual lobes are almost invisible, and in frogs and toads, they are large and they can see perfectly. The main feature of the brain of birds and mammals is the large and complex large hemispheres.

Mammals are also characterized by a large, massive cerebellum; its cavity, which is free in the lower forms of vertebrates, is occupied here by branches of nerve fibers which form a particular motif in the section - "the tree of life". The visual lobes are transformed into a pair of anterior tubers of the so-called quadruple and play a subordinate role in vision. Its main center has moved in mammals to the occipital lobe of the cerebral hemispheres.

The spinal cord extends in vertebrates of the head through the spinal canal formed by the upper (neural) arches of the vertebrae. A deep and narrow back crack and thinner and wider abdominal cracks extend along its entire length. Paired vertebral ribs extend from the lateral surfaces, also along its entire length. Each begins with two roots - the dorsal and the ventral, which then merge. The vertebral root carries the ganglion (nervous ganglion), this is not the case on the abdomen. In the lower vertebrates, both roots contain motor nerve fibers and the dorsal, in addition, sensory. In mammals, the dorsal root is purely sensory and the abdominal root is motor.

The number of paired spinal nerves varies widely - from 10 in frogs to several hundred in snakes. In three places on each side of the body, they are interconnected in plexus: cervical, shoulder (at the level of the shoulder girdle) and sacral (in the pelvic region). The nerve connections inside the plexuses are weak in fish, more developed in amphibians and reptiles, and extremely complex in mammals.

Cranial nerves. A typical cranial nerve leaves the brain and leaves the skull through a small opening. It was traditionally believed that fish and amphibians have 10 pairs of nerves, while reptiles, birds and mammals have 12. However, this generalization requires some corrections. In 1895, before the first, the terminal (terminal) nerve was discovered, which turned out to be present in all vertebrates, except birds. It has been called zero to avoid confusion in the existing numbering system.

The names and numbers of the cranial nerves are: 0 - terminal, I - olfactory, II - visual, III - oculomotor, IV - block, V - trigeminal, VI - abducens, VII - facial, VIII - auditory, IX - glossopharyngeal , X - wandering, XI - additional, XII - sublingual.

These nerves are homologous in series with the roots of the spinal nerves, but are more specialized. The thin terminal nerve is considered sensory. The scent determines sensitivity to odors (in primary aquatic vertebrates, it reacts to odorous substances in water, not in air). The optic nerve is formed as an outgrowth of the brain and is initially a branch of the neural tube. At its peripheral end is the retina of the eye, from which it transmits impulses to the brain. The third, fourth and sixth nerve are the motor nerves that control the eye muscles. The trigeminal nerve, combining sensory and motor functions, appears as two separate nerves, uniting in the gasser (lunar) ganglion. In fish, it is divided into 4 main branches, going to different parts of the head, and in reptiles, birds and mammals - in three, it is therefore called trigeminal. The facial nerve, also mixed (motor and sensory), innervates the hyoid arch, the jaws and the organs of the lateral line on the surface of the head in fish. In its functions, it is similar to the trigeminal, but located more superficially. The sensory auditory nerve is connected to the inner ear. In the higher terrestrial vertebrates, it is divided into two branches: the cochlear goes to the auditory receptors, and the vestibule goes to the vestibule and the semicircular canals (vestibular apparatus), this is why it is also called vestibular cochlear. The nerve as a whole serves as hearing and orientation in space. The mixed glossopharyngeal nerve in fish innervates the region of the first gill slit. In higher vertebrates, its branches go to the tongue and pharynx. A large vagus nerve, also sensorimotor, of the parasympathetic nervous system, controls the gill region behind the first cleft and sends large branches to internal organs, especially the lungs and stomach. It was born from the union of at least four spinal nerves, the roots of which have moved forward - on the oblong cord. During evolution, the accessory motor nerve is separated from the vagus nerve, the branches of which go to the neck and shoulders. In snakes, it has degenerated. The hyoid nerve controls the muscles of the tongue. It is already observed in sharks, but in other fish and amphibians. In snakes, it has degenerated. The hyoid nerve controls the muscles of the tongue. It is already observed in sharks, but in other fish and amphibians. In snakes, it has degenerated. The hyoid nerve controls the muscles of the tongue. It is already observed in sharks, but in other fish and amphibians. The nerves XI and XII are unknown.

The autonomic (autonomic) nervous system is mainly composed of a paired chain of nerve ganglia that extends along the dorsal side of the abdominal cavity. It is connected to the cranial nerves, each spinal nerve being close to the confluence of its roots and with all the internal organs. This system, acting involuntarily (autonomously), controls the smooth muscles, the heart muscle, the iris and the ciliary muscle of the eye, all the glands, as well as the muscles of the skin associated with the roots of feathers and hair.

In its composition, two systems with opposite effects are distinguished - parasympathetic and sympathetic. If an organ controlled by these nerves receives a stimulating signal from one of them, then the other inhibits its activity. This double nervous control of the glands, blood vessels, heart, intestines and internal muscles of the eye ensures the harmonious functioning of all the organs of the body.

The parasympathetic system is connected to three centers - in the middle and spinal cord and in the sacral region of the spinal cord, and to the sympathetic system - with spinal nerves along the entire spinal cord from the oblong cord to the sacral region . The autonomic nervous system is similar in all vertebrates, but in the higher forms it is more complicated.

Sensory organs . Everyone knows the sensory organs of various animals, such as antennae (antennae, stretchers), ears, nose and eyes. There are many others - hair, statocysts, sensory bodies, chemoreceptor kidneys (taste), etc. In vertebrates, five senses are generally distinguished: vision, hearing, taste, smell and touch; however, they still have a sense of balance (position of the body in space) and the corresponding organ, represented by three semicircular canals of the inner ear and extremely important, for example, for birds and the fish. In pit snakes, there is a small depression in front of each eye, where there is a thermoreceptor that takes heat from a distance. Allocate and so-called general sensations (i.e. not related to special organs): thirst, hunger, cold, pain, pressure, muscular and tendon sensations.

In typical cases, sensory impulses reach the central nervous system either along the cranial nerves or along the dorsal roots of the spinal nerves, and internal organs through the fibers of the autonomic nervous system. The organs of the lateral line, represented by special channels in the skin of the head and trunk of the fish, are clearly visible even in the larvae of amphibians and their aquatic forms, but they disappeared without a trace in all terrestrial vertebrates. The organs of chemical sensation - smell and taste - are not always easy to distinguish in aquatic vertebrates, but, as a rule, they are located in the mouth and nasal cavity of terrestrial animals. In insects, they are found in the antennae, and in some fish, on the skin.

Eyes. In lower invertebrates, these may be slightly specialized age spots. Spiders at the top of their heads usually have 8 simple eyes. In millipedes, the simple eyes form two clusters on the sides of the head. Crayfish, lobsters and crabs are characterized by two complex eyes, made up of a large number of small "eyes". Insects usually have three simple eyes and two complex eyes, but many small shapes do not have simple eyes. In cephalopods and vertebrates, despite their strong specialization, they are striking for their similarities. They come from completely different embryonic primordia, but in their final form, they are arranged almost identically, down to the level of the eyelids, pupils, iris, lenses, fluids and retinas containing rods and cones; however, the optic nerves are far from the same.

Ears . The hearing organs appear in some insects in the form of tympanic membranes on the trunk or legs and associated structures. The vertebral ear is a double sensory organ - hearing and balance.

DIGESTIVE SYSTEM

The digestive system is the intestinal tract (digestive tract) with all its auxiliary parts. It is most developed in vertebrates, in which it consists of the mouth, followed by the pharynx, esophagus, stomach, intestines and the anus or sump. In addition, the digestive system includes their salivary glands, the liver and the pancreas.

Invertebrates. In protozoa, so-called digestive vacuoles inside the cell. The ciliates have a lot of them, and they act like little stomachs. In sponges, formations comparable to the stomach or intestines are absent. These animals feed on plankton, that is to say microscopic living creatures suspended in water, which are carried in their body by numerous pores following the beating of special flagella, the so-called cervical cells. In the intestinal cavity, in the wall of the body, there are only two layers - the ectoderm and the endoderm, and this can be compared to a two-layer bag. The inner layer, the endoderm, lines the intestinal cavity in all organized animals more complex than sponges. Thus, the intestinal cavity has a kind of stomach (or intestines), but the remaining digestive organs are absent, with the exception of the mouth corresponding to the blastopore. In all animal embryos, the blastopore is the main opening leading to the digestive tract. In almost all invertebrates, with the exception of echinoderms and certain small groups, it turns into a mouth opening. In echinoderms and chordates, the blastopore becomes the anus and the oral later bursts in the digestive system. In echinoderms, it occurs in the center of the body on its underside and in the chordates, where the head develops. It seems that this change in position of the mouth indicates that the head of the body of the invertebrates is homologous to the caudal of the chordates. and the oral breaks out later in the digestive system. In echinoderms, it occurs in the center of the body on its underside and in the chordates, where the head develops. It seems that this change of position of the mouth indicates that the head of the body of the invertebrates is homologous to the caudal of the chordates. and the oral breaks out later in the digestive system. In echinoderms, it occurs in the center of the body on its underside and in the chordates, where the head develops. It seems that this change in position of the mouth indicates that the head of the body of the invertebrates is homologous to the caudal of the chordates.

In flatworms, a mesoderm appears in which the digestive tract lined with endoderm is immersed. Their mouth is homologous to the intestinal cavity and there is also no anal opening. Both, so to speak, evacuate undigested food residue through the mouth. In parasitic tapeworms and scrapes, the digestive system has degenerated. In round and annular worms, it is equipped with a mouth and an anus, and their intestines are represented by a long tube. The earthworm has a distinct goiter and stomach. The complex oral apparatus of arthropods includes paired sucking or gnawing structures, and their digestive tract is highly developed. In higher insects, such as insects, flies and wasps, the intestines are very long and convoluted. Molluscs also have a highly developed digestive system, usually with the esophagus, stomach, convoluted intestines,

Vertebrates. The components of the digestive system in invertebrates and vertebrates are called the same depending on their functions. However, most likely, only the stomachs are homologous to each other, since the mouth and anus have been exchanged. Apparently, to the ancestral line of chordates, echinoderms and other "secondary cirrus" in invertebrates, only protozoa and enterocephalus belong. At the level of the latter, the evolutionary trajectories of the animal kingdom have strongly diverged.

Fish. The digestive system of thorny sharks (Squalus) is a good illustration of a primitive variant for fish. A large mouth is located on the underside of the head. The teeth, which are modified placoid scales, form several consecutive rows. In their form, they are only suitable for cutting prey, although the ability to grind food before swallowing is extremely beneficial. Many bony fish have long, pointed teeth, suitable only for catching and holding prey; some species of this group are toothless, but they are also armed with pressing teeth.

It can hardly be said that sharks have a tongue, apart from a rather loose fold of skin that covers the inside of the cartilaginous hyoid arch. In bony fish, this arch can penetrate from below into the oral cavity, but never forms a muscular structure.

The shark's throat is a prolonged extension of the oral cavity. Its side walls are supported by five branchial arches. 5 gill slits are typical for all fish. Almost all sharks and their close relatives have an altered gill slit behind the eye associated with the hyoid arc. This is called a sprinkler: through it, water washes the gills and then enters the throat, which is necessary if the mouth is occupied with food. In all cartilaginous fish, not counting chimeras, each gill slit, including spinach, opens on the lateral surface of the body behind the head. In chimeras and bony fishes, these openings are covered externally with a cover.

In almost all fish, the pharynx leads directly to the stomach, and it is difficult to speak of the presence of the esophagus here. In sharks, the stomach is J-shaped and relatively very large. Like many other fish, the inner surface of the wall of its heart section (head) sits with long, multi-branched papillae. These glandular formations secrete the powerful digestive juices necessary for animals swallowing their prey in whole or in large pieces. When the stomach is free of contents, it collapses and the middle and lower areas of its internal surface form longitudinal folds. When the stomach is stretched, they are smoothed.

The shark's intestines are short, which is generally characteristic of carnivorous animals (meat eaters), while in herbivorous forms it is long. In the short intestine, the meat does not linger long, otherwise it would start to rot. The pyloric valve (a slightly modified annular sphincter muscle) separates the stomach from the small intestine. Immediately after it, the canals of the gallbladder and the pancreas flow into it. The small small intestine continues with a large thickness, with a spiral fold inside, what is called a spiral valve. This formation considerably increases the internal surface of the intestine and therefore the absorption rate. A spiral valve has been found in lampreys, sharks, bipeds, ganoids and some primitive bone fish. In the latter, the intestines are often elongated, heavily convoluted and surrounded by layers of fat.

In sharks, it ends in a large chamber, a sump, in which the ducts of the kidneys and reproductive organs open. Cesspool is characteristic of cartilaginous and double-breathing fish, amphibians, reptiles, birds, as well as primitive laying mammals. In typical bony fish and mammals, the bowel and genitourinary system exits are separated from each other. Many bony fish have three such holes: for feces, urine and reproductive products.

Amphibians in all aspects of anatomy occupy a transitional position between ancient pulmonary fish and reptiles. They are characterized by small uniform teeth and a fleshy tongue. In frogs, toads and some tailed forms, it is sticky and can quickly be thrown out of the mouth to catch small insects. In the tailless, it is attached to the front edge of the lower jaw and rests in the mouth with its apex back. Such a tongue is thrown passively - with a clear opening of the mouth, and is pulled back due to the contraction of its muscles. In caudate amphibians, the tongue is advanced forward in translational motion.

An amphibian pharynx forms in the gill region, which is found in their aquatic larvae and in adults of certain aquatic species, but in terrestrial forms, the gills disappear before landing. The stomach, as in fish, is almost not separated from the cavity oropharyngeal, and the esophagus is weakly expressed. Salamanders are inherent in a long stomach, corresponding to the shape of the body, and their intestines form curls and are slightly twisted in a spiral. In frogs and toads, the stomach is curved, so that its posterior section is oriented approximately through the spine, as in many mammals, and the intestines are curled up.

Reptiles with their digestive systems differ little from amphibians, with the exception of the oral cavity. The large conical teeth of the crocodiles are covered with a layer of enamel. Both crocodiles and lizards are all identical in shape - such a system is called homodontic (in mammals, they are different and the dental system is heterodontic). The poisonous teeth of snakes have a longitudinal channel, or gutter, and form something like an injection needle.

Snakes and lizards are not able to chew. Crocodiles snatch prey and turtles bite. In some snakes, the mouth is so stretched (the jaws are connected by elastic ligaments) that they can swallow prey, four times larger than their head in the resting position.

The long forked and retractable tongue of the snake is very sensitive. It continuously protrudes, then retracts and vibrates in front of its nose when it is excited. A chameleon has a long sticky tongue thrown away from its mouth to catch small prey. Turtles and crocodiles have short, fleshy tongues.

All reptiles have a pronounced esophagus and stomach, followed by a long collapsed intestine.

Birds are distinguished by a specialized digestive system, partly due to the presence of a beak which does not allow them to chew food: the jaws must be strong, therefore heavy, which is incompatible with flight. The internal integument of the oral cavity is generally hard and dry, with few taste buds. The shape of the tongue varies considerably: it is often bifurcated or serrated closer to the posterior end (this helps to push food towards the esophagus). The pharynx is not clearly expressed: this area is distinguished by the respiratory opening which leads to the larynx. The esophagus is a long tube that almost always includes an extended area for storing food, which is called goiter. In geese, owls and some other birds, the entire posterior part of the esophagus is enlarged and we can say that there is no goiter or that this whole enlarged area corresponds to it. Pigeons are the only birds Food enters the esophagus (goiter) into the glandular anterior section of the stomach, mistakenly thought of as part of the esophagus. It is an extension of the digestive tract, in the thick walls of which there are glands which secrete gastric juice. It is followed by a muscular stomach ("navel"), a unique anatomical formation. Its muscles are a derivative of the light, involuntary muscles of the intestinal wall, but due to their high activity, they have turned dark red and look like streaks, although they retain their involuntary nature. In grain-eating birds, the muscular stomach is particularly well developed and is lined with corneal tissue that does not contain glands. In carnivores, its walls are weaker and their lining is soft. It is believed that some dinosaurs also had a muscular stomach like a bird.

In birds of prey, the intestines are short, in herbivores - very long and convoluted. Near its posterior end, a pair of hollow growths, the so-called cecum. In owls, they are very extensive, in chickens, they are represented by long tubes, and in pigeons, they are rudimentary.

Mammals are characterized by a diversified and very efficient digestive system. First, their lips have reached their highest development. They are already observed in amphibians and, with the exception of turtles, birds and whales, they increase regularly during the evolution of vertebrates, culminating in rodents in the form of their huge cushions.

The teeth of mammals can be almost identical and conical (like dolphins and other toothed whales), adapted only to grip and hold prey, but, as a rule, they are heterogeneous and of complex structure.

A typical animal tooth consists of a crown covered with a layer of enamel. Below is the dentin, which extends to the root, which is surrounded by a layer of cement. In the center of the dentin is a cavity containing what is called pulp - soft tissue with an artery, a vein and a nerve. As a rule, tooth growth stops when a certain size is reached. However, the defenses of some animals, the incisors of rodents and the molars of bulls and horses wear a lot at the top of the crown and, to continue to function, grow continuously at the base, where dentin, cement are formed. and enamel. The pulp cavity of teeth of the latter type is open (it does not close at the root, which is actually absent). These teeth are called gypsum. Typically, mammals have two sets of teeth. The first, the so-called dairy, fall and are replaced by constants. Mermaids and toothed whales have only one tooth change. For mammals, 4 varieties of teeth are characteristic: incisors, fangs, pre-radicals (premolars) and molars (molars). These only appear once - during the second tooth change. Fangs are particularly developed in predators, absent in rodents, small or absent in barnacles, deer and horses. On the molars and premolars of carnivorous animals are specialized cutting edges. In pigs and humans, the tips of these teeth are relatively flat and used to crush food. In cattle, elephants and horses, the layers of enamel, dentin and cement form complex folds in the flat-topped grinding teeth. Here, the outer layer of cement not only surrounds the root, but also extends to the top of the crown.

The tongue in mammals develops mainly from a tuber at the bottom of the pharynx. It develops forward and combines with other tissues in this area, forming a complex and multifunctional muscle structure. It is a good touch organ and the main area for the placement of taste buds. Usually the tongue is flattened and moderately extendable. For anteaters, it is round in section and can be moved away from the mouth, like woodpeckers; in whales it is almost immobile; in cats, it is covered with horn papillae to scrape the meat from the bones.

The esophagus extends from the throat to the stomach in the form of a soft tube, varying slightly within the class. Food and liquids can be pushed into it due to contractions of the peristaltic muscles.

The relatively large mammalian stomach is generally transverse to the anterior abdominal cavity. Its anterior cardiac end is wider than the posterior pyloric. The rest of the inner surface of the stomach wall in unstretched form is collected in folds, like sharks and reptiles. In ruminants (cows, sheep, etc.), the stomach is made up of four sections. The first three - the scar, the mesh and the book - derived from the esophagus and the last - the abomasum - correspond to the stomach of most groups (according to some authors, the esophagus only gave birth scar and mesh). Ruminants eat quickly, filling a huge scar with food, from which separate portions of chewing gum form in the grid. Each of them burps, once again chews and swallows thoroughly, this time entering the book, from where it goes to the abomasum and further to the intestines.

In mammals, the small and large intestines are clearly distinguished. In typical cases, the first consists of three parts: duodenal, lean and iliac. The duodenum is so named because its length in a person corresponds approximately to the total width of 12 fingers (20-30 cm). The person's jejunum is approximately 2.4 m long and the ileum is approximately. 3.4 m There are no clear boundaries between these departments. In the jejunum, food is mainly digested and in the ileum, absorption occurs.

The large intestine is made up of the cecum, colon and rectum; the latter ends with the anus. The cecum is a hollow growth at the beginning of the colon. This characteristic mutable formation of mammals is not inherited by them from reptilian ancestors, but has developed during the evolution of the class as a place of accumulation of food requiring a particularly long digestion. The cecum reaches its largest size in primitive herbivorous forms, which are characterized by its large hollow protrusion - the appendix (appendix). In a rabbit, it is a bag 36 cm long; in a pig, the blind tube is 90 cm long; in humans, the appendix is rudimentary; it is absent in a cat. The ileum is located at right angles to the awning. The main function of the colon is to retain the remains of the digested food and to remove as much water as possible. The rectum is always represented by a short straight tube which ends in the anus, surrounded by two rings of sphincter muscles. The first works involuntarily, the second - arbitrarily.

VASCULAR SYSTEM

The typical vascular system of the upper groups of animals consists of two parts - circulatory and lymphatic. In the first, the blood circulating in the heart circulates through a closed network of tubes (blood vessels - arteries, capillaries and veins): the arteries transport the blood, the veins. The lymphatic system includes the lymphatic vessels, pockets and glands (nodes). Lymph is a colorless liquid, similar in composition to blood plasma. Its source is a liquid filtered through the walls of blood capillaries. It circulates in the intercellular spaces, enters the lymphatic vessels and, through them, into the general blood circulation. The vascular system provides all organs with nutrition and oxygen, while eliminating breakdown products. The walls of the lymphatic capillaries are more permeable than those of the blood, so certain substances, such as proteins.

Invertebrates. Circulation in one form or another is characteristic of all animals. In ciliates, the digestive vacuoles (the simplest) move in the cytoplasm approximately in circles (what is called cyclosis). The flagellated collar cells conduct water through the body of the sponges, ensuring respiration and filtering of food particles. The intestinal cavities do not have a special circulation system, but their digestive cavities diverge in the channels to all parts of the body. In the hydra and many others, they even penetrate the tentacles. Thus, the body cavity plays a double role here - digestive and circulating.

Nemerthins are the most primitive modern animals with a real vascular system. It consists of three blood vessels that span the entire body. In echinoderms, the blood simply cleans the large cavities of the body. Ringworm is characterized by red blood and its organs (hearts) that pump it. Invertebrates have red blood: a red respiratory pigment, hemoglobin, is dissolved in its plasma. Squid, octopus and certain other molluscs and crustaceans have another respiratory pigment - hemocyanin (it gives blood a blue color). A beautiful vascular system with a complex network of arteries and veins and a well-developed heart is characteristic of molluscs. Arthropods also have a blood-pumping organ, which can be called the heart, but their circulatory system is not closed: blood freely washes the spaces, or sinuses, inside the body, and the vessels are poorly developed, especially in insects. In the latter, the tracheal network releases blood from the gas exchange function.

Vertebrates. The lancets are the only representatives of the chordates, deprived of heart, but the general diagram of their primitive circulatory system is typical of the higher groups.

In all vertebrates, the heart is located closer to the abdominal side of the body. The blood is colored red with hemoglobin, which is found in special cells (red blood cells); the plasma is colorless. For fish, with the exception of double respiration, a two-chamber heart, composed of the atrium and the ventricle, is characteristic. The ventricle pumps blood to the gills, where it is saturated with oxygen and turns bright red (arterial). From there it enters the head through the carotid arteries, and to the remaining parts through the vertebral aorta, which continues through the tail in the form of a caudal artery. Two pairs of large branches are separated from the aorta - subclavian and iliac arteries. The first goes to the pectoral fins and adjacent body walls, the second - to the pelvic region and the ventral fins. Other paired arteries supply blood to the muscles of the back, kidneys and reproductive organs. The arteries Unpaired branching from the aorta go to the internal organs of the body cavity. The largest of these - the celiac - sends its branches to the swim bladder, liver, spleen, pancreas, stomach and intestines. The fact that the swim bladder of fish is supplied with blood differently from the lungs serves as an additional argument against the recognition of these organs as homologs.

After passing through the capillaries of all the organs of the body, except the gills and the lungs, the blood, losing oxygen, becomes dark (venous). From the head, it enters the atrium through two large anterior cardinal veins. In sharks, it first fills the large venous sinus located immediately in front of the atrium. Venous blood flowing from the trunk and fins enters it through four pairs of large veins: subclavian (of the shoulder girdle and pectoral fins), abdominal lateral (lateral walls of the body and ventral fins), hepatic (of liver) and posterior (cardinal and kidney).

In the abdominal cavity, the portal vein carries venous blood to the liver from the stomach, intestines, and spleen. Fish used - most of the blood from the tail vein to the heart goes through the kidneys. During the evolution of vertebrates, less venous blood is sent to them. In amphibians, it goes mainly to the liver. In mammals, the venous blood from all parts of the body behind the shoulder girdle does not enter the kidneys, but travels directly to the heart through the posterior vena cava.

It is a large, unpaired vein passing through the upper abdominal cavity. It is absent in fish, with the exception of double respiration. In amphibians, it is already well expressed, and in the American proteus (Necturus), it works with the posterior cardinal veins. In tailless amphibians, reptiles, birds and mammals, the latter are reduced.

Heart. In typical fish, all the blood from their bicameral heart goes into the body through the gills. In fish and amphibians with double respiration, after the appearance of the lungs, only part of the blood goes to the gills of the heart. In the upper left, there is a second atrium, receiving arterial blood (rich in oxygen) from the lungs; the heart becomes three chambers. Its same structure is preserved in typical reptiles. However, in crocodiles, a septum appears in the ventricle, dividing it into two parts, i.e. the heart turns into 4 chambers. It is the same with birds and mammals. In animals with a 4-chamber heart, the blood, making a full circle through the body, crosses the heart twice. From the head and the region of the shoulder girdle, it enters the right atrium through one or two anterior vena cava, and from the rest of the organs through the posterior vena cava. From the right atrium, blood enters the right ventricle and is sent to the lungs through the pulmonary arteries. It returns from the pulmonary veins to the left atrium, from there it is pushed into the left ventricle, and from there it is distributed throughout the body along the aorta and its branches.

Arch of the aorta. If we consider the sparger as the first gill slit, then modern sharks have six. In a typical embryo of any vertebrate, respectively, six arterial arches extending from the aorta appear; thus, this number can be considered as the starting point for the whole group, although the lancet larva has 19, and some sharks have more than six. In modern sharks, in adulthood, 5 pairs of branchial arteries detach from the abdominal aorta and go to the gills, bringing them blood from the heart. However, only 4 pairs of branchial arteries flow from the gills to the vertebral aorta (the anterior part directs it towards the head). In its middle part, each arterial arch breaks down into branchial capillaries, dividing it into branchial arteries bringing back and taking. In typical bony fish, only 4 pairs of aortic arches lead to the gills, the same number of efferent gill arteries flowing into the vertebral aorta. In the gills preserving amphibians, the first 3 of the 6 arches participate in the development of the internal and external carotid arteries. The same is observed in all higher animals, although in a highly modified form. The fourth arches are large vessels that are the same on both sides of the body in amphibians, but different in reptiles. In birds, the left aortic arch does not develop, in mammals, the right. The fifth arc has disappeared with the gills in frogs and adult toads. It is also absent in adult reptiles, birds and mammals. The outer end of the sixth arch has also disappeared in almost all four legs, and its inner section (closest to the heart) has turned into a pulmonary artery. In snakes, the left pulmonary artery is small or absent. In double-breathed fish and gill amphibians, the pulmonary artery branches from the sixth arch remaining. In the gills preserving amphibians, the first 3 of the 6 arches participate in the development of the internal and external carotid arteries. The same is observed in all higher animals, although in a highly modified form. The fourth arches are large vessels that are the same on both sides of the body in amphibians, but different in reptiles. In birds, the left aortic arch does not develop, in mammals, the right. The fifth arc has disappeared with the gills in frogs and adult toads. It is also absent in adult reptiles, birds and mammals. The outer end of the sixth arch has also disappeared in almost all four legs, and its inner section (closest to the heart) has turned into a pulmonary artery. In snakes, the left pulmonary artery is small or absent. In double-breathed fish and gill amphibians, the pulmonary artery branches from the sixth arch remaining. In the gills preserving amphibians, the first 3 of the 6 arches participate in the development of the internal and external carotid arteries. The same is observed in all higher animals, although in a highly modified form. The fourth arches are large vessels that are the same on both sides of the body in amphibians, but different in reptiles. In birds, the left aortic arch does not develop, in mammals, the right. The fifth arc has disappeared with the gills in frogs and adult toads. It is also absent in adult reptiles, birds and mammals. The outer end of the sixth arch has also disappeared in almost all four legs, and its inner section (closest to the heart) has turned into a pulmonary artery. In snakes, the left pulmonary artery is small or absent. In double-breathed fish and gill amphibians, the pulmonary artery branches from the sixth arch remaining. although in a very modified form. The fourth arches are large vessels that are the same on both sides of the body in amphibians, but different in reptiles. In birds, the left aortic arch does not develop, in mammals, the right. The fifth arc has disappeared with the gills in frogs and adult toads. It is also absent in adult reptiles, birds and mammals. The outer end of the sixth arch has also disappeared in almost all four legs, and its inner section (closest to the heart) has turned into a pulmonary artery. In snakes, the left pulmonary artery is small or absent. In double-breathed fish and gill amphibians, the pulmonary artery branches from the sixth arch remaining. although in a very modified form. The fourth arches are large vessels that are the same on both sides of the body in amphibians, but different in reptiles. In birds, the left aortic arch does not develop, in mammals, the right. The fifth arc has disappeared with the gills in frogs and adult toads. It is also absent in adult reptiles, birds and mammals. The outer end of the sixth arch has also disappeared in almost all four legs, and its inner section (closest to the heart) has turned into a pulmonary artery. In snakes, the left pulmonary artery is small or absent. In double-breathed fish and gill amphibians, the pulmonary artery branches from the sixth arch remaining. The fifth arc has disappeared with the gills in frogs and adult toads. It is also absent in adult reptiles, birds and mammals. The outer end of the sixth arch has also disappeared in almost all four legs, and its inner section (closest to the heart) has turned into a pulmonary artery. In snakes, the left pulmonary artery is small or absent. In double-breathed fish and gill amphibians, the pulmonary artery branches from the sixth arch remaining. The fifth arc has disappeared with the gills in frogs and adult toads. It is also absent in adult reptiles, birds and mammals. The outer end of the sixth arch has also disappeared in almost all four legs, and its inner section (closest to the heart) has turned into a pulmonary artery. In snakes, the left pulmonary artery is small or absent. In double-breathed fish and gill amphibians, the pulmonary artery branches from the sixth arch remaining.

RESPIRATORY SYSTEM

The main function of the respiratory system is to provide oxygen to the body and to remove one of the oxidation products from it - carbon dioxide (carbon dioxide).

Invertebrates. Protozoa breathe the entire surface of the cell. The intestine and sponges also lack a specialized respiratory system. Some annelids use gills, but in general, their respiratory structures are not typical. The body of some echinoderms is covered with numerous small skin gills. Molluscs breathe with gills or lung sacs. Insects are characterized by tracheal tubes that penetrate their entire body. Crustaceans breathe with gills. Spiders for breathing are the so-called lung books with leaf-shaped gas exchange structures.

Vertebrates can breathe through their gills, their lungs and through the surface of the skin.

Their gills are soft, threadlike, abundantly washed with bloody growths in the wall of the gill slits leading from the pharynx to the sides of the body. These pharyngeal gills are a unique characteristic of chordates. The pharyngeal lancet, huge compared to the total size of the body, is penetrated by about 90 pairs of gill slits. Tunisians also have a similar pharyngeal chamber. Lampreys are characterized by 7 pairs of gill sacs and, in hagfish, 6 to 14 pairs. The typical number of gill slits in fish is 5, although some primitive sharks have 7. In most sharks, one more - the front - the gap is changed in the sprinkler and noticeably separated from the rest . Splashes can also be found in ganoid fish.

In antiquity, one of the groups of primitive freshwater fish (Cysteraeanus) acquired lungs as additional respiratory organs. They arise in the embryo in the form of a protrusion from the abdominal wall of the pharynx, which takes a tubular shape, regrows and branches off, turning into two hollow bags. Later, they are moved to the dorsal wall of the body cavity and are surrounded by a special membrane, the pleura. The lungs are located under the epithelial wall of this wall (unlike the swim bladder located above) and receive blood from the pulmonary artery, which moves away from the sixth branchial arterial arch.

The swim bladder developed in the ancestors of modern bony fish. It appeared as an unpaired protrusion from the upper wall of the pharynx and eventually settled along the body cavity above the wall of its dorsal wall, but below the kidneys (mesonephros). The swim bladder is supplied with blood not by the pulmonary artery, but by the celiac; the exception is silt fish (ammonia). The differences listed between the lungs and the swim bladder indicate that they appeared independently of each other and are non-homologous structures. However, the swim bladder is sometimes used as an additional air breathing organ, especially in ganoids (silt, armored pike and sturgeon). Multi-feathered African (Polypterus) the swim bladder is double, abdominal, necessary to breathe with the gills and is served by the pulmonary arteries, that is to say, in fact, it is light. Cartilaginous fish have neither lungs nor swim bladders.

in ganoids (silt, armored pike and sturgeon). Multi-feathered African (Polypterus) the swim bladder is double, abdominal, necessary to breathe with the gills and is served by the pulmonary arteries, that is to say, in fact, it is light. Cartilaginous fish have neither lungs nor swim bladders.

The tube leading from the ventral side of the pharynx to the lungs is kept in adult animals like a trachea. In fish and amphibians with double respiration, it is a short channel with soft walls, and in reptiles, birds and mammals, it is a rigid tube with cartilaginous rings in the walls that don't allow it to collapse.

The mammalian vocal chamber, the larynx, develops behind the pharynx at the entrance to the trachea and esophagus. In birds, the source of the sounds emitted is an additional lower larynx located deep in the chest, where the trachea branches into two bronchi that go to the lungs. Thus, the vocal organs of birds and mammals are not homologous.

Larvae of amphibians living in water develop 3 pairs of external gills of ectodermal origin, which are not completely homologous to the internal gills of fish. The larvae of double-breathed African and South American fish are equipped with 4 pairs of external gills, the larva of a multiopera - only one. Amphibians at different stages of their life can breathe wet skin, external gills, internal gills and the lungs. Frogs and salamanders stripped of the breast, i.e. incapable of costal breathing movements, pushing the air into the lungs, as if it were swallowing it, and exhaling due to the contraction of the muscles of the abdominal wall. Turtles breathe similarly due to the stillness of their shell, but the rest of the reptiles, along with birds and mammals, ventilate the lungs, rhythmically enlarging and shrinking the chest.

In birds, the lungs are directly connected to the chest. In addition, many air sacs escape from it, which are placed between internal organs and even in hollow bones. In mammals, the lungs hang freely in the chest cavity and fill up when the pressure drops. This cavity is separated from the abdominal cavity by a single flat muscle, the diaphragm, which in the relaxed state forms a dome directed towards the head. Reducing during inhalation, it flattens, thereby increasing the chest cavity and creating a pressure drop necessary for inspiration.

EXCRETION SYSTEM

The excretory system (excretory) removes metabolic waste from the body. Excretion products (feces) can be represented by undigested food debris, followed by carbon dioxide, bile (from the liver), or urine that forms in the kidneys. Here, only the kidneys and functional structures will be taken into account, i.e. specialized vertebral excretory organs.

Invertebrates. Excretion in protozoa is provided by contractile vacuoles. In flatworms and certain other invertebrates, primitive nephridia or protonephridia, consisting of large "fiery" cells and related tubules, serve this purpose. The "inflamed" cells function simultaneously as a filter and as a "motor", providing a flow of liquid excretion through the excretory system: metabolic waste and water come from the surrounding tissues, and they conduct the resulting fluid in the tubules and further down the conduits to the excretory pores. In the cavity of each "fiery" cell, there is a bundle of cilia ("ear flame"), the flutter of which causes the excretion of fluid through the excretory tubes of the body. In annelids, the excretory system is represented by another type of nephridia - the so-called metanephridia. They are paired tubules, located metamerically, generally long and convoluted; one end of each tubule opens with a ciliary funnel into the coelomic cavity of the previous body segment, and the other outwards. The fluttering of eyelashes creates a flow of fluid through the tubule and, as it moves, the formation of urine occurs. Otherwise, the excretory system of terrestrial invertebrates is organized. The liquid excretion products exit through the malpigium vessels in the posterior intestine, where water is absorbed; dehydrated excrement is excreted through the anus. This system allows you to reduce the loss of water from the body. The liquid excretion products exit through the malpigium vessels in the posterior intestine, where water is absorbed; dehydrated excrement is excreted through the anus. This system allows you to reduce the loss of water from the body. The liquid excretion products exit through the malpigium vessels in the posterior intestine, where water is absorbed; dehydrated excrement is excreted through the anus. This system allows you to reduce the loss of water from the body.

Vertebrates. Three types of kidneys appear sequentially in vertebrates: proephros, mesonephros and metanephros. Pronephros develops at the beginning of the embryo in the form of an accumulation of a few tubes - nephrons (renal tubules) - along the front-upper part of the inner wall of the body cavity. Among these, urine enters the primary ureter, called the proonephric or wolf channel. In all vertebrates except hagfish, the pronephros only work temporarily. After that, tubules of similar but more complex mesonephros form, which in fish and amphibians become a functional kidney. At the same time, the Wolf channel is still used to remove urine from the external environment or from the sump. In reptiles, birds and mammals, a third type kidney, or metanephros, develops behind the mesonephros. It is even more complicated histologically, it works more efficiently and forms its own exit channel, the secondary ureter. The Wolf channel is preserved in males for the excretion of sperm and in females, it degenerates. Some reptiles (for example, snakes and crocodiles) and birds do not have a bladder and their ureters open directly into the sump. In mammals, they lead into the bladder, from where urine is passed through the unpaired canal, the urethra. All animals, except the oviparous, do not have a sump. from where the urine is eliminated through the unpaired channel - the urethra. All animals, except the oviparous, do not have a sump. from where the urine is eliminated through the unpaired channel - the urethra. All animals, except the oviparous, do not have a sump. Fish mesonephros are long bands extending along the dorsal side of the body cavity between the swim bladder and the base of the ribs. In amphibians, they are more compact and attached to the body wall by the mesentery. In snakes, the kidneys are very elongated and divided into segments. In birds, they are densely packed in paired hollows of the pelvic bones. In mammals, they are bean-shaped or lobed. The kidneys of all maxillae, except mammals, are supplied with blood which flows through both the arteries and veins; the latter form door systems there. The portal system is the second network of capillaries into which blood enters the path from the vertebral aorta to the heart. It is always located in the glandular organs such as the liver, adrenal glands or the kidneys. In mammals, the work of the kidneys requires high blood pressure, and it only enters through the arteries.

REPRODUCTION SYSTEM

The reproductive organs (gonads) are the testes of males and the ovaries of females. In the animal kingdom, one can find many specialized variants of the device of these two organs themselves and of the channels which transport their products out of the body.

Invertebrates. Many lower invertebrates are hermaphrodites, that is, their individuals are not divided into two sexes and each is capable of producing both sperm and eggs. For intestinal and parasitic flatworms, an alternation of reproductive generations is characteristic: sexual generation is followed by asexual. Roundworms, echinoderms, arthropods and vertebral dioecious.

Vertebrates.

If the lancet gonads located segmentally on both sides of the body cavity are devoid of canals, all of the upper vertebrates have genital canals, often of fairly complicated structure.

In sharks, large paired gonads are located in the front near the dorsal side of the body cavity. The eggs are also large and after fertilization or develop in special chambers of the oviducts, the so-called uteri, or deposited in water, covered with a dense protective shell. The embryonic stage takes a long time, and by the time of birth or hatching, sharks manage to reach fairly large sizes. In bony fish and birth to live cubs, but most reptiles lay their eggs and almost always bury them in the ground.

In all four-legged fish and some fish, the outlet channel of the sperm testes, i.e. via the vas deferens, the wolf channel is used, i.e. the primary ureter of protonephros . In females of higher vertebrates, the oviducts continue to function, although with significant changes, the same channels as sharks. In all vertebrates, with the exception of mammals and bony fish, they open separately in the cloaca. In evolutionarily advanced mammals, the two oviducts are combined to one degree or another and form an unpaired chamber for carrying the baby - the uterus.

During the evolution of vertebrates, their gonads are increasingly displaced towards the posterior end of the abdominal cavity. In many mammals, the testes migrate into a special sac, the scrotum.

ENDOCRINE GLANDS

The animal glands can be divided into two categories - with or without excretory channels (exocrines). In the second case, the excreted products enter the bloodstream. These glands are called endocrine or endocrine glands. Many exocrine glands are located in the skin and secrete their secret on its surface (sometimes the channels formed are also practically absent here). These include, for example, the mucous, sebaceous, poisonous, transpiring, mammary glands, the coccygeal gland of birds. Inside the vertebral body there are exocrine glands such as saliva, pancreas, prostate, liver and gonads. Certain glands, such as the pancreas, ovaries, and testes, function simultaneously as glands of both categories.

The endocrine glands secrete hormones which, along with the nervous system, coordinate the work of different parts of the body. In humans, this category includes: the pineal gland (pineal gland), pituitary gland, thyroid gland, parathyroid glands, goiter (thymus), secretin-producing cells of the duodenum, islets of Langerhans in the pancreas , adrenal glands, testes and ovaries.

The pituitary gland has a double origin. During its formation, a cornice develops from the base of the diencephalon, which meets the ascending growth of the roof of the oral cavity and forms a whole with it. The pituitary gland forms several hormones and is present in all vertebrates. In sharks, it is a large lobed gland.

Thyroid glands and parathyroid glands. The bilobed thyroid gland develops from the growth of the pharyngeal fundus and is present in all vertebrates, starting with fish. The intensity of the metabolism and the level of heat production, the condition of the skin and its derivatives, as well as the moulting processes in animals to which it is characteristic, depend on its activity. The parathyroid glands also develop from the wall of the pharynx. Their number varies according to the vertebrates from 2 to 6. In humans, there are 4, immersed in the posterior surface of the thyroid gland. They participate in the regulation of calcium metabolism in the body.

Goiter and pancreas. Goiter also develops from the embryonic pharynx and, in the lower vertebrates, it is one of the cervical glands. In mammals, it moves to the front of the chest. Its dimensions are relatively large in newborns and young animals, and in adults gradually decrease. It plays an important role in the body's immune defense.

The pancreas contains two types of secretory cells: exocrine, which produces digestive enzymes, and endocrine, which secretes the hormone insulin. In cyclostomes, these cells exist separately. As a single organ, the pancreas first appears in fish.

The adrenal glands are inherently double and consist of two tissues, each secreting its hormones. The inner part (brain) develops from the nervous tissue of the embryo and secretes adrenaline. In lower vertebrates, it can be distributed along the upper wall of the body cavity, while remaining isolated. The outer layer (cortex) of corticosteroids in the secret adrenal gland.

The sex glands form three important hormones: testosterone (in the testicles), estrogen (in the ovaries and placenta), and progesterone (in the ovary's corpus luteum). Testosterone and estrogen stimulate the development of secondary sexual characteristics, respectively, male and female. All female sex hormones collectively control the sex cycle. However, in females, the physiology of sex is under the triple control of the pituitary gland, the thyroid and the gonads.

Bibliographic references

Andrews, E. B. (1985). Structure and function in the excretory system of archaeogastropods and their significance in the evolution of gastropods. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 383-406.

Angyalossy, V., Angeles, G., Pace, M. R., Lima, A. C., Dias-Leme, C. L., Lohmann, L. G., & Madero-Vega, C. (2012). An overview of the anatomy, development and evolution of the vascular system of lianas. *Plant Ecology & Diversity*, *5*(2), 167-182.

Bagi, C. M., Berryman, E., & Moalli, M. R. (2011). Comparative bone anatomy of commonly used laboratory animals: implications for drug discovery. *Comparative medicine*, *61*(1), 76-85.

Carrier, D. R. (1991). Conflict in the hypaxial musculo-skeletal system: documenting an evolutionary constraint. *American Zoologist*, *31*(4), 644-654.

Dahdul, W. M., Balhoff, J. P., Blackburn, D. C., Diehl, A. D., Haendel, M. A., Hall, B. K., ... & Segerdell, E. (2012). A unified anatomy ontology of the vertebrate skeletal system. *PloS one*, *7*(12), e51070.

Dao, T. T. (2009). *Modélisation du système musculosquelettique des membres inférieurs: Modèle biomécanique vs. méta modèle* (Doctoral dissertation, Université de Technologie de Compiègne).

Delamarche, P., Multon, F., Horrut, T., & Nougier, V. (2018). *STAPS: anatomie, physiologie, neurosciences et biomécanique*. Elsevier Health Sciences.

Desfeux, C., Maurice, S., Henry, J. P., Lejeune, B., & Gouyon, P. H. (1996). Evolution of reproductive systems in the genus Silene. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, *263*(1369), 409-414.

Dumm, C. L. G., Cortizo, A. M., & Gagliardino, J. J. (1985). Morphological and functional changes in several endocrine glands induced by hypothyroidism in the rat. *Cells Tissues Organs*, *124*(1-2), 81-87.

Ellenberger, W., Baum, H. A., Baum, H., Dittrich, H., Dittrich, H., & Davis, F. A. (1956). *An atlas of animal anatomy for artists*. Courier Corporation.

Gordy, M. B. (2000). A comparative anatomy of credit risk models. *Journal of Banking & Finance*, *24*(1-2), 119-149.

Huxley, T. H. (1869). *An introduction to the classification of animals*. J. Churchill & sons.

Huysseune, A. (2000). Skeletal system. In *The laboratory fish* (pp. 307-317). Academic Press.

Kappers, C. U. A., Huber, G. C., & Crosby, E. C. (1936). The comparative anatomy of the nervous system of vertebrates, including man.(2 vols.).

KURITA, M. (2002). Change in the Intellectual and Physiological Functions of 1550 Persons Who Learned Kurita's Speed Reading System for Ten Days (< Main Topics> Human PSI Forum" Human Potential Science" International Forum: Physical and Physiological Approach Joint with" Mystery of Mind and Body" International Forum and The Fourteenth Symposium on Life Information Science (International Version) 22-27 August 2002, OVTA, Makuhari, Chiba (near Tokyo), Japan). *Journal of International Society of Life Information Science*, *20*(2), 662-667.

Leveque, J. L., & Saint Leger, D. (1993). *U.S. Patent No. 5,262,407*. Washington, DC: U.S. Patent and Trademark Office.

Locy, W. A. (1884). Anatomy and physiology of the family Nepidae. *The American Naturalist*, *18*(3), 250-255.

Lőw, P., Molnár, K., & Kriska, G. (2016). *Atlas of animal anatomy and histology*. Springer.

McCracken, T. O., & Kainer, R. A. (2013). *Color atlas of small animal anatomy: the essentials*. John Wiley & Sons.

McGreevy, J. W., Hakim, C. H., McIntosh, M. A., & Duan, D. (2015). Animal models of Duchenne muscular dystrophy: from basic mechanisms to gene therapy. *Disease models & mechanisms*, *8*(3), 195-213.

Sarnat, H. G., & Netsky, M. G. (1974). *Evolution of the nervous system*. Oxford U. Press.

Schachner, E. R., Lyson, T. R., & Dodson, P. (2009). Evolution of the respiratory system in nonavian theropods: evidence from rib and vertebral morphology. *The Anatomical Record: Advances in Integrative Anatomy and Evolutionary Biology: Advances in Integrative Anatomy and Evolutionary Biology*, *292*(9), 1501-1513.

Yonge, C. M. (1937). Evolution and adaptation in the digestive system of the Metazoa. *Biological Reviews*, *12*(1), 87-114.


More Books!
yes
I want morebooks!