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BIOLOGY

for foreign citizens of preparatory division

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В учебно-методическом пособии рассматриваются: сущность жизни, уровни организации живого, биология и физиология клетки, размножение организмов, индивидуальное развитие, наследственность и изменчивость, вирусы, бактерии, водоросли, лишайники, грибы, растения, животные, особенности строения и физиологии человека. Большое внимание уделяется медицинским аспектам рассматриваемых разделов, нервной, сердечно-сосудистой, выделительной и другим системам человека.

Учебно-методическое пособие составлено с учётом современных дидактических требований и отражает профилизацию преподавания биологии слушателям подготовительного отделения факультета подготовки иностранных граждан в медицинском вузе на русском и английском языках обучения.

Для иностранных граждан, поступающих в медицинские университеты, слушателей подготовительного отделения, студентов первого курса, обучающихся на русском и английском языках.

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INTRODUCTION

Number of foreigners which comes in medical universities of the Republic of Belarus every year increases.They decide to devote themselves to the medical profession, a pharmacist, a dentist.

The majority of foreign students entering the medical universities choose a system of training in Russian and English languages and are nationals of various Asian and African countries. A very different system of training in secondary schools and colleges is present in these countries. There is no comprehensive study of the biology in most countries. They study two, three sections (botany, zoology, human anatomy), or only questions of general biology. Differences in training of foreign students in biology, as well as their lack of basic training in biology necessitated the creation of this guide. This manual is written in accordance with the basic program of biology for the preparatory department of Vitebsk State Medical University (2015).

Many years of experience teaching biology in Vitebsk State Medical University at the preparatory department were used by authors during writing grants and the reception entrance examinations for foreign applicants. To understand biology better we suggest the following sequence of presentation: first, givethe general fundamental questions of biology (basic cytology, reproduction, individual development, genetics), and then open the modern ideas about the structure and functions of bacteria, fungi, lichens, plants, animals and human which are based on the knowledge of the general laws of life.

The purpose of this manual is to help foreigners to understand the most important issues of biology and study the material in accordance with the requirements of the entrance exams. In more simple issues clearly set out in the internationally-recognized English language textbooks, the authors found it possible to confine concise instructions. Therefore allowance does not replace, but complements the textbooks. It presents stated material in a more concise manner, focusing on the formation of the future outlook of the student.

Authors

Chapter 1. General biology

Biology is a science which studies the life as a special form of matter, the laws of its existence and development. The subject of biology is living organisms and natural communities, their relationship with each other and with inanimate nature.

Biology is a set of disciplines united by common objectives and aimed at essence of life and the laws of its manifestations. The basis of this complex constitute general biological disciplines studying the fundamental properties of living (cytology, genetics, evolutionary theory); morphological discipline describing the structure of plant and animal organisms (anatomy, histology); physiological - exploring the function of living beings (physiology of cells, plants, animals and human); environmental, describing life of animals and plants and their relationship with environmental conditions (ecology, biogeography, biogeocenology); frontier disciplines studying the composition and structure of tissues and cells at the junction of related sciences (biochemistry, biophysics, radiobiology, space biology, molecular biology).

During the development of biology accumulated material was systematized and depending on the outlook of scientists to create hypotheses and theories were made conclusions. Scientists from ancient times divided into idealists and materialists. Idealists believed that the matter is base of consciousness, universal mind. Materialists argue that nature exists objectively, independently of consciousness from human which is the product of matter and society development.

The knowledge of the essence of life is one of the main problems of biology in which clearly demarcated mind of idealists and materialists. Life arose from nonliving in the evolution of our planet on definite stage of its development. Life exists in the form of open biological systems of varying degrees difficulties. Depending on the complexity of difference following levels of organization of biological systems:

– molecular-genetic (elementary structure are codes of hereditary information that is transmitted from generation to generation, elementary phenomena is the reproduction of these codes);

– cell (elementary structures are cells, the elementary phenomena is their division);

– organismic (elementary structures is organism, elementary phenomena is their individual development and differentiation);

– population-species (elementary structures are populations, elementary phenomena is directional change their genetic makeup);

– biosphere-biogeocenotic (elementary structures are biogeocoenoses, elementary phenomena is transitions of biocenosis from one state to another).

The fundamental properties of living are self-renewing, self-reproduction and self-regulation. They determine the basic signs of life - metabolism and energy, reproduction, individual development, heredity and variability, discontinuity and continuity, homeostasis.

All wildlife is divided into two superkingdom: prenuclear organisms (prokaryotes) and nuclear (eukaryotes). All prokaryotes consists of two kingdoms – Bacteria and Blue-green algae, eukaryotes have three kingdoms: fungi, plants and animals.

At the present stage of biology development the important role played in the biosphere is not established biogeocoenoses natural and created by man agrocenosis. The latter should provide humanity with food and support the cycling of matter which is to preserve the atmosphere, soil and hydrosphere in the state allows people to be on Earth. Knowledge of the laws of genetics and breeding, as well as the physiological characteristics of cultivated and wild plants and animals helps to develop methods of breeding, the removal of a products varieties and breeds.

Biology has a great importance for medicine as its theoretical basis. For example, selection of microorganisms produces enzymes, vitamins, hormones needed to treat a number of diseases. The development of genetic engineering opens up broad prospects for biotechnology of biologically active compounds and drugs. Knowledge features of pathogenic reproduction and distribution of viruses, bacteria, protozoa, worms is necessary to treatment infectious and parasitic diseases of human and animals.

1.1 Bases of cytology

Cytology is a science of cell. Subject of cytology are monocellular (bacteria, protozoa, algae, fungi) and multicellular organisms (animals and plants).

Cytology tasks includes study of structure and function of the cells, their chemical composition and relationship with each other in a multicellular organism, reproduction and development of cells, their adaptation to environment.

The discovery of cells associated with the names of the great scientists with microscopic use. Robert Hooke (1635-1703) and N. Grew (1641-1712) described the cellular structure of many plant facilities. M. Malpighi (1628-1694) established microscopic structure of some tissues and organs of animals and human rights; A. Leeuwenhoek (1632-1723) for the first time has seen cells of protozoa, spermatozoa, bacteria, erythrocytes. But naturalists of XVII-XVIII centuries consider that the main role in the life of the cell belongs to the wall. Only in 1825, J. Purkinje (1787-1869) found a nucleus in chicken egg, located in a semi-liquid substance (protoplasm). In 1831 R. Broun (1773-1858) first described the plant cell nucleus and in 1837 M. Schleiden (1804-1881) came to the conclusion that the nucleus is an important component of the cell. The result of all this work was the creation of the cell theory formulated in 1839 by the german physiologist and cytologist T. Schwann (1810-1882). He introduced the following conclusions, retains its value and now: the cell is the main structural unit of plant and animal organisms; the formation of cell determines their growth and development of organism.

Perfection of microscopic techniques helped further development of cell theory. In 1858 the German scientist R. Virchow (1821-1902) made a conclusion that cells develops only from the cells.

K.M. Baer (1792-1876) opened ovum of mammals and found that all multicellular organism begin its development from a single zygote cell. Cell division studied I.D. Chistyakov in 1874 and I.E. Strasburger in 1875 opened mitosis. V.I. Belyaev described in 1894 meiosis, and S.G. Navashin in 1898 opened double fertilization in flowering.

The modern cell theory has the following statements:

– cell is the basic unit of structure and development of all living organisms, the smallest unit of the living;

– cells of monocellular and multicellular organisms are similar in structure, chemical content and important manifestation of life;

– cells reproduction occurs by dividing the original cells;

– cells of special tissue form organs.

1.1.1 The structure and functions of the cell

Cell is an integrated system in which distinguish shell cytoplasm and the nucleus. The shell of plant cells consists of cellulose. The shell may be subject to lignification, suberization, mineralization and kutinisation depending on the

function performed by the cell. It is riddled by pores through which goes strands of cytoplasm – plasmodesma that connect cells together. The shell is formed in the result the cytoplasmic organelles action in basically by Golgi complex. In the living organisms cells usually do not have a shell or it has a different structure.

The cytoplasm consists of the plasmalemm, hyaloplasm, organelles and inclusions.

Plasmalemm (elementary biological membrane) comprises three layers: an external and internal protein and the lipid layer with two rows of phospholipid molecules located between them (Figure 1.1). Protein layers can interlock and form special hydrophilic pores through which water-soluble substance as ions. Non-soluble complex molecules of protein, vitamins, lipids penetrate special enzymatic membrane pores. This is done as follows: enzymes synthesized embedded in the cell membrane and bind in the cytoplasm and is performed only needed substances.

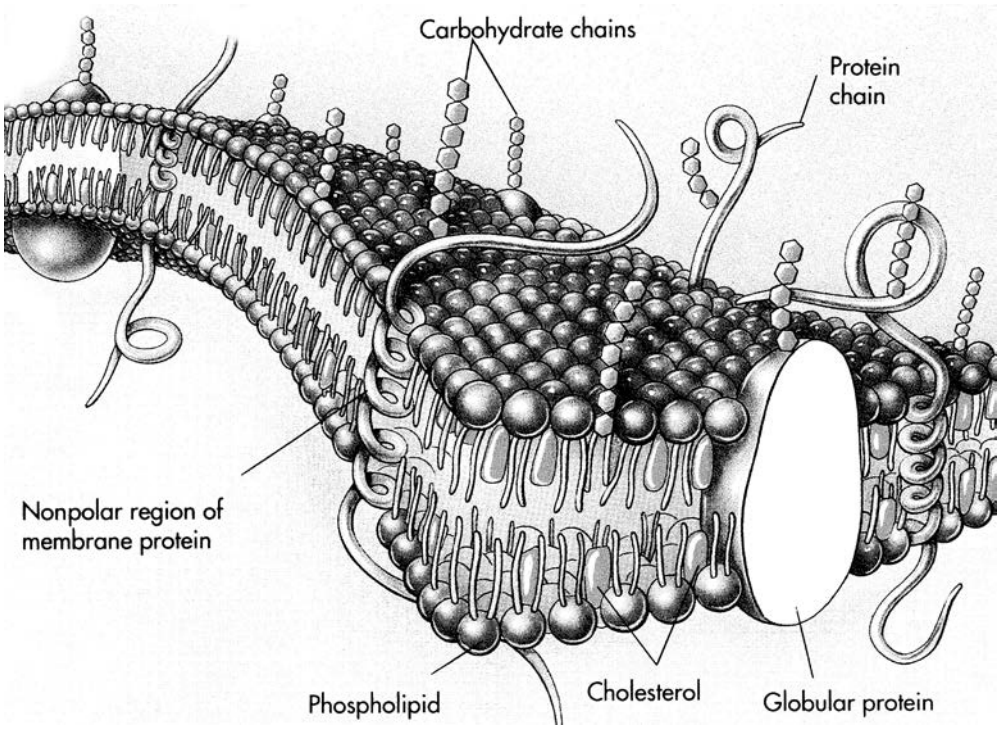


Figure 1.1. Cells have complex surfaces, by Raven & Johnson.

Plasmalemm has a wavy, folded superficiality which increases the area of its suction. She makes several important functions: regulate metabolism and energy between the cell and the outside world perceives and converts external signals (chemical, sound, mechanical and so on), carries the uptake of solid foreign particles (phagocytosis) and liquid droplets (pinocytosis) (Figure 1.2).

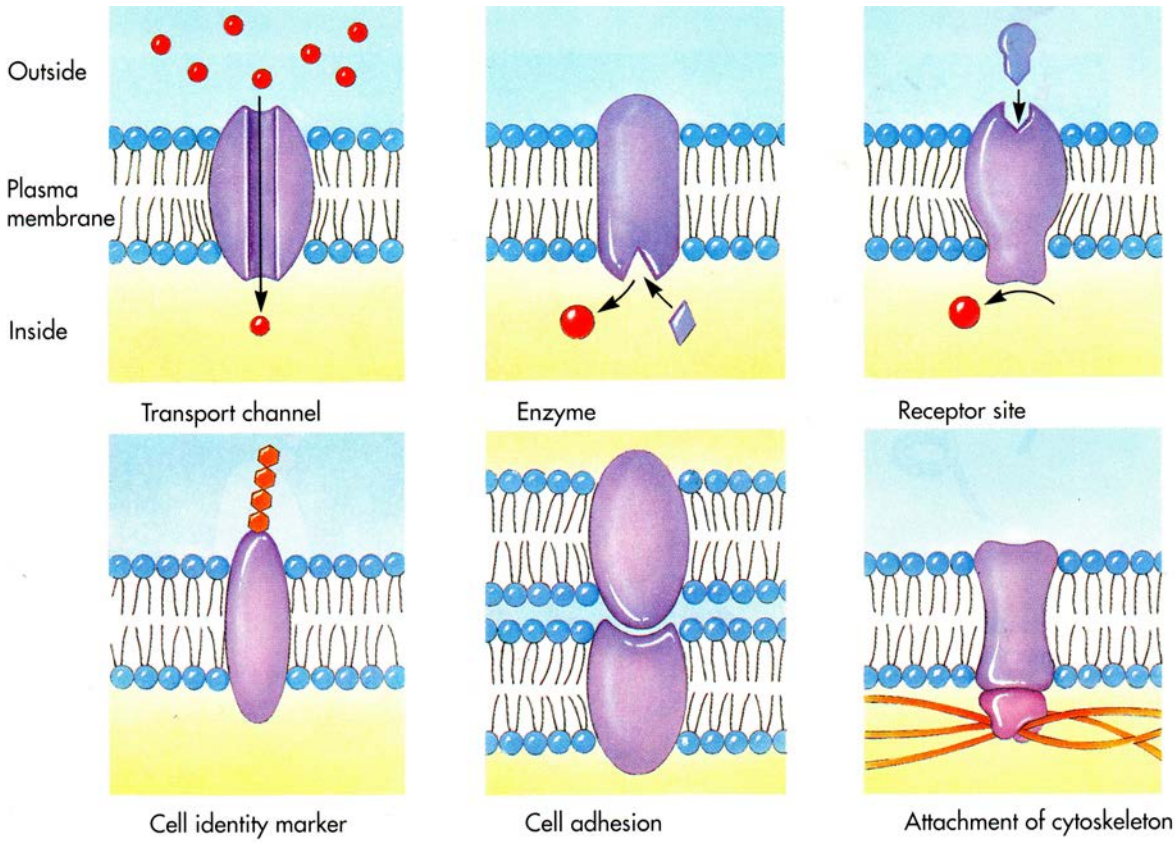


Figure 1.2. Functions of plasmalemm, by Raven & Johnson.

Hyaloplasm is heterogeneous colloidal solution that provides the interconnectedness of all cell organelles and processes of its life. Colloidal hyaloplasm is characterized by two states: liquefied – solium, dense – gel, and may be solium - gel transitions depending on the conditions of life. Hyaloplasm provides cell viscosity elastics, contractility, internal movement.

Microtubules and microfilaments are specific protein structures that perform a supporting function of the cell are situated in it. For example: microtubules is a main components of flagellum – organoid with special movement function for example in sperm (Figure 1.3).

Organelles are specialized permanent components of the cytoplasm which have a certain structure and perform a particular function in the life of the cell. They are divided into two groups: organells of general purpose (mitochondria, Golgi complex, plastids, cell center, vacuoles, endoplasmic reticulum, ribosomes, lysosomes) and organelles of special purpose (cilia, flagellum, neurofibrils, myofibrils and others).

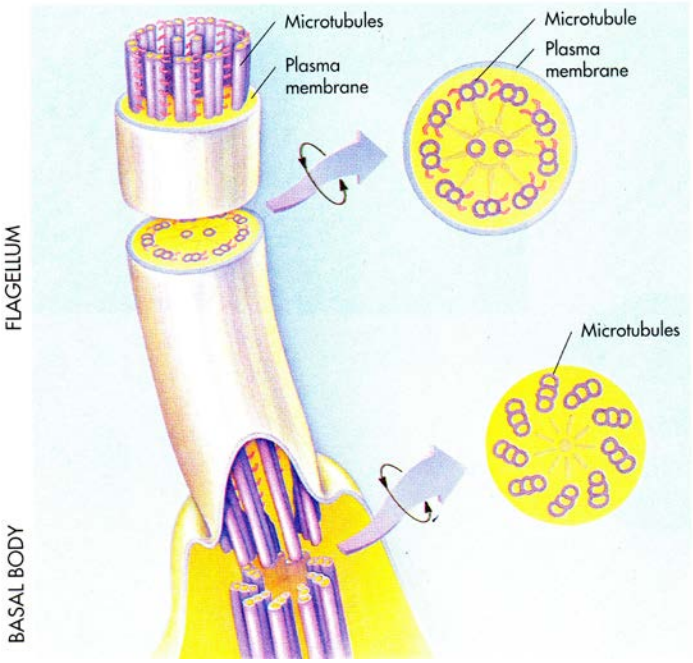


Figure 1.3. Structure of a flagellum, by Raven & Johnson.

The mitochondria is small, spherical shape or long bodies size of 0,2-7,0 mm which consist of two membranes – outer and smooth inner which forms projections (crista), extending deep into the matrix (Figure 1.4). The latter is a pellet which accumulates calcium and magnesium ions, glycogen, ferments catalyzing energy metabolism and the synthesis of adenosine triphosphate (ATP). The matrix contains mitochondrial deoxyribonucleic (DNA) and ribonucleic acid (RNA) which make reproduction of mitochondria during cell division. The main function of mitochondria is the oxidation of organic compounds and the accumulation of energy in the form of ATP molecules.

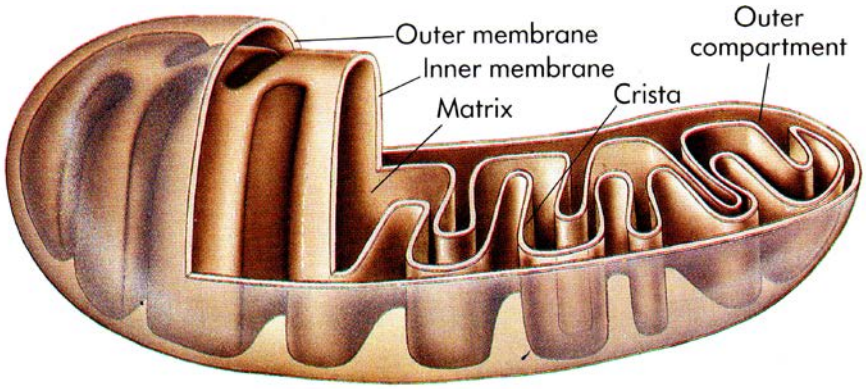


Figure 1.4. Mitochondria.

Complex or apparatus Golgi body is a cell organelle, structural and functional unit is dictyosome. It is 5-20 flattened membrane sack that form on the periphery of the bulge – tubules (Figure 1.5). It named after the Italian scientist K. Golgi (1844-1926). The primary function of the Golgi complex is concentration and sealing products intercellular secretions and substances coming from outside and is need to separate from the cell and synthesis of inclusions.

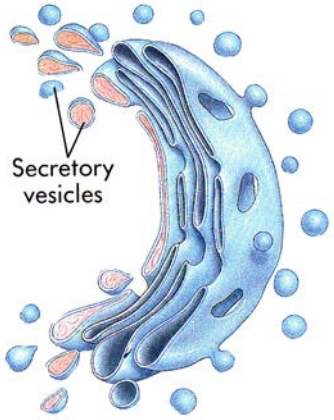


Figure 1.5. Golgi complex.

Plastids are organelles that are unique to plant cells. They are divided into three main types – chloroplasts, chromoplasts and leucoplasts. Every of them can appear to another under certain conditions.

Chloroplasts are the green plastids whose color is due to pigment chlorophyll. Through chlorophyll green plants use light energy by which synthesize organic matter from nonorganic. Chloroplasts have a shell consisting of two membranes. Recent surround plastids body (stroma) which are located side – piles of chlorophyll layers separated by a membrane (Figure 1.6).

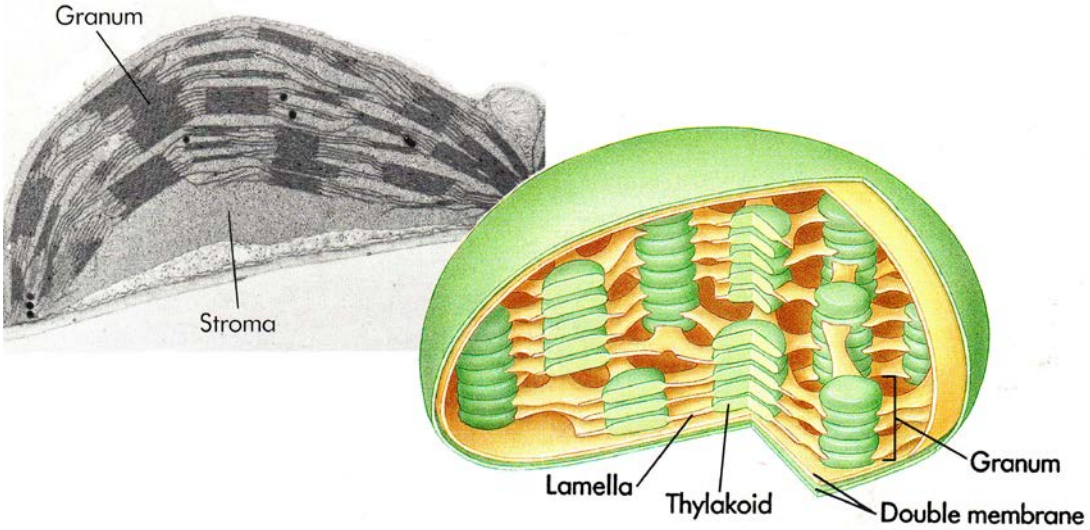


Figure 1.6. Chloroplast structure.

Granum takes place on the membranes of light-dependent reactions of photosynthesis, and on the membranes of the stroma – the dark. In higher plants, plastids have lenticular shape, the diameter of the average is 4-6 microns. The structure of the chloroplasts contains proteins, fats, chlorophyll, small number of DNA and RNA and some other substances.

Chromoplasts are colored plastids. Color is made by presence of orange-yellow (carotene), yellow (xanthophyll) or red (lycopene) pigments. The form of chromoplasts in different plant species are different – rod-shaped, round, crescent. Chromoplasts takes participate in photosynthesis and determine the color of fruits, roots and leaves.

Leucoplasts are colorless plastids lacking pigments. The shape and size are similar to the chloroplasts; contained in the roots. They accumulate reserve nutrients – starch, proteins, fats.

The cell center or centrosome is organelle characterized for animal cells and lower plants (Figure 1.7). It consists of two centrioles, having the form of a hollow cylinder with diameter about 150 microns and a length of 300-500 microns. Cell center is involved in cell division.

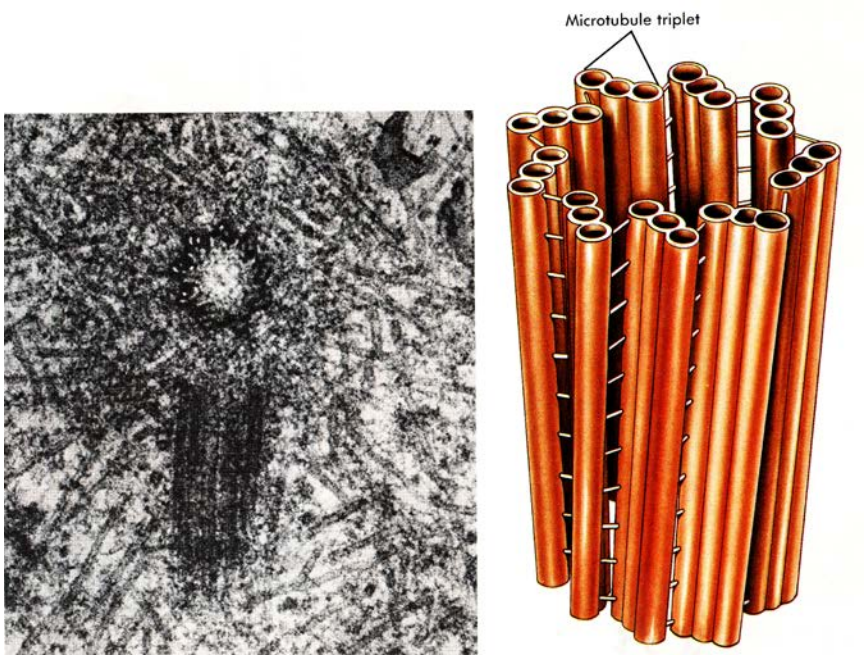


Figure 1.7. Centrioles.

Vacuoles are cavities in the cytoplasm of plant cells, protozoa, bounded by a membrane. These bubbles are formed from complex Golgi, endoplasmic reticulum extensions of the outer cell membrane. Vacuoles of plant cells filled cell juice containing 90-95% water, simple proteins, mono- and disaccharides, vitamins, pigments, organic acids, glycosides, tannins and others. In the

simplest cell vacuoles containing digestive enzymes, water, mineral salts. Vacuoles can be digestive and the contractile (secretory). Vacuoles maintain osmotic pressure cells and are involved in osmoregulation.

Endoplasmic reticulum is organelle which weave sheets through the interior of the cell and with the nucleus and the plasma membrane (Figure 1.8). In is a system of channels, voids, reservoirs which wall is a membrane with a smooth or rough surface. On a smooth surface places enzymes which are necessary for the synthesis of fats and carbohydrates, on the rough – ribosomes (single or group – polysomes) providing protein synthesis. Endoplasmic reticulum formed from the nuclear membrane or plasma membrane folds.

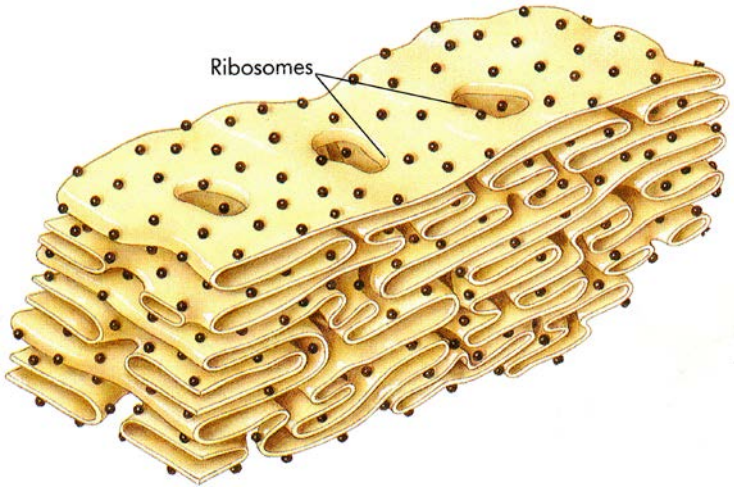


Figure 1.8. Rough endoplasmic reticulum.

Ribosomes are particles of complex shape with a diameter of 20 nm near consisting of ribosomal RNA (r-RNA) and protein. They are located on the rough surface of the endoplasmic reticulum, occasionally in the cytoplasm.

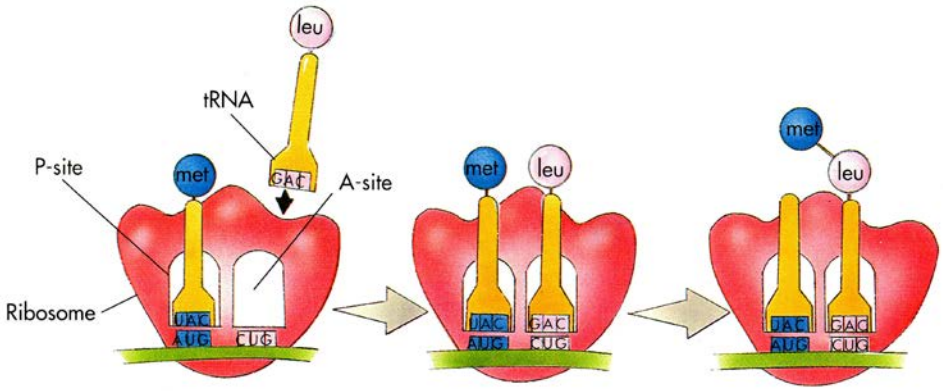


Figure 1.9. How polypeptide synthesis proceeds, by Raven & Johnson.

Ribosomes are formed due to the activity of the nucleolus and enter the cytoplasm. One molecule of messenger RNA (mRNA) can combine several ribosomes in the polysome. Ribosome involved in protein biosynthesis (Figure 1.8).

Lysosomes are small oval bodies limited by membrane. They are formed as extensions of the endoplasmic reticulum and Golgi complex, where filled with hydrolytic enzymes, and then are isolated and fed into the cytoplasm. Under normal conditions, lysosomes digested with particles that get into the cell through phagocytosis, and organelles dying cells. Products of lysis output through the lysosome membrane into the cytoplasm, where included in new molecules.

Inclusions are time components of the cytoplasm which are formed in the cell at certain times of her life. There are trophic, secretory and excretory inclusions. Trophic inclusion is reserve nutrients (starched and proteinaceous grain fat droplets – in plant cells, glycogen, and fat in animal cells). Secretory inclusions are waste products glandic cells (hormones, enzymes, secrets). Excretory switching exchange represented by the final products of plant and animal cells (calcium oxalate crystals, gypsum, uric acid, and others).

The nucleus is a main part of all cells of unicellular and multicellular organisms. The typical wall which isolates nucleus finds only in bacteria and blue-green algae. Most cells have a single nucleus, some have many nuclei (fungus Mucor cells, bone marrow, liver). Shapes and sizes of the nucleus is mainly determined by the shape and size of cells: in globular cells - most often rounded, elongated - oblong. The nucleus is typically located in the center of the cell, sometimes - on the periphery. In appearance, the nucleus is a homogeneous or a mesh body, clearly demarcated by a thin cytoplasmic nuclear envelope (karyolemm) with tiny pores (Figure 1.10). Karyolemm consists of two membranes. The cytoplasmic matrix is situated between them. External membrane is associated with the channels of the endoplasmic reticulum. The nuclear membrane controls the exchange of substances between nucleus and cytoplasm. The content of the nucleus is represented by the nuclear juice and immersed in decorated elements (chromatin, nucleolus). Nuclear juice (karyoplasm) is similar by physical and chemical hyaloplasm composition, but differs a high content of proteins and nucleic acids.

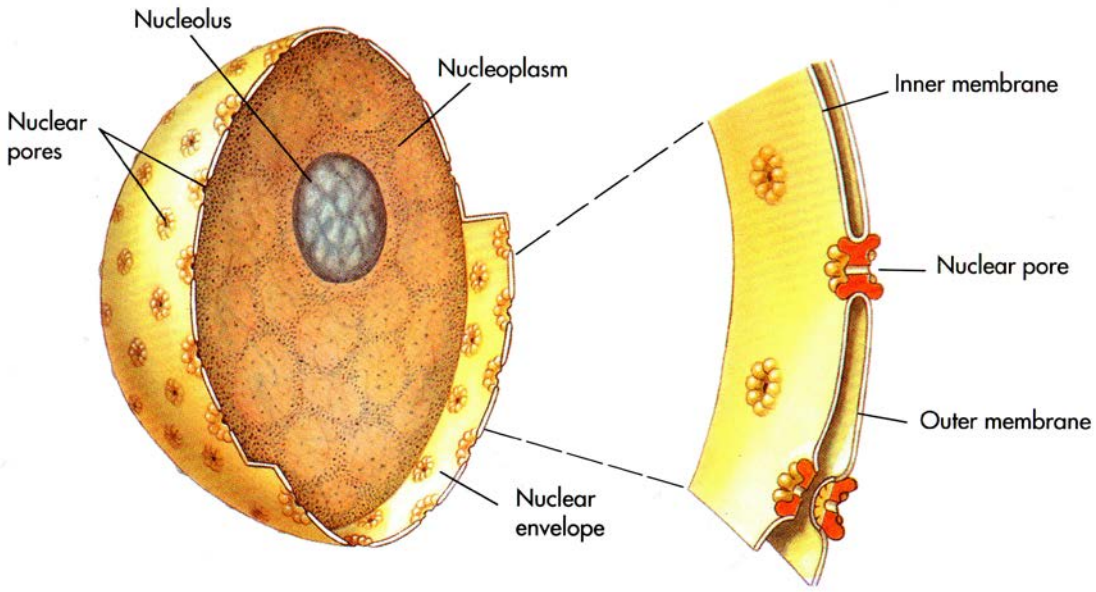


Figure 1.10. Nucleus, by Raven & Johnson.

Chromatin is the structural component of the nucleus during interphase in the formed network of fine threads, is a complex of DNA with histone proteins – deoxyribonucleoproteins (Figure 1.11).

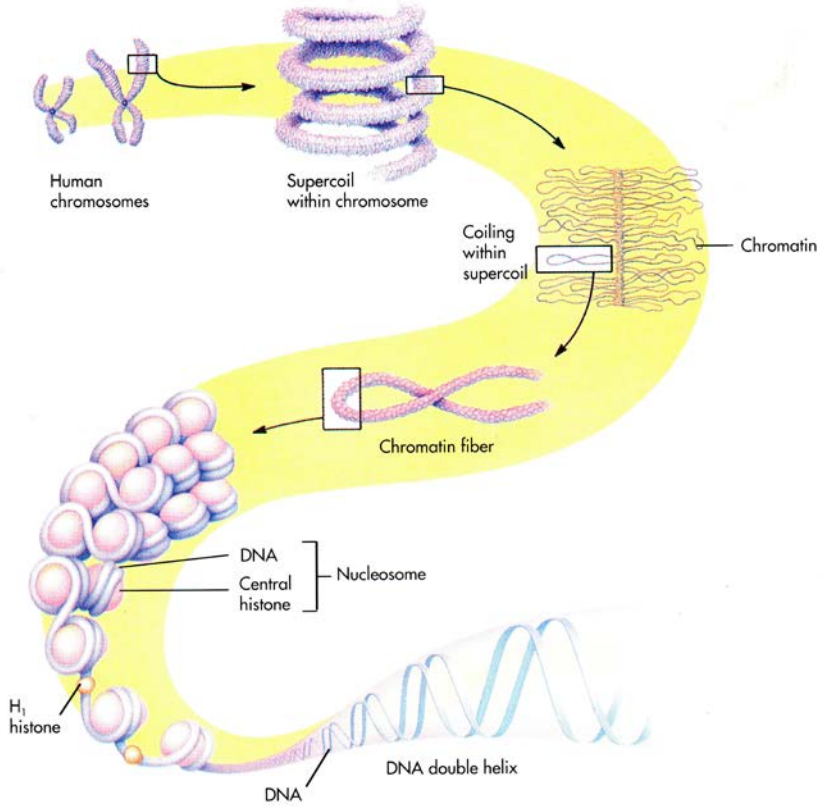


Figure 1.11. Levels of chromosomal organization, by Raven & Johnson.

During cell dividion chromatin fibers form chromosomes. It is the basic structural and functional elements of the cell nuclei which are the carriers of genes. Each chromosome comprises two copies of the longitudinal – chromatids connected in centromere or primary constriction. Centromere is a nondedicated chromosome section which is attached to the spindle thread. Primary constriction divides the chromosome into two arms – short and long (Figure 1.12). It can be four types of chromosomes: telocentric (without short arm) acrocentric (one arm is very long, more - much shorter) submetacentric (one arm is slightly longer than the other) and metacentric (arms of equal length) depending on the location of the waist. Sometimes can be formed and the secondary constriction (satellite) in the chromosome. Chromosomes are able to reproduce, exhibit structural and functional individuality and maintain it in a number of generations.

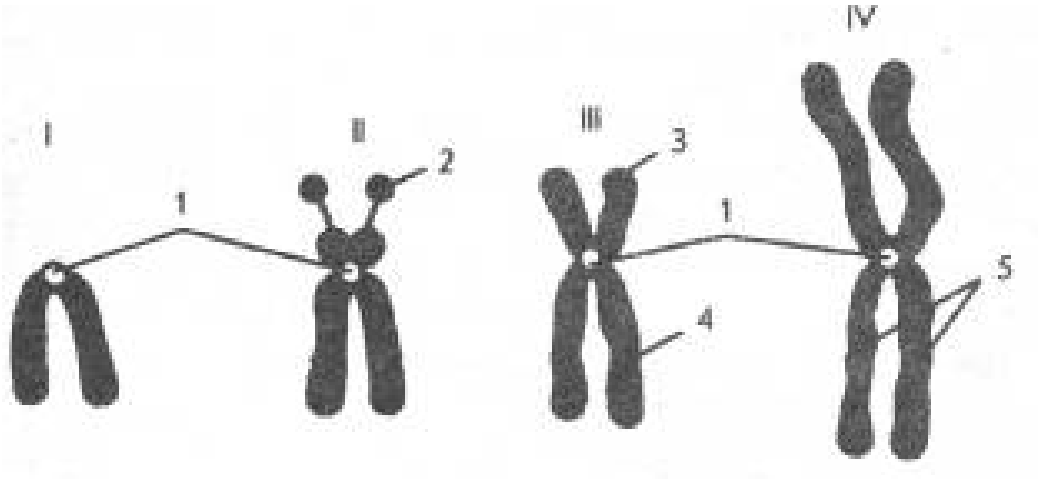


Figure 1.12. The chromosomes' shapes:
I - telocentric; II- acrocentric; III - submetacentric; IV - metacentric (1 — centromere; 2 - satellite, 3 -short arm, 4 - long arm).

All somatic cells of any organism contains a certain number of chromosomes, and it is strictly constant for each type of cell. The number of chromosomes in the somatic cells is always diploid (2n), because they are formed by the merger of two sex cells having single - haploid (n) number of chromosomes.

Nuclei is round, highly compacted areas of the nucleus. At the nucleus can contain from one to ten nucleoli. Nucleoli are formed 80% protein, at 10-15% – r-RNA, and a small amount of DNA, and others chemical components. During fission nucleoli are destroyed, and at the end of the newly formed division around a certain area of the chromosome (nucleolar organizers). Nucleoli control the synthesis of ribosomal RNA. The nucleolus is an association of

RNA to protein, thereby forming precursors of ribosomes – ribonucleoproteins that disputes over the nuclear membrane move to the cytoplasm. It ends with the formation of ribosomes. The nucleolus is the center of RNA synthesis and self-assembly of ribosomes.

1.1.2 Chemical organizing of cells

Plant and animals cells are very similar to that proves the unity of their origin in chemical composition and structure. In the cells of living organisms are found about 90 elements of Mendeleev system. They devides into three groups: macronutrients (oxygen, carbon, hydrogen, nitrogen components in the amount of 98% content of cells), trace elements (magnesium, sodium, ferrum, potassium, calcium, sulfur, phosphorus, chlorine, to their proportion is about 1.9%) and ultramicroelements (zinc, copper, iodine, fluorine, bromine, gold, silver, aluminum, and other - less than 0.1%). All these elements are part of organic and inorganic substances of the living organism.

Water and mineral salts are inorganics substances in a cell. Content of water in the body ranges from 40-95%, depending on the physiological activity of a cell. This water can be in two forms - linked (4-5%) and free (about 95%). First forms due to the formation of hydrogen bonds with water molecules of the protein when the protein molecules around forms water (solvation) shell that do not let to aggregation of protein molecules. Free water plays the role of a universal solvent. It is solutes salts, proteins, carbohydrates, etc. (Figure 1.13).

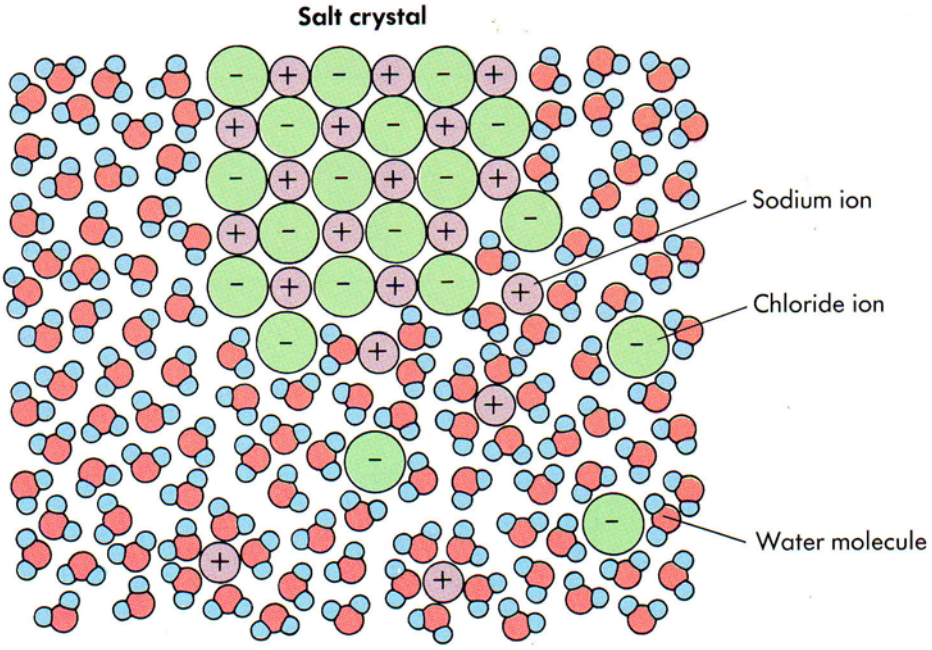


Figure 1.13. Why salt dissolves in water.

Relative to the water substances are divided into hydrophilic or soluble (mineral salts, alkalis, acids, simple carbohydrates and other alcohols) and hydrophobic or insoluble (starch, fat, cellulose, etc.). Besides water, solvents in the cell may be fats, alcohols, through which it receives fat-soluble vitamins (A, D, E, etc.). Water is active participant chemical reactions in the cell. It is also necessary to remove cells from the liquid product exchange. As natural substance water has a high heat capacity, heat conducting, thanks to the cytoplasm of cells and the organism as a whole are protected from overheating.

The intensity of metabolism in cells is directly depends on the amount of water in it. For example, in organs with intense metabolism (brain, liver, kidneys, muscles) the water is 70-80%. Water content of the cells is decreases by reducing the metabolic rate due to the aging of an organism or cell anabiosis.

Mineral salts are necessary for normal cell life. In the dissociated state in the cytoplasm are the chlorides of sodium, potassium, calcium and magnesium carbonates and sodium, potassium and calcium; salts of nitric, sulfuric and phosphoric acids. Mineral salt supports the acid-alkaline balance of cytoplasm and tension (turgor) of cell membranes, affect the excitability of nerve and muscle tissue, activating enzymes. Phosphorus and calcium carbonates are part of the vertebral bone, shellfish exoskeleton of crustaceans. High levels of potassium in the body have a toxic effect on the heart and other muscles. The function of several organs is disrupted when low level of potassium in the cells.

Potassium, sodium, calcium affects cell membrane permeability and the water level in the tissues.

Organic substances cell include proteins, carbohydrates, fats, nucleic acids, ATP.

Proteins are organic macromolecular compounds consisting of amino acid residues. The molecular weight of proteins varies from 10,000 to many millions of units. There are simple (albumin, globulins, histones) and complex proteins, representing a compound protein with carbohydrates (glycoproteins), fats (lipoproteins) and nucleic acids (nucleoproteins). Amino acids are the structural units of proteins. Each amino acid consists of a hydrocarbon radical and connected thereto a carboxyl (-COOH) and amino (-NH2) groups. Aminoacids have both acidic and alkaline properties. Using peptide linkages (-CO-H-) amino acids joined to each other in the polypeptide chain, whereby water is released (Figure. 1.14). Compound of two amino acids is called a dipeptide, three – tripeptide, a few tens or hundreds of aminoacids – polypeptide.

Polypeptides are formed protein molecule. It usually consists of several polypeptides.

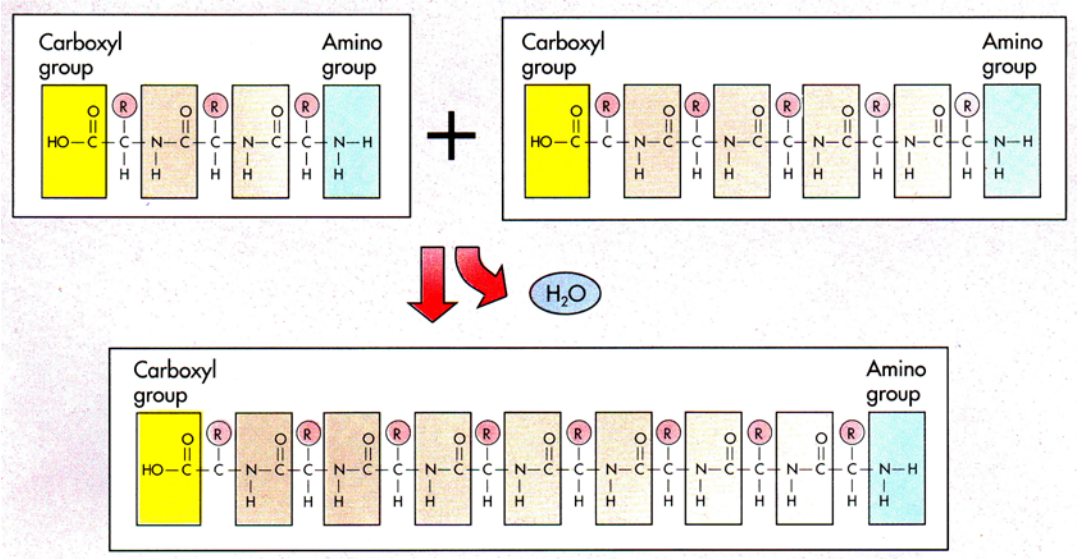


Figure 1.14. Peptide bond, by Raven & Johnson.

Polypeptide chains are primary, secondary, tertiary and quaternary structure of the protein molecule depending on the spatial configuration. Primary structure is a sequence of amino acid residues in the polypeptide chain. It is specific for each protein determines all his properties and functions encoded by the genetic information of DNA. The secondary structure is determined by hydrogen bonds that occur between the two peptide groups one (helical configuration) or two polypeptide chains. The secondary structure characteristic of fibrillar proteins (fibrinogena, collagen, silk fibroin). Tertiary structure formed as a result of the conversion of helical and non-helical regions of the polypeptide chain into three-dimensional formation of spherical (globule). It appears in result arises between the side chains of amino disulfide, ionic and hydrogen bonds, or as a result of hydrophobic interactions. Globular structure typical of all essential proteins. The quaternary structure is formed by combining of some individual protein molecules in a single system. It is characteristic of regulatory proteins such as hemoglobin (four globules and complex geminov group with iron ion) chromoproteids (compound chlorophyll protein) and others.

Nucleoproteids (complex of protein and nucleic acid – DNA or RNA) are complex of proteins which has a special significance in the life of the cell. Nucleoproteins are mandatory components of the nucleus and cytoplasm of all plant and animal cells. The structure of the protein molecules is disturbed under the influence of various chemical (heavy metals, alcohol, acetone, acids,

alkalis) and physical (high temperature, radiation, ultraviolet and X-rays, ultrasound, high pressure) factors. This process is called protein denaturation; more often it is reversible. When irreversible denaturation of proteins loses their properties, cell metabolism stops, and the cell dies.

Proteins in the cell perform structural, reduce, enzymatic, signaling, safety, energy and transport function. They are part of the cytoplasm, plasma membrane, membranes, organelles, chromosomes, horny substance as a building material. Reduce function are special proteins - actin and myosin are available in all the muscles, flagella, cilia. Actin is typically in the form of globules, but in the presence of potassium chloride and ATP takes form of filaments. Contractile function is achieved by the interaction of actin and myosin when ATP is present. The filaments penetrate between one protein and another fiber strands shortening. Contractile function of proteins provides irritability and cell movement. The enzymatic function of proteins due to protein enzymes that catalyze chemical reactions in the cell synthesis and decomposition of substances. Signal functions of proteins is carried out thanks to ability to change its structure under the influence of physical and chemical factors. The protective function is the ability to form special protein antibodies in response to the intake of foreign antigens. Transport function provides by ability of soluble proteins of blood, lymph and interstitial fluid carry organic and nonorganic substance to the tissue cells. In some cases, proteins serve as a source of energy (1 g protein allocates 17.6 kJ).

Carbohydrates are organic compound in which includes carbon, hydrogen and oxygen. Carbohydrates divides into monosugars, disugars and polysugars. Monosugars are simple sugars, consist of three or more carbon atoms (triose, pentose, hexose, etc.). Typical representatives of monosugars are glucose, fructose (redundant solutes), ribose and deoxyribose (structural elements nucleic acids). Disugars are formed from two molecules of monosugars with separation of the water molecule (sucrose, lactose, maltose, etc.). Polysugars are synthesized by polymerize monosugars also release water molecules. These include starch, glycogen, cellulose. Glycogen molecule comprises from 5,000 to 500,000, and cellulose - from 500 to 36,000 glucose units.

Carbohydrates are produced in plants in photosynthesis and used for the biosynthesis of amino acids, fatty acids, glycosides, etc. In addition, they serve as a source of energy (1 g allocates 17.6 kJ) are deposited in the stock in the form of glycogen (in animals) and starch (in plants). Cellulose, chitin are components of the cell walls, where they perform a support function. In

conjunction with the protein part of the carbohydrate of bones, ligaments and tendons.

Fats or lipids are esters of glycerol and higher fatty acids (oleic, stearic, palmitinov et al.). The fats are the main source of energy in the cell (1 g fat gives 37.6 kJ). Fats of cytoplasm dissolve some vitamins (A, D, E, K), accumulate in the subcutaneous fat, which makes protective and heat-insulating function. There can be simple lipids, or triglycerides, and esters, which are composed of simple lipids which form complex protein (lipoprotein), carbohydrates (glycolipids), phosphoric acid residues (phospholipids) and others. Fats can be of two types – saturated and unsaturated (Figure 1.15). The complex lipids are part of cellular membranes, nerve cells, egg yolk and so on.

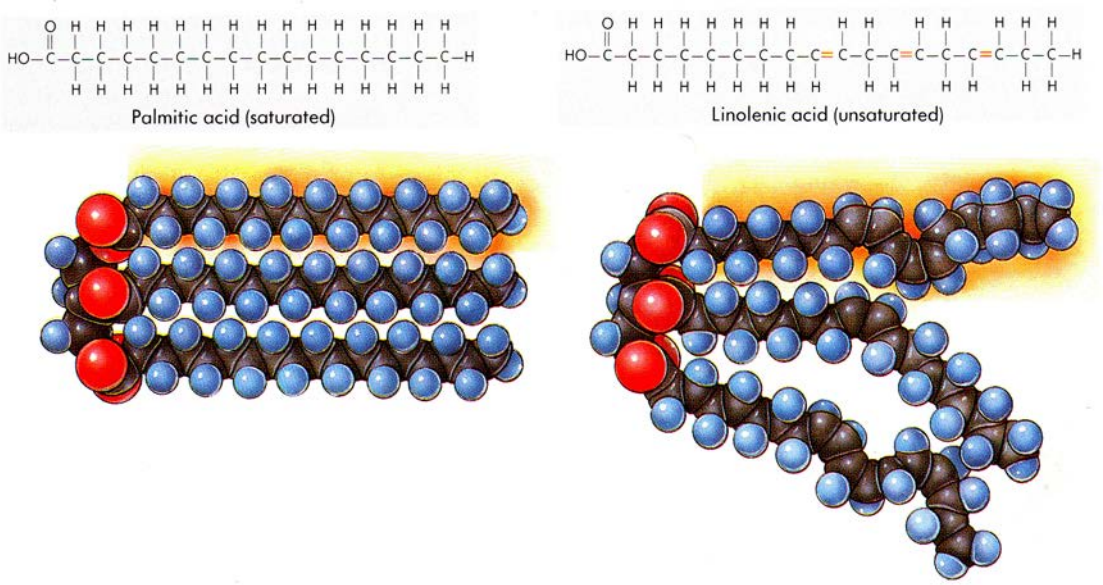


Figure 1.15. Saturated and unsaturated fats, by Raven & Johnson.

Nucleic acids are organic macromolecular compounds, storing and transmitting hereditary information. Distinguish deoxyribonucleic (DNA) and ribonucleic acid (RNA). Nucleic acid was first described in 1868 by F. Miescher, however model DNA was offered only in 1953 by George Watson and Crick. Monomer of nucleic acid is a nucleotide comprising an organic base, 5-carbon sugar and a phosphate group (Figure 1.16). Organic bases are adenine, thymine, guanine, cytosine and uracil, 5-carbon sugars – ribose and deoxyribose. Nucleotides are called on member of those nitrogenous bases. The structure of DNA nucleotides contains of carbohydrate deoxyribose and composition of nucleotides in the RNA – ribose. DNA contains four types of nucleotides: adenine (A), thymine (T), guanine (G) and cytosine (C); RNA - also four, and three of them are the same as in the DNA instead of thymine

nucleotides it contains uracil (U). Nucleotides are interconnected to form a polynucleotide chain by covalent bonds that arise between a carbohydrate and a single nucleotide residue of phosphoric acid of another.

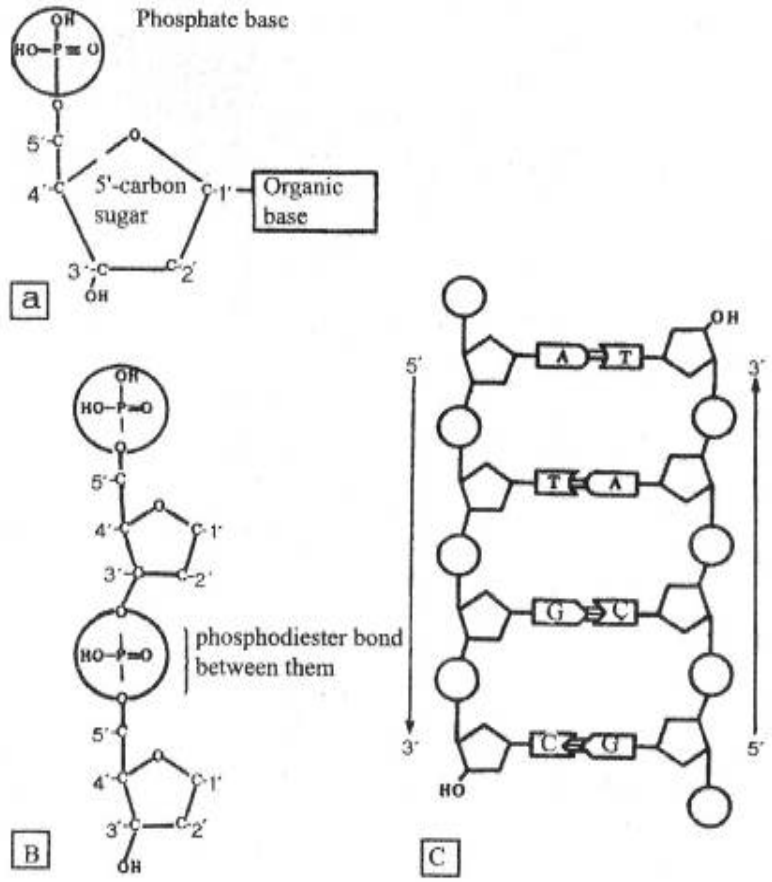


Figure 1.16. The Structure of nucleic acids:
a - nucleotide structure, b - nucleotide linkage to polymer chain, c - scheme of DNA molecule structure, by V.N. Yarygin.

The DNA molecule consists of two polynucleotide chains and is a double helix. Nitrogenous bases of each polynucleotide chains are located opposite each other on the principle of complementarity. Adenine is complementary to thymine and connects him by two hydrogen bonds, and guanine - cytosine forming three hydrogen bonds (Figure 1.17).

DNA is localized in the cell nucleus, a part of the chromosomes in the form deoxyribonucleoproteins. In addition, the DNA contained in the matrix of mitochondria and plastids. The most important property of DNA is its ability to self-doubling or replication. DNA synthesis occurs in a certain point of life cycle of cells, typically in preparation for the division. The DNA synthesis based on the principle of complementarity. Under certain conditions and the presence of the enzyme DNA polymerase DNA molecules begin to untwist which is accompanied by the release of hydrogen bonding and exposing the

substrates. Cells always have free nucleotides which strict accordance with the principle of complementarity to begin adds free base. As a result, each of the parent DNA molecules produced two new chains with the same nucleotide composition. Every strand of DNA is a matrix, so it is called the doubling of matrix synthesis.

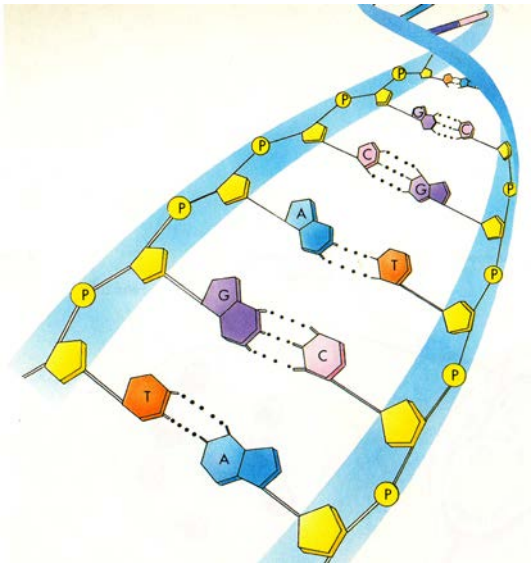


Figure 1.17. DNA Base pairing.

The RNA molecule consists of a single polynucleotide chain. There are three types of RNA – matrix (m RNA), transport (tRNA) and ribosomal (rRNA). They differ in molecular size, structure and functions. All RNA species is a copy of sections DNA except viral synthesized DNA molecule. Matrix RNA is about 5% of cell RNA. It carries information from DNA molecules to ribosomes where the information is realized with the protein biosynthesis. The RNA molecules and include from 300 to 3000 nucleotides. TRNA transports the amino acids during protein biosynthesis and is approximately 10% of total cell RNA. Its molecule consists of 70-100 nucleotides (Figure 1.18). These RNA are not bound to any particles. While realization of genetic information each of tRNA bind and transfer specific amino acid. The complementary bindings of pairs make a "clover leaf-like" structure. There are four parts in this structure which carry out different functions. The first is accepting part, made by two complementary bounded terminal parts. It is consist of 7 base pairs. Each amino acid in the cytoplasm of cells transferred specific m-RNA. Polynucleotide chain of tRNA has the shape of a clover leaf. Ribosomal RNA is a part of the ribosomes. It accounts for 90% of the total mass of the cell RNA. Molecule rRNA combines up to 3000-5000 nucleotides.

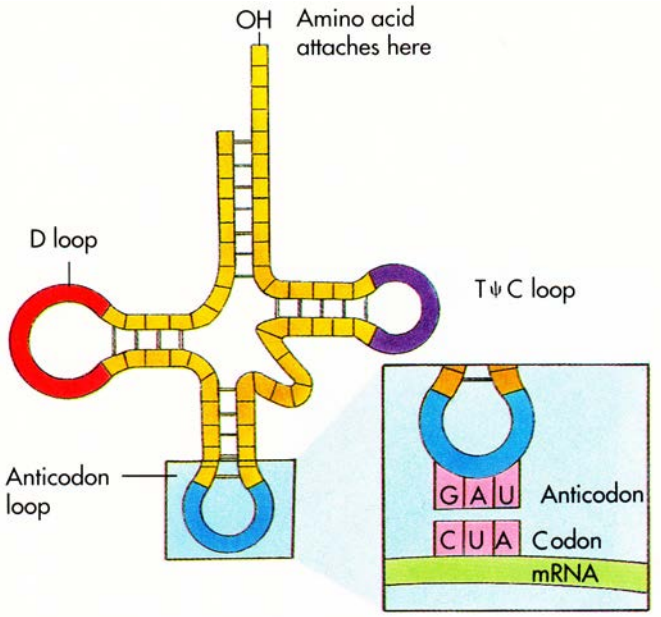


Figure 1.18. Structure of tRNA molecule, by Raven & Johnson.

Adenosine triphosphate (ATP) is mononucleotide containing adenine, ribose and three phosphoric acid residue. The phosphate group of ATP interconnected high energy bonds. If ATP hydrolysis is one such bond pays 25 kJ/mol. Thus ATP becomes adenosine diphosphate (ADP). Upon further hydrolysis ADP to adenosine monophosphate (AMP), this also goes with release of energy.

1.1.3 Metabolism

Metabolism is a totality of chemical reactions of the cell biosynthesis (assimilation) and dissimilation underlying the functioning of the body and ensuring its relationship with the environment. Metabolism is based on the processes of plastic and energy exchange, aimed at continuous updating live. Plastic metabolism, or assimilation is a set of synthesis reactions aimed at structural parts of cells and tissues formation. It is protein biosynthesis, photosynthesis, the synthesis of fats and carbohydrates. Protein biosynthesis is one of the most important and character properties of living cells. Primary structure of nucleus, as mentioned, determined by the genetic code, incorporated in the DNA molecule, the different portions there of encoding the synthesis of various proteins. So, one DNA molecule stores information about the structure of many proteins. The properties depend on protein amino sequence location in the polypeptide chain. In turn, the alternation of amino acids is determined by the sequence of nucleotides in DNA. The mRNA

corresponding to a particular amino acid of every triplet is group of three nucleotides, called a codon (Table 1.1).

Table 1.1. Genetic code iRNA

1st letter	2 nd letter				3rd letter
	U	C	A	G	
U	PHENYLALANINE	SERINE	TYROSINE	CYSTEINE	U
	PHENYLALANINE	SERINE	TYROSINE	CYSTEINE	C
	LEUCINE	SERINE	STOP	STOP	A
	LEUCINE	SERINE	STOP	TRYPTOPHAN	G
C	LEUCINE	PROLINE	HISTIDINE	ARGININE	U
	LEUCINE	PROLINE	HISTIDINE	ARGININE	C
	LEUCINE	PROLINE	GLUTAMINE	ARGININE	A
	LEUCINE	PROLINE	GLUTAMINE	ARGININE	G
A	ISOLEUCINE	THREONINE	ASPARAGINE	SERINE	U
	ISOLEUCINE	THREONINE	ASPARAGINE	SERINE	C
	ISOLEUCINE	THREONINE	LYSINE	ARGININE	A
	START-METIONINE	THREONINE	LYSINE	ARGININE	G
G	VALINE	ALANINE	ASPARTIC ACID	GLYCINE	U
	VALINE	ALANINE	ASPARTIC ACID	GLYCINE	C
	VALINE	ALANINE	GLUTAMIC ACID	GLYCINE	A
	VALINE	ALANINE	GLUTAMIC ACID	GLYCINE	G

Gene is all triplets of DNA carrying information about the structure of a protein molecule. Protein biosynthesis begins with a nucleus of debiting information about the structure of the protein molecule with DNA and RNA on the principle of complementarity. This process occurs as a reaction of matrix synthesis and transcription (Figure 1.19).

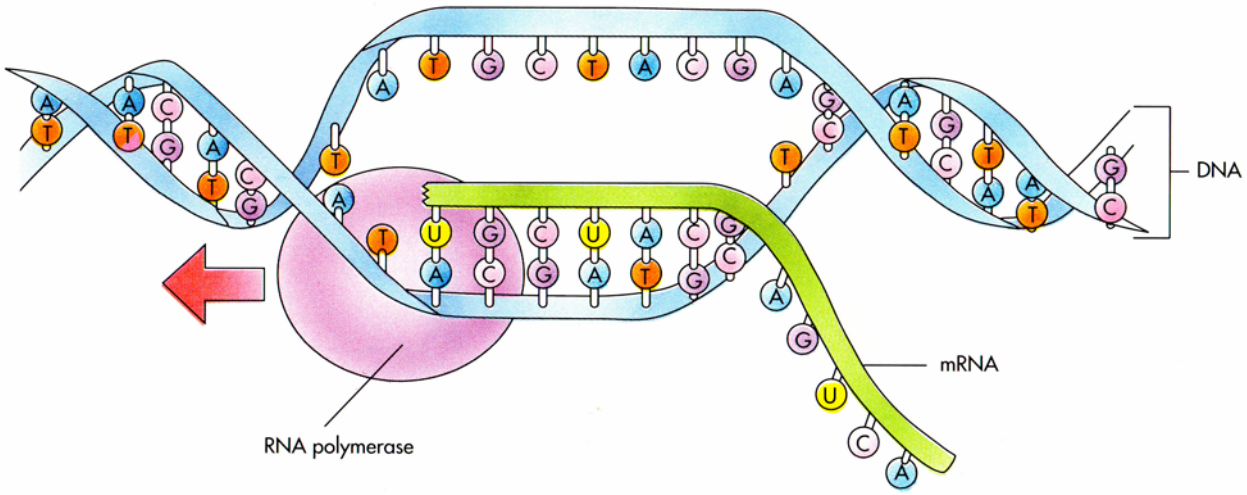


Figure 1.19. Transcription, by Raven & Johnson.

The molecule resembles a tRNA cloverleaf structure, on top of which is a triplet of nucleotides same code particular amino acids (anticodon) and base ("stalk") serves as the point of attachment of the amino acids (Figure 1.20).

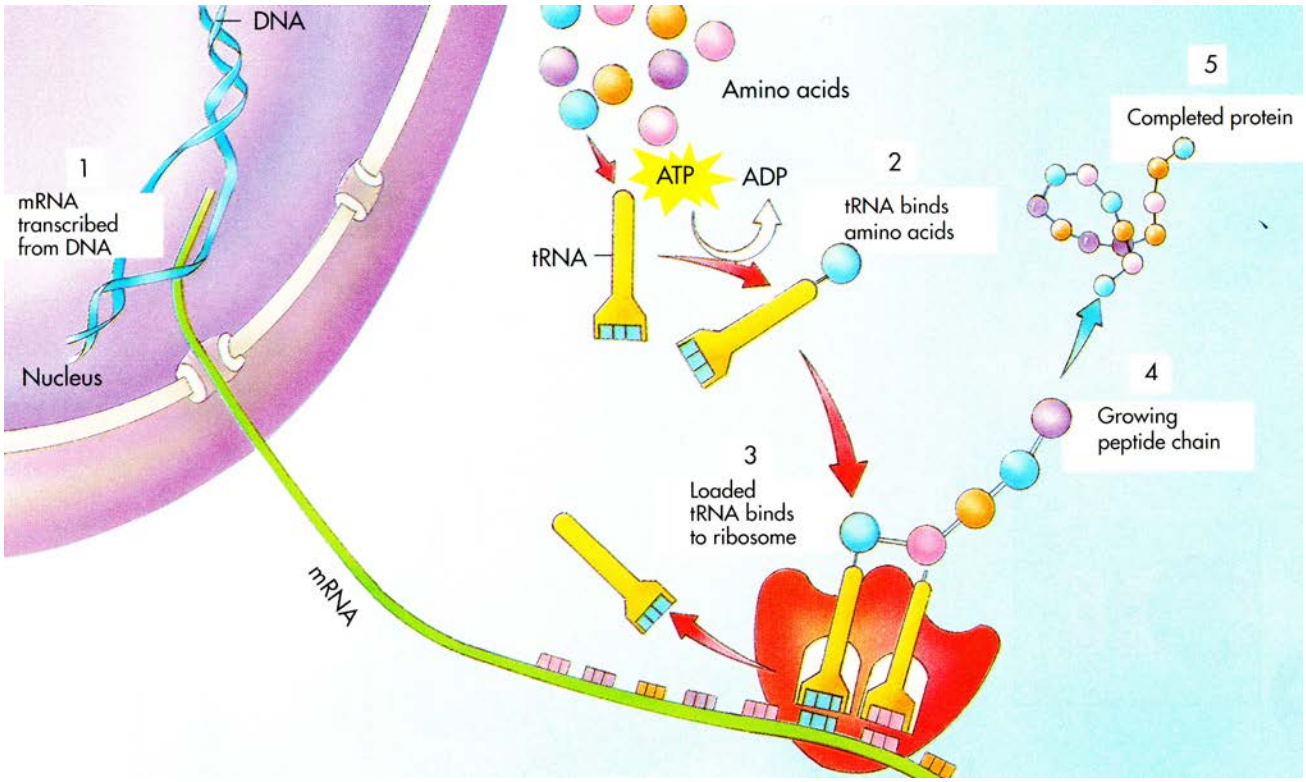


Figure 1.20. Overview of protein synthesis, by Raven & Johnson.

Transport delivers aminoacids RNA to ribosomes. Anticodon binds to its codon and amino acid located in the active site of the ribosome and with enzymes coupled with the previously amino acids according to the principle of complementarity. Then, the tRNA is released from amino acids and RNA molecules and is moving forward on a triplet, and the process repeats. So gradually increase the protein chain in which the amino acids are in strict accordance with the localization of coding triplets in the molecule and RNA. The synthesis of polypeptide chains from the matrix protein mRNA is called translation.

Photosynthesis is the process of converting energy of sun light into chemical energy flowing in the green leaves of plants that occurs due to the presence of photosynthetic chloroplasts pigments - chlorophyll and carotenoids (carotene, ksantofill). Chlorophyll carries light absorption, the primary energy storage and its subsequent conversion to chemical energy. Total process of photosynthesis can be written as follows:

$$6CO_2 + 6H_2O \xrightarrow{light} C_6H_{12}O_6 + 6O_2$$

There are light and dark phase of photosynthesis. Light phase begins with the absorption of a photon of the chlorophyll molecule. At the same time one of the electrons molecules becomes "excited" state flows into a higher orbit which joins the hydrogen ion (H^+) and restores it to a proton (H). Last connected to nikotinamiddinukleotidphosphat (NADP) - carrier of hydrogen and restores it to NADF. H2. There is a process of decomposition of water under the influence of light (photolysis). Hydroxyl ion (OH-) gives its electron and transformed into a radical (OH) which is connected to the other radicals forms water and free oxygen. Electronic returns from the hydroxyl molecule of chlorophyll and electron fills the place of the departed. Such appears energy for ATP synthesis. The result of light phase of photosynthesis is the formation of ATP, the release of oxygen and restoration of NADP to NADF H_2. Difficult enzymatic reactions occur during dark phase of photosynthesis. They are based on recovery of carbon dioxide molecules to organic compounds, carried out with the participation of products of light reactions. Carbon dioxide from the atmosphere in doing leaf through the stomata, have special substance - acceptor (for example, a five-carbon sugar - ribozodiphosphat), resulting in the formation of unstable substances fall into two molecules of acid phosphoroglicerins. Recently restored with the help of products of light reactions – NADF H_2 and ATP. Eventually, through a series of intermediates are formed carbohydrates (mono-, di- and polysugars) and other organic compounds (proteins, fats, organic acids).

Optimal conditions for photosynthesis are:

- sufficient light, achieved at a certain density planting (note the difference in need of light light-loving and shade-loving plants);
- sufficient soil moisture, depending on correct irrigation needs of plants in the moisture;
- normal concentration of carbon dioxide in the air (increasing its concentration disrupts the breath);
- sufficient mineral nutrition of plants, provides the best course of metabolic reactions.

Energy metabolism, or dissimilation, the set of decomposition reactions (including glycolysis, fermentation, respiration), accompanied excretory of energy. It takes place in three stages.

The first step (preliminary) is occurs in the cytoplasm of plant cells, protozoa, in the digestive tract of animals and human. Nutrients under the

influence of digestive enzymes are broken down into monomers: proteins – into amino acids; carbohydrates – to monosugars; lipids – to fatty acids, alcohols and aldehydes; nucleic acid – nucleotide. As a result, a small amount of energy is dissipated as heat. At this stage there is no ATP synthesis.

The second stage (anaerobic) takes place in the cytoplasm of cells (Figure 1.21). Monomers formed in the first stage are further splitting the absence of oxygen to form energy. For example, one molecule of glucose is enzymatically cleaved by to two molecules of pyruvic acid. Two molecules of ATP synthesizes from adenosine and phosphoric acid. In plant cells, and in some yeasts is glucose decomposition by alcohol fermentation.

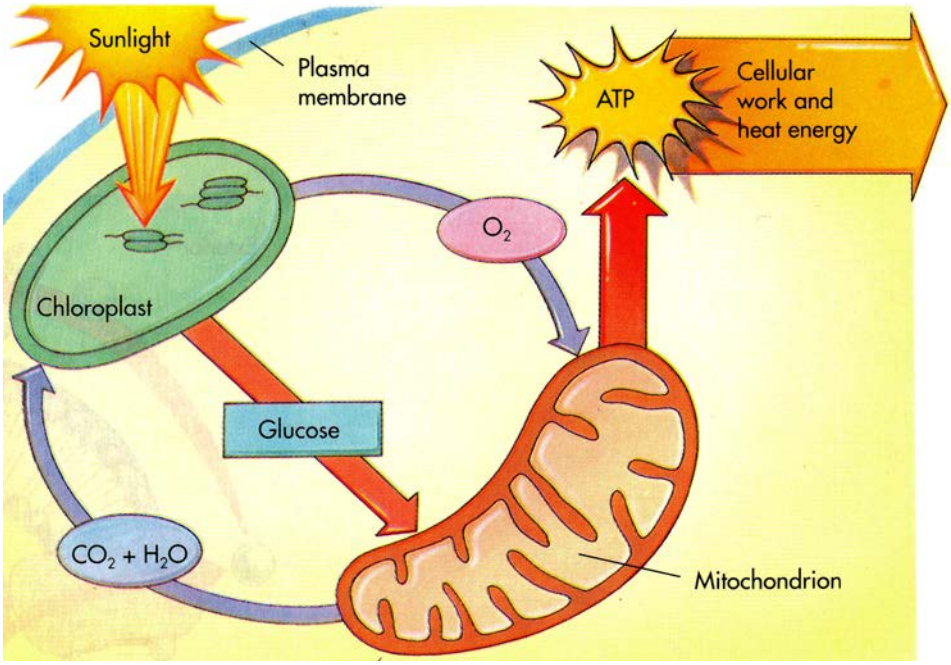


Figure 1.21. Overview of aerobic metabolism, by Raven & Johnson.

Third stage (aerobic) - ensure subsequent cleavage of organic materials to the final products with oxygen takes place in the mitochondria (Figure 1.22). As a result of further oxidation of pyruvic acid are formed of carbon dioxide and water. This releases energy, which is stored in the form of 36 molecules of ATP.

From one molecule of glucose formes 38 molecules of adenosine triphosphate. ATP is quickly restored in the cell. For example, a person every molecule of ATP synthesized and divides again in 2400 once a day. The average life expectancy of ATP less than a minute. When dissimilation split not only carbohydrates, but the breakdown products of proteins, fats and other complex compounds. Thus, amino acids are cleaved to

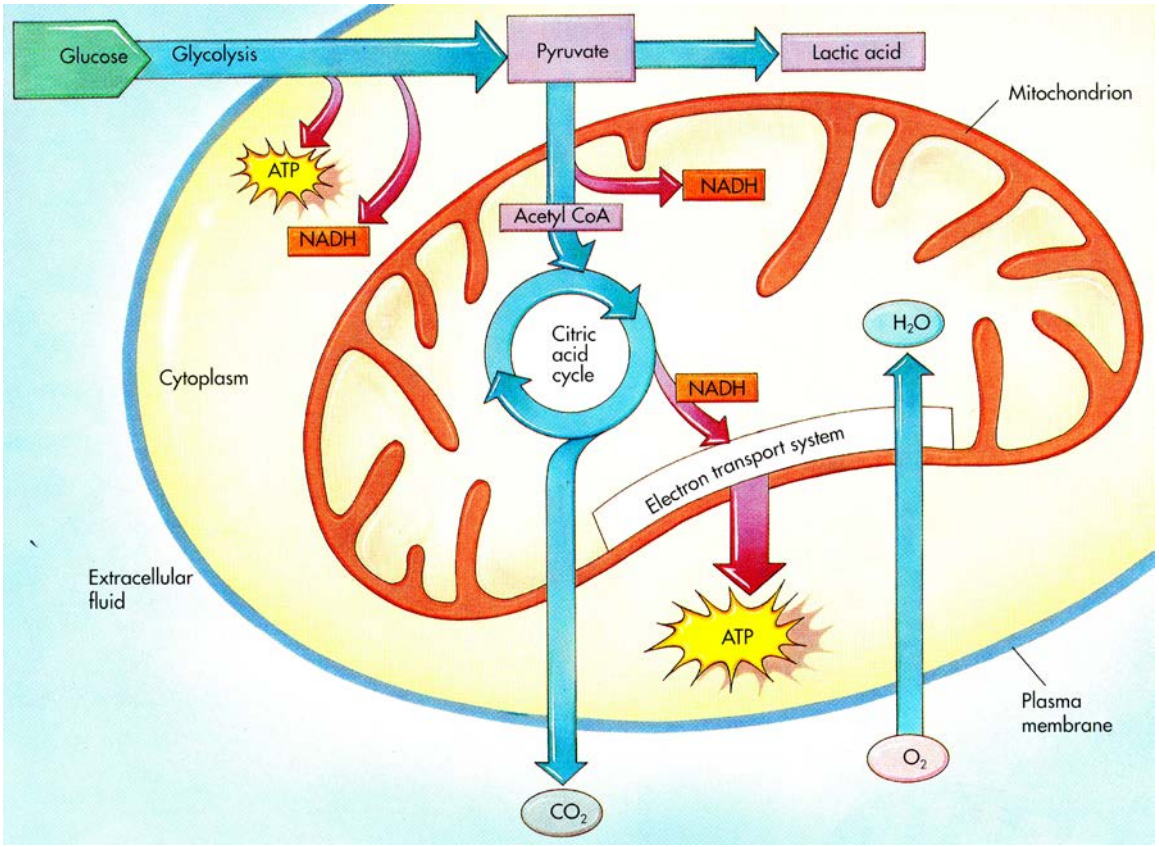


Figure 1.22. Overview of cellular respiration, by Raven & Johnson.

dioxyde carbon and water and to the nitrogenous substances coming from the synthesis of urea vertebrates. Dissimilation usually occurs as a result of oxidation reactions and hydrolitic and proceeds as in absence of oxygen (anaerobic glycolysis, fermentation) and at its participation (aerobic pathway - respiration).

1.1.4 Cell division

An important feature of the cell as a living system is its ability to reproduce (divide) which is the basis of growth, development and reproduction of organisms. The period from the end of one division before next called life or the cell cycle. For highly specialized (differentiated) cell life cycle lasts from the moment of formation of the cell until its death. In the life cycle of cells distinguish two periods: the first – the period between the divisions – interphase, when the cell grows and prepares for division; the second – the period of division.

The interphase is a series of major physiological processes: DNA replication, doubling the number of chromosomes, education chromatin spindle protein, ATP synthesis, biomass growth cells. In interphase distinguish three periods:

– presynthetic (G_1) – the cells grow, synthesis of RNA, proteins, ATP, but DNA synthesis occurs; cell contains a diploid set of chromosomes (2n), which is represented every of one chromatid;

– synthetic (S) – comes into cells DNA synthesis, each chromosome completes chromatid missing, as a result the number of chromosomes is 2n;

– postsynthetic or predmitotic (G_2) – proteins of the mitotic apparatus are synthesized in the cell, there is a doubling of the centrioles, accumulated energy, the number of chromosomes (2n) is maintained.

Followed by cell division, which may be indirect (mitosis) or direct (amitosis).

Mitosis is method of cell reproduction which leads to the formation of genetically equivalent cell chromosomes and continuity in several generations. Mitosis can be of two kinds: the actual mitosis and meiosis. There are four phases of this process: prophase, metaphase, anaphase, telophase (Figure 1.23).

At prophase the volume of the cell nucleus increases. The cell rounds: reduced or even terminated its functional activity. Centrioles diverge toward the poles. Chromosomes spiralized, become thicken and shorten, whereby the reading of genetic information from DNA molecules becomes impossible. At the end of prophase, the nuclear envelope dissolves and the chromosomes randomly lie cytoplasm.

During metaphase chromosome helix reaches a maximum, they rush to the equator of the cell and being located at an equal distance from the poles to form a so-called equatorial or metaphase plate. At this stage of mitosis under a light microscope clearly shows that the chromosome is composed of two chromatids connected only in the region of the centromere. From centrioles which are located at the poles of the cell to the centromeres suitable thread spindle.

In anaphase each chromosome splits into two chromatids called daughter chromosomes. Threads spindle attached to the centromeres, cut and carry away the daughter chromosomes to the poles of cells. The duplicated chromatids in anaphase still differ in the interphase chromosomes to one ends of the cell. In telophase chromatids unwind and becomes despiralized. From cytoplasmic membrane structures formed nuclear envelope. During the formation of the

waist cell divides into two daughter. The daughter cells copy genetic information of the information contained in the mother cell.

During mitosis exactly evenly distributed genetic material between daughter cells, in result each of them gets a diploid number of chromosomes. The duration of the different periods of the mitotic cycle is different (from several minutes to several hours) and depends on several factors: tissue type, physiological condition of body, temperature, light, etc. chemical substances.

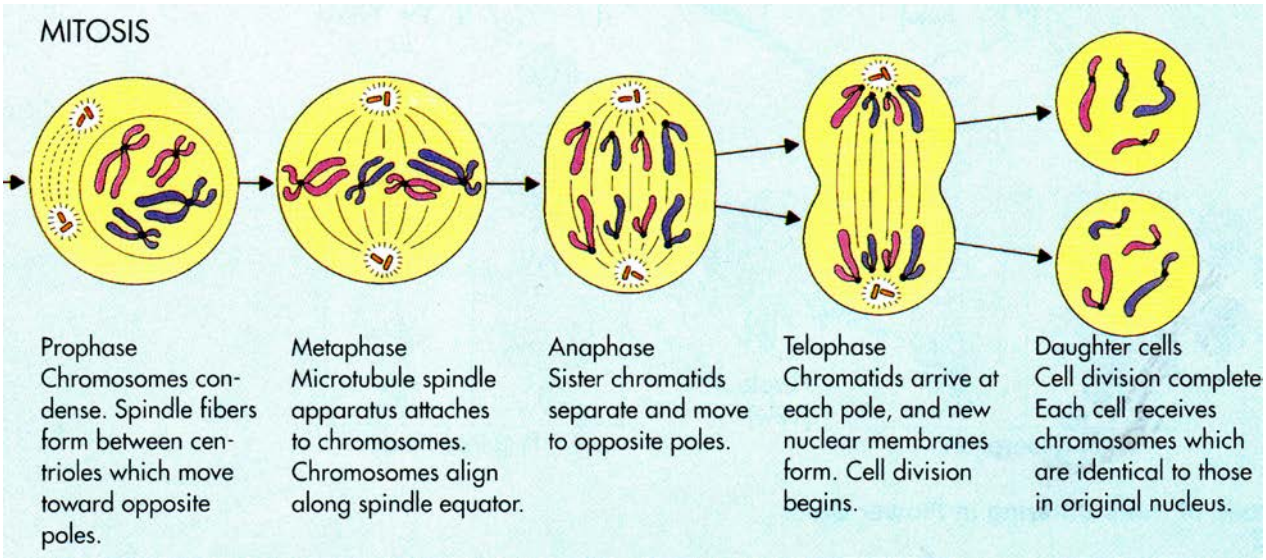


Figure 1.23. Mitosis, by Raven & Johnson.

Meiosis is a special form of mitosis in which cells of the diploid state transformed into haploid that is necessary for the recovery of conjugation of the diploid number of chromosomes. In higher plants during meiotic spores are formed, and in animals – gametes. Meiosis comprises two successive division (meiosis I and meiosis II) which distinguish the same phase as during mitosis (Figure 1.24). As a result of meiosis I (reduction division) number of chromosomes is reduced by half. Meiosis II (equational, or egalitarian division) keeps the haploid set of chromosomes. During meiosis I homologous chromosomes in prophase conjugated and share homologous regions. The process of naming was crossing over. In metaphase cells are located at the equator than individual chromosomes and a pair of conjugated chromosomes. In anaphase homologous chromosomes, each of which consists of two chromatids to opposite poles disperse. In telophase of meiosis each daughter cell receives a haploid set of chromosomes, and immediately begins meiosis II, so the DNA replication does not have time to occur and prophase can be very short or does not occur. In meiotic metaphase II chromosomes consisting of two

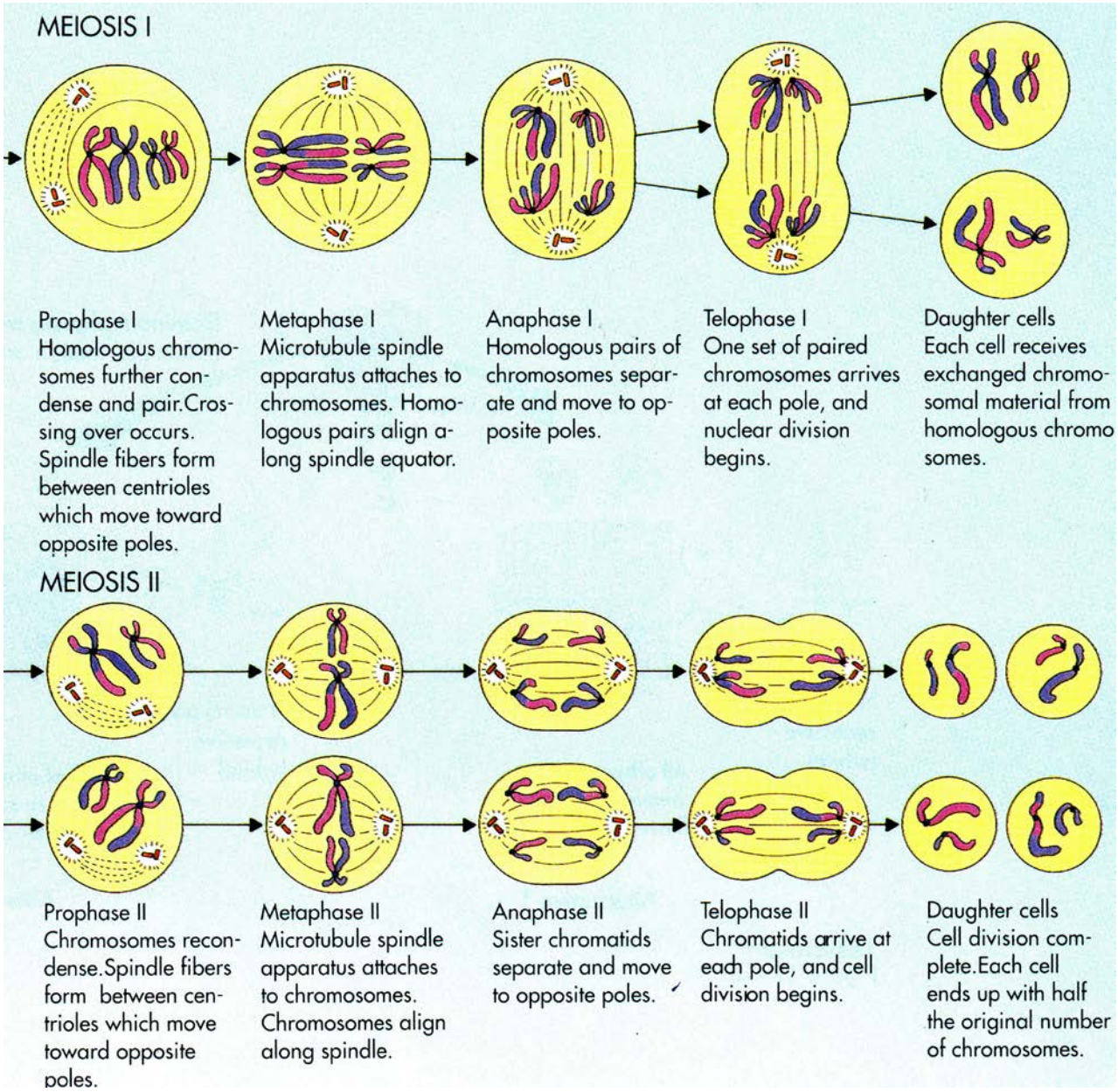


Figure 1.24. Meiosis, by Raven & Johnson.

chromatids are located in the equatorial plane, and in anaphase chromatids to opposite poles disperse. In telophase form four haploid cells. Thus, the role of meiosis is not only in that it leads to the formation of gametes from haploid set of chromosomes, but also causes sequential divergence of homologous chromosomes and chromatids, and crossover. All this leads to a variety of gametes with unique combinations of genes from "his father" and "mother" chromosome. Consequently, meiosis is a source of variability combinative having great importance in organic evolution.

Amitosis is direct division of interphase nucleus by the waist without the formation of chromosomes, followed by division of the cytoplasm of the cell

(Figure 1.25). Nucleus during amitosis initially divided into two or more parts without helix chromosomes then cytoplasm devides and form two or more new cells. This process is accompanied by a division of the cytoplasm or is limited only by fission. Consequently, as a result amitosis can form binuclear or multinuclear cells.

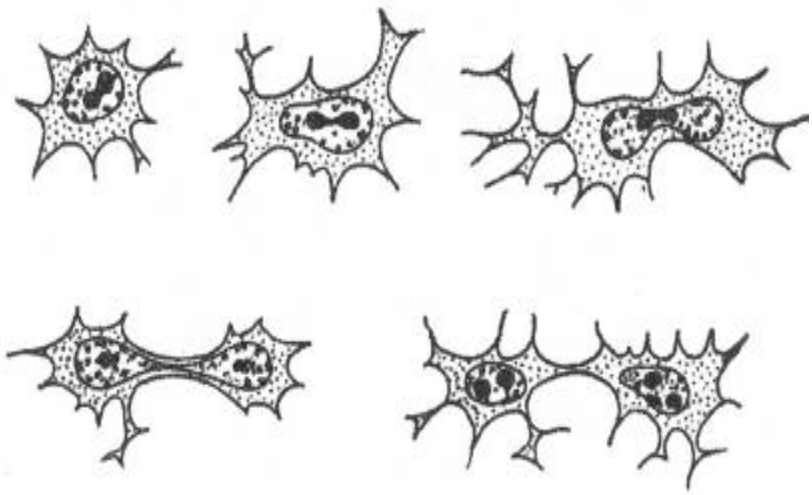


Figure 1.25. The amitosis: stages of division of mouse cell, by P.B. Gofman-Kadoshnikov.

Amitosis share simple, single-celled plants and some of the cells of multicellular animals (epithelial cells, liver and others).

1.2 Reproduction and individual development of organisms

The entire organism is composed of discrete units – cells. Its existence is maintained by cell division. Since each individual is mortal, the existence of species in nature is supported by parents organisms reproduction of new generations of individuals and their subsequent personal development. The ability to reproduce is an inherent property of any individual. On the basis of provided save each species and life itself in nature.

1.2.1 Reproduction

Reproduction of organisms is the property of a living organism to reproduce their own kind, to ensure continuity and continuity of life in a number of successive generations. There are two types of reproduction – asexual and sexual.

Asexual reproduction is the method of reproduction in which only one parent takes part by dividing its somatic cells form new individuals, genotype

identical to the original parent. Asexual reproduction includes vegetative reproduction and spore formation.

Vegetative reproduction is asexual reproduction type of organisms for which a new organism is formed from part of the parent. It is observed in fungi, plants and lower multicellular animals. In fungi and plants vegetative reproduction at the expense of the body performing the basic functions of nutrition and metabolism with the environment - the vegetative organs. These are the leaves and leaf stalks (have room violets, kalanchoe), stems and stem cuttings (for currants, gooseberries), slips (for raspberries), whiskers (for strawberries), rhizomes (from lily of the valley, valerian), tubers (the potato) bulbs (onions from, tulip), root cuttings (from cherries, plums). The vegetative reproduction in animals occurs by budding and fragmentation. In the first case, part of the body wall is gradually separated from the mother's body, and a new individual to take shape, and then segregated. Budding occurs in sponges, cnidarians.

With the fragmentation of the original specimen is divided into several parts and each of them is gradually supplemented to the whole organism. This method of vegetative propagation occurs in flat (dairy Planaria) and annelid worms. It is based on regeneration.

Spore formation is type of asexual reproduction in plants and a number of parasitic protozoa, capable of forming specialized cells – disputes, which develop during the germination of new individuals. Genotype they are exact replicates of the parent. In algae and fungi spores are formed by mitosis from any cell, the higher spore (spread Moss family, ferns) from diploid cells by meiosis in specialized multicellular bodies (sporangia). Disputes breed malaria parasites and some other protozoans.

Sexual reproduction is method of reproduction in which a new individual develops as a result of the merger of male and female sex cells. In this way, multiply all eukaryotes.

Sexual reproduction can be carried out by conjugation, copulation, parthenogenesis.

Conjugation is the convergence of two somatic cells and the formation of cytoplasmic bridges between them, through which the exchange of hereditary material, after which special expenses (ciliates), or merge both the cytoplasm of cells (algae, lower fungi). The number of animals does not increase, but it updates their hereditary material (Figure 1.26). After conjugation, individuals begin to reproduce asexually.

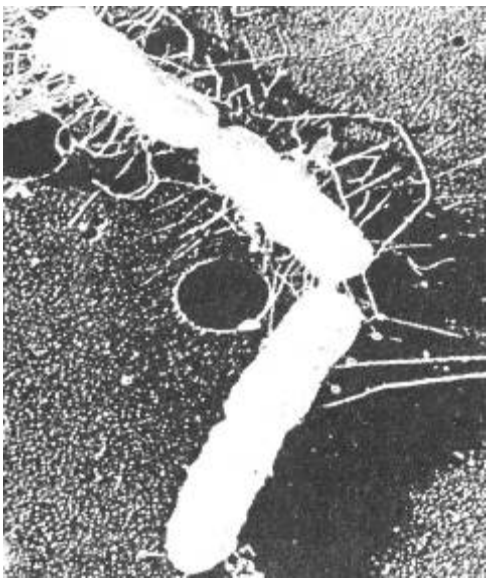


Figure 1.26.The electronic microscope photo of bacteria conjugation, by N.P. Dubinin.

Copulation is the merger of two of the same or different in shape, size and mobility of sex cells (gametes) – female (egg) and male (sperm). The formation of reproductive cells (germ line) occurs in the gonads through meiosis. The formation of male germ cells occurs in the testes (spermatogenesis), and women – in the ovaries (oogenesis). In gametogenesis distinguish four periods – reproduction, growth, maturation and formation (Figure 1.27). During the breeding season the primary germ cells through mitosis makes while maintaining the diploid number of chromosomes. In the period of growth they do not share, but increase in size. In the period of maturation primary germ cells divide by meiosis twice (the first and second maturation division), resulting in formation of the haploid germ cells. Recently during the formation it transformed into mature gametes. The processes of spermatogenesis and oogenesis in principle are the same, but between them there are differences.

Oogenesis does not have formation period. As a result, four of spermatogenesis sperm formation and oogenesis ends forming a single egg. This is due to the fact that the first and second division of oocyte maturation is not divided in half and separates the small, so-called of the guide (reducing) cells that are full chromosome sets, but virtually devoid of cytoplasm and soon die. The formation of these cells is aimed at preserving the maximum amount in the egg yolk needed for the future development of the embryo. Number of yolk depends on where the fetus develops. In mammals and human occurs in the uterus where the nutrients come from the maternal organism through the placenta, as their poor egg yolk. In fishes, amphibians, reptiles, birds and

shellfish embryo egg yolk contains much that is focused on one of the poles of the egg (vegetative) develops outside the mother's body.

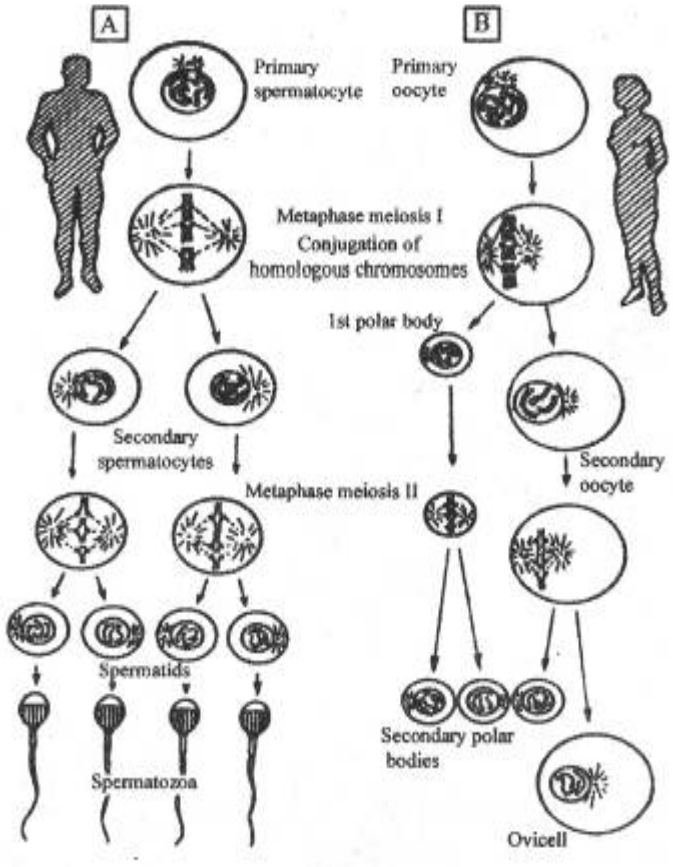


Figure 1.27. The spermatozoa (A) and ovicells (B) formation in human, by N.P. Dubinin.

The egg is oval, large, usually fixed cell having no organelles of movement and centrosomes. Spermatozoa consist of a head, neck, tail. The nucleus and the small amount of cytoplasm are concentrated in the head, neck located in the cytoplasm centrosome ATP.

A number of processes responsible for the meeting of sperm and egg is called insemination. There are external insemination (fish, amphibians) and internal (in reptiles, birds, mammals). In the first case gametes stand out in an aqueous environment, where it is their meeting, the second – with the help of the sperm entered the male copulative organs directly into the female genital tract. This increases the likelihood of fertilization and ensures the formation of the zygote in a relatively constant conditions.

Fertilization is fusion of male and female gametes to form a diploid zygote, where each pair of chromosomes is represented by the paternal and maternal chromosomes. During the development of wildlife sexual reproduction became

dominant in the plant and animal world, as compared to the asexual has a number of advantages. Firstly, it provides a large number of new species; secondly, if it is updated organisms in relation to the union maternal and paternal genetic information. This extends the adaptive capabilities of the new organisms in a changing environment, it is necessary in the struggle for existence.

Parthenogenesis is a form of sexual reproduction in which a new organism develops from an unfertilized egg. Observed in some animals (flatworms, some insects) and plants (Asteraceae, Solanaceae, cereals, etc.). The body's ability to reproduce is the basis of his individual development.

1.2.2 Individual development

Individual development, or ontogenesis, is the development of a living being from the moment of conception to death. There are two periods: embryonic and postembryonic.

Embryonic development is development period, starting from the moment of the zygote formation before the release of a new organism from the egg shells or before birth. It begins with the division of the zygote by mitosis, called fragmentation (Figure. 1.28). If it increases the number of cells of the embryo, and the size of each of them are reduced so that the total live weight of the fetus is not affected. The nature of crushing the zygote is dependent upon the number and location of yolk in the egg. For example, with a small amount of yolk is a full uniform crushing eggs lancelet, and mammals. Complete uneven crushing undergo egg yolk with a moderate amount, such as a frog. The eggs of other animals (fish, reptiles, birds) contain a lot of egg yolks, so they crushed only drive the cytoplasm to the nucleus, and the yolk is broken. When splitting a result of alternation of the longitudinal and transverse divisions consistently produced 2, 4, 8, 16, 32, 64, 128, and so on blastomeres and eventually formed the germ resembling the mulberries (morula).

The single layer of the hollow spherical embryo is end crushing blastula formation. Its walls called the blastoderm, and located inside the cavity – blastocoel (primary body cavity). The next stage of embryonic development – gastrulation (Figure 1.29). This process of formation of a single-layer double-layer of the embryo called the gastrula. Gastrula contain of two types of cells forming respectively two germ layers: the outer and – ectoderm, inner – endoderm. The opening into the cavity of the gastrula is called blastopore primary or mouth. In mollusks, arthropods and worms blastopore in the

formation of the adult organism turns into his mouth. Such animals are called protostomes. In echinoderms and chordates blastopore converted into the anus, and at the opposite end forms the mouth. It is deuterostome animals.

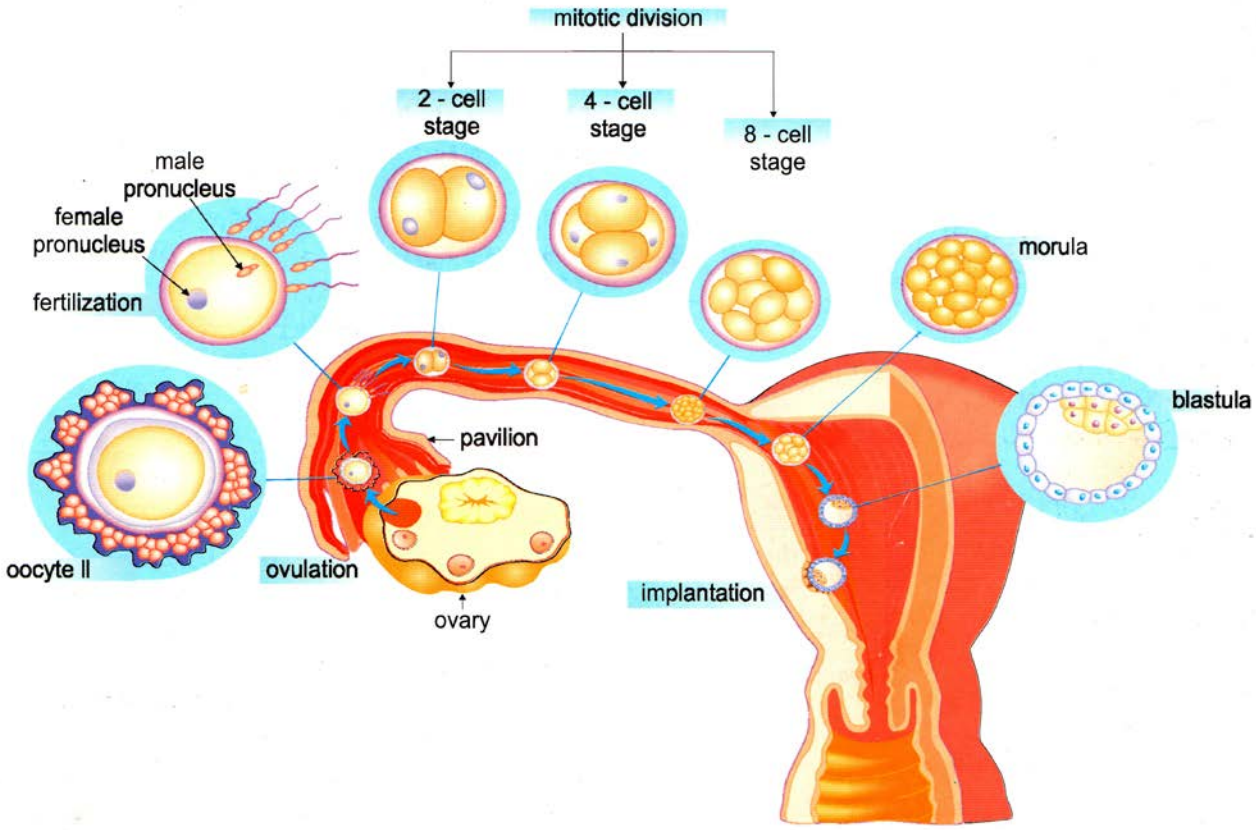


Figure 1.28. Reproduction and first stages of embryonic development.

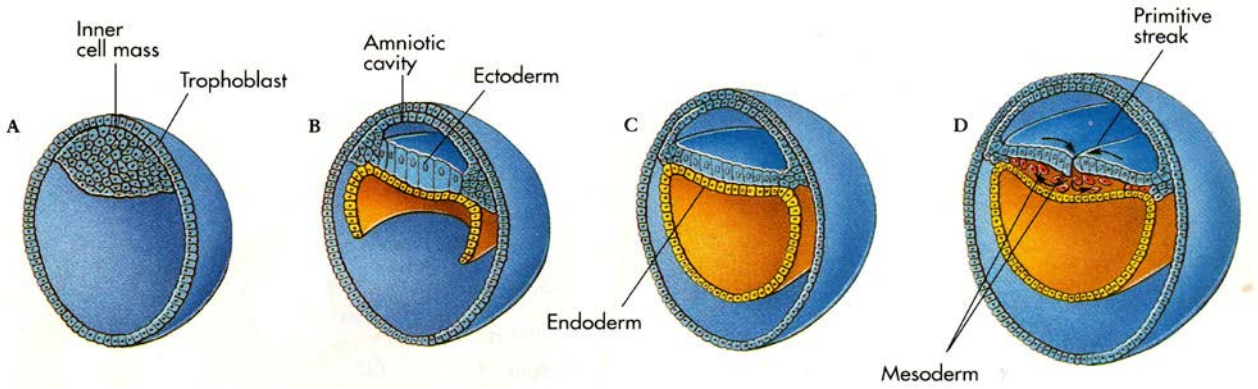


Figure 1.29. Mammalian gastrulation.

In stage two ends with the development of germ layers in coelenterates. The rest of the ectoderm and endoderm between due to the ongoing cell division embryonic endoderm forms the third piece - mesoderm. Differentiated into three germinal sheet material gives rise to all the tissues and organs of the

developing fetus. In vertebrates, the ectoderm formed from surface epithelium, nervous system and sense organs, from the endoderm – the intestinal epithelium, digestive glands, lungs, from the mesoderm – the skeleton, muscles, circulatory, excretory, and reproductive systems.

Postembryonic development is a period of development, starting with the release of a new organism from the egg shells or at birth from the womb of his mother and ending with natural death. Postembryonic development can be direct or indirect.

In the direct postembryonic development of an organism is a common newborn to an adult body plan, but are smaller and structural and functional immaturity of some organ systems (mammals, man).

In the indirect postembryonic development of the egg membranes larva, morphologically and physiologically different from the adult, which she converted after some profound changes across the stage or pupae (insects). In the first case of postembryonic development called indirect development with incomplete metamorphosis (mites), in the second - with complete metamorphosis (butterfly). Environmental factors(light, temperature, chemical composition of the environment, food and so on.) influences on the individual development. Among them distinguish the factors necessary for normal development, and unwanted or even harmful. So, on the human development of harmful effects of alcohol, nicotine, drugs.

1.3 Fundamentals of genetics

Genetics is a science of heredity and variation in living organisms. The birth of genetics as a science usually referred to 1900, when X. De Friz, K. Correns and E. Chermak discovered the laws of Mendel, described them in 1865 hereditary characteristics of an organism to provide the material and functional continuity between generations. Heredity is realized in succession or playback a number of generations of the specific nature and metabolism of the individual, under certain environmental conditions. The material basis for it with asexual reproduction are somatic cells and during sexual are gamete (egg, sperm). Hereditary factors are localized in the nucleus of chromosomes, some cytoplasmic organelles (mitochondria, plastids) and called genes.

Gene is functionally indivisible unit of genetic material which is a portion of the DNA molecule (in some viruses – RNA) encoding the primary structure of the polypeptide molecules or transport and ribosomal RNA. The set of genes of a cell or organism that determine its development called genotype. It is not

mechanically set of independently functioning genes and their single system. Phenotype is the complex features and properties of the organism formed during the interaction of genotype with the environment.

Diversity is a property of living organisms altered by environmental factors as a result of new appearance or loss of existing traits. Diversity reflects the instability of the hereditary characteristics of an organism and is one of the most important factors of evolution, providing the adaptability of populations and species to changing conditions of existence. Each gene that controls the expression of a trait always doubles (one from mother, the second from father).

Allelic genes are a pair of genes located in the same locuses of homologous chromosomes and defining the contrast (alternative) characteristics, called. Alternative sign manifested in the hybrids in the first generation is called dominant, not manifested (suppression) – recessive. Genes controlling these traits, respectively, are called dominant or recessive.

Alleles are usually denoted by the same letters of the alphabet: dominant – capital letter (A), same recessive – (a). Organisms with identical alleles of a gene, for example, both alleles are dominant (AA) or both recessive (aa), respectively called homozygous or homozygotes (Figure. 1.30). Organisms have different alleles of one gene – one dominant (A) and other recessive (a) is called heterozygous or heterozygotes (Aa). As a result of meiotic homologous chromosomes and with them the alleles differ at different gametes. Since homozygous both alleles are the same, it forms a type of gametes. Heterozygous organism has two types of gametes – one with a dominant, the other with a recessive gene. The material basis of heredity and variation of organisms at the molecular, cellular, organism and population levels of the organization of the living is the subject of genetics.

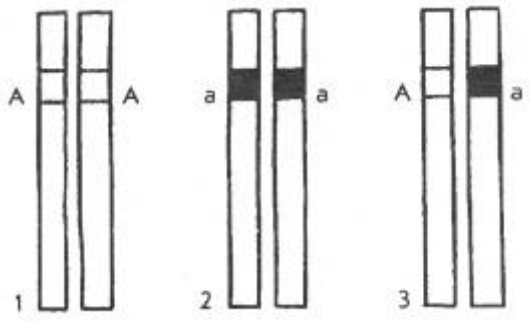


Figure 1.30. The scheme of allelic genes localization in homologous chromosomes: 1 – dominant homozygote; 2 – recessive homozygote; 3 – heterozygote.

Genetics as a science have the following objectives:

– study the problems of storage of genetic information, determining the structure of the cells which are the material substratum of genetic information, and the means of coding;

– determination of the mechanisms and laws of transmission of genetic information from cell to cell, from generation to generation;

– analysis of ways to implement the genetic information into specific signs organism and its interaction with the environment;

– study of changes in the genetic information types and mechanisms of their occurrence.

The material basis of heredity (chromosomes) studied by cytological method. An analysis of patterns of inheritance of individual properties and characteristics of organisms with sexual reproduction, as well as the variability of genes and their combinatorics spend hybridological method developed by G. Mendel (Figure 1.31). Mendel studied the inheritance of certain traits in offspring pairs obtained by crossing the parental species, which differ in one or two pairs of alternative characters. He proposed to comply with the following conditions:

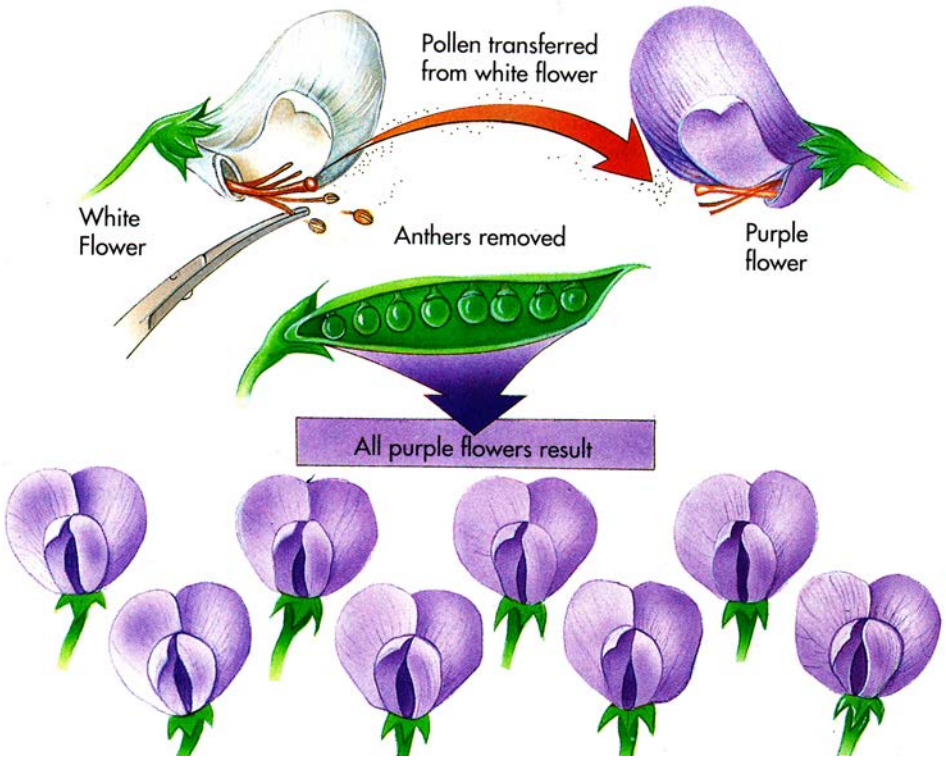


Figure 1.31. How Mendel conducted his experiments, by Raven & Johnson

1) in each generation to keep records separately for each pair of alternative characters without other distinctions be crossed organisms;

2) a quantitative account of hybrid organisms differ in individual pairs of alternative characters in a series of successive generations;

3) to carry out an individual analysis of each hybrid offspring from the body.

Hybridological combination with cytology method is independent cytogenetic method. It provides an opportunity to study the human karyotype to detect changes in the structure and number of chromosomes. The action of genes in the process of individual development is investigating developmental method. Combined with the biochemical method allows carriage recessive genes in heterozygous phenotype. Quantitative accounting of inheritance of traits is carried by mathematical methods. The frequency of different genes in the population is determining the population-statistical method. Pedigree of highly productive animals and human types of inheritance of characters set in different generations (genealogical method). Twin method is based on a study of twins with identical genotypes and allows you to find out the impact of the environment on the formation of symptoms.

1.3.1 Basic laws of inheritance

Patterns of inheritance of traits were discovered by Mendel. Monohybrid is crossing, in which the parent individuals are analyzed on one pair of alternative signs, of two - dihybrid, in many alternate signs - polyhybrid. Experiments are record as a hybridization schemes. Parent individuals designated by the letter P, the first generation of individuals – F_1, the second generation – F_2, and so on; crossing – the multiplication sign (X); genotype of individuals recorded the first maternal and paternal – the second; the first line of a parental genotypes, in the second – types of gametes, in the third – the genotypes of the first generation hybrids (Figure 1.32).

For the experiments, Mendel took peas, seeds of different color (yellow and green). The crossing homozygous yellow (AA) of individuals with green (aa) each parent forms one type of gamete "A" and "a" which give hybrids with the same genotype, wherein a pair of alternative characters develops only one (dominant) and second (recessive) is suppressed (Figure 1.33). Based on these data, Mendel formulated the first law of dominance, or the law of the uniformity of the first generation hybrids: homozygous individuals in crosses, differing from each other by a pair of alternative signs, all first generation hybrids have the same genotype and phenotype. They are heterozygous by genotype

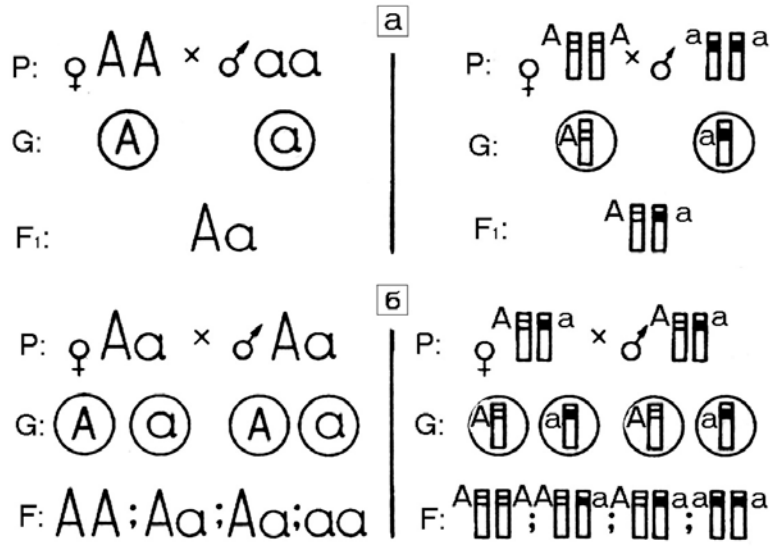


Figure 1.32. The scheme of crossing and cytological basements of first (A) and second Mendel's laws.

and phenotypes which are dominant. Experiments have shown that each individual hybrid can form two types of gametes are due to crossing with each other may provide both individual with dominant (75%) and with recessive (25%) features. Thus, the phenotype obtained by cleavage of 3: 1 and genotype-1AA: 2Aa: 1AA). Based on the results of the second hybridization, Mendel described second law - the law of segregation: when crossing between two heterozygous individuals, the hybrids analyzed by one alternative pair traits in the progeny cleavage of the phenotype in a ratio of 3: I and genotype 1 : 2 :1.

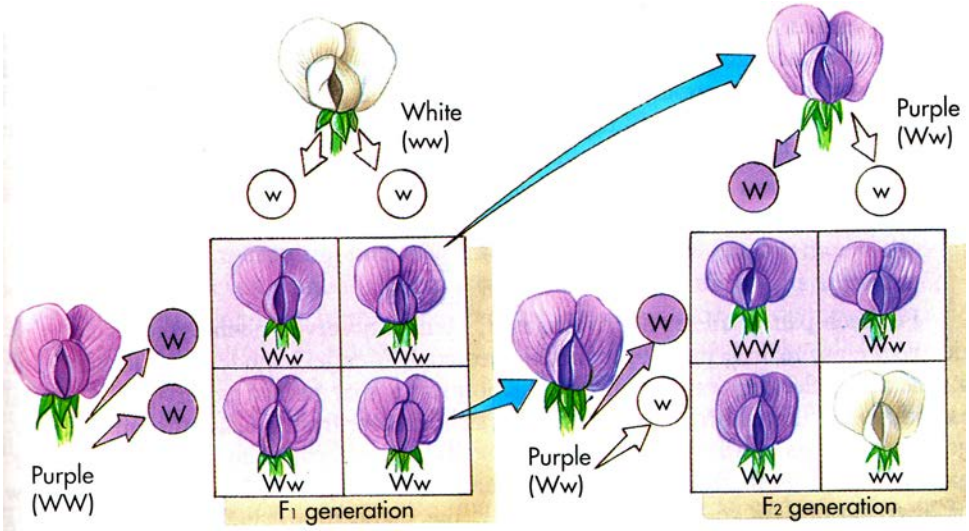


Figure 1.33. Mendels cross of pears differing in flower color, by Raven & Johnson

William Bateson made in 1902 a generalization to explain the laws derived from the second law of Mendel. It became a part of genetics, called the law of purity of gametes: genes in gametes from hybrid individuals are non-hybrid and clean. Mendel's laws and the law of purity of gametes can be explained from the cytological point of view by the fact that hybrids of each pair of alleles are identical locuces of homologous chromosomes, one of which – the parent, and the other – a father. During gametogenesis due meiotic homologous chromosomes differ in different gametes, with each pair of gamete is only one chromosome with a single allelic gene in the "pure" form. As a result of fertilization of male and female gametes of both types can be coupled with equal probability, then the cleavage is carried out and genotype in the ratio of 1AA : 2Aa : 1AA.

In some cases the hybridological analysis has to figure out an unknown genotype hybrid organism. For this purpose is used a so-called test cross – hybrid interbreeding individuals, the genotype is unknown, with "analyzer" (homozygous for the recessive alleles of individuals). If the hybrid is heterozygous for the analyzed pair alleles (Aa), it forms two types of gametes and recessive "analyzer" (aa) – one type gametes resulting hybrids occurs splitting progeny by analyze basis in the ratio 1: 1 (50% individuals with a dominant trait and 50% – recessive). If the hybrid is homozygous for the analyzed trait (AA), he, like a recessive "analyzer", forms one kind of gamete. All hybrids are due to manifestations dominant gene are phenotypically uniform and heterozygous genotype (Figure 1.34).

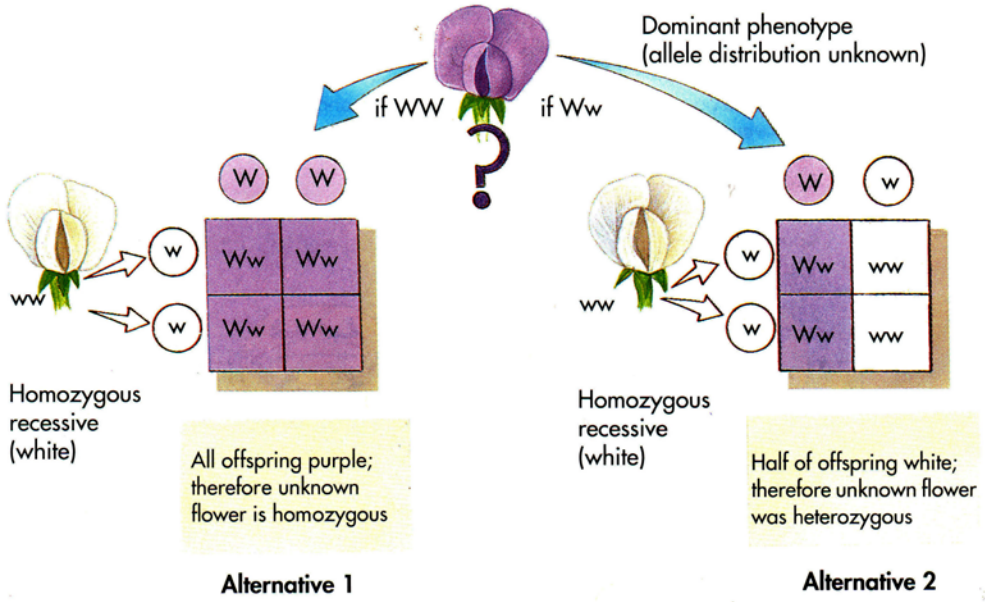


Figure 1.34. Testcross, by Raven & Johnson.

For dihybrid cross Mendel took homozygous pea plants that differ by two traits. At the parent plant seeds were smooth yellow, from his father – wrinkled green. After their crossing seeds of hybrids of the first generation appeared yellow smooth. Hence, they form a smooth seed (B) dominates wrinkled (b), and the yellow color (A) – of green (a). Since genes shape seeds and their coloration are located in different pairs of homologous chromosomes and are manifested by different signs, they are called non-allelic genes. By crossing digeterozygotes hybrids (AaBb) interconnected each can form four types of gametes – AB, Ab, aB, ab. When equiprobable their merger in the second generation produced 16 different genotypes (Table 1.2).

Table1.2. Splitting of the second generation in the dihybrid cross.

Gametes ♂	Gametes ♀			
	AB	Ab	aB	ab
AB	AABB yellow, smooth	AABb yellow, smooth	AaBB yellow, smooth	AaBb yellow, smooth
Ab	AABb yellow, smooth	Aabb yellow, wrinkled	AaBb yellow, smooth	Aabb yellow, wrinkled
aB	AaBB yellow, smooth	AaBb yellow, smooth	aaBB green, smooth	aaBb green, smooth
ab	AaBb yellow, smooth	Aabb yellow, wrinkled	aaBb green, smooth	aabb green, wrinkled

English geneticist R. Pennet (1906) for the convenience of the account offered to record the genotypes formed in a grid. Phenotypically this splitting in shape and color gives 9 parts of smooth yellow seeds, 3 smooth green, wrinkled yellow 3 and 1 part of wrinkled green semyam (the ratio of 9: 3: 3: 1). Thus, analyzing the inheritance signs hybrids of the second generation, Mendel found that the shape of peas are not dependent on their color, the splitting of each feature (for each allele pair) is independent of the other features (other pairs of alleles) in a ratio of 3:1. This is the third Mendel's law or the law of independent inheritance of characters: homozygous individuals in crosses, which differ by two (or more) pairs of signs, in the second generation there is

an independent inheritance and combining signs in combinations not typical parental and ancestral individuals.

Cytological basics of Mendel's third law are divergence free and independent combining paternal and maternal chromosomes during meiosis in the formation of gametes hybrids. First generation hybrids (AaBb) can form with equal probability are four types of gametes (AB, Ab, aB, ab). At fertilization gametes are joined also by the rules of random combinations with equal probability for each, so in the second generation there are all the possible types of zygotes in the same ratio as in the crossing.

1.3.2 The chromosomal theory of heredity

Chromosome theory of heredity is study of the localization of hereditary factors (genes) in the chromosomes of cells which states that continuity properties of organisms in a number of generations are determined by the continuity of their chromosomes. The chromosomal theory of heredity was developed by T. Morgan and co-workers at the beginning of the twentieth century and it was confirmed in the first place in the study of genetic mechanisms of sex determination in animals.

Sex is a set of morphological and physiological characteristics of the organism providing its sex reproduction and transmission of genetic information due to the formation of gametes. Individuals of both sexes differ chromosome set in gametes. For example, in the female of some species (Drosophila, human) all paired chromosomes, and males - two unpaired, one of which is the same as that of the female.

Chromosomes which are different individuals, male and female, are called sex chromosomes: chromosome pair is indicated by the letter X, unpaired – letter Y. Chromosomes in which male and female do not differ are called autosomes (A). For example, a person has 23 pairs of chromosomes, 22 pairs are autosomes and only 1 couple – sex chromosomes. Chromosome set of women can be written as follows: 44A + XX men - 44A + XY. In Drosophila the female chromosome set is 6A + XX, the male – 6A + XY. Gene controlled by chromosomes of same sex that produces one type of gamete (X-linked) was named homogametic, and the opposite sex which is controlled by different chromosomes, producing two types of gametes (with X- and a Y-chromosome) - heterogametic. In Drosophila, mammals and other homogametic female and heterogametic is male; birds, butterflies – on the contrary. In this case, female chromosome is designated by the letter W, and the men – the letter Z. Sex

inherited as a typical sign of Mendelian. Sex chromosomes in addition to the genes that determine gender, carry genes that do not have any relation to it. Signs inherited through sex chromosomes are called sex-linked.

Symptoms which inherited in human through the Y-chromosome, may be only in males, and in X-chromosome – in both sexes. Female of the genes of the X chromosome may be either homo- or heterozygous. Recessive alleles appear only in the homozygous state. In men, the genes of the X chromosome may occur in recessive state. When recording the transmission characteristics, coupled with the floor, in addition to genetic formulas symbols genes that control these traits recorded and sex chromosomes in which they are localized. In humans, sex-linked traits are such as hemophilia (incoagulability blood), blindness (red-green blindness) and others. Inheritance of characteristics linked to the X chromosome comes from the mother to the sons and father-daughters.

The genes are linked not only in sex chromosomes, but in autosomes. Linked inheritance of genes has been studied in autosomes. T. Morgan, according to a third independent Mendelian combination of features can be provided, if the genes that control these traits are in different pairs of homologous chromosomes. Consequently, every organism number of pairs of features that can be inherited independently, limited by the number of chromosome pairs. However, in one organism number of features of controlled genes, considerably larger than the number of chromosome pairs present in its karyotype. Consequently, each chromosome is not a single gene, but many. If this is true, then the third Mendel's law applies only to free combination of chromosomes rather than genes. Analysis manifestations third Mendel's Law shows that in some cases, new combinations of genes hybrids completely absent. There is full engagement between the genes in parental forms phenotype is split 1: 1. In other cases, independent inheritance combinations of features are made with less than it should have been, frequency. Coinheritance of genes located on the same chromosome, the genes has been called clutch. Genes located in the same chromosome are arranged consecutively (linearly) and form a linkage group. Each type of organisms, their number is haploid set of chromosomes. It was found that the homologous chromosomes paired regularly exchanged genes.

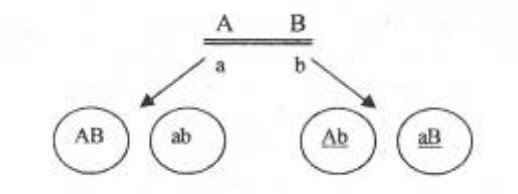
The process of exchanging identical portions of homologous chromosomes with the contained genes called chromosomes chiasm or crossing-over. Crossover occurs during meiosis and provides new combinations of genes

in homologous chromosomes. Crossover frequency depends on the distance between the genes, it is usually expressed as a percentage. The phenomenon of crossing-over as grip genes is characteristic of microorganisms, plants and animals. When the genes are on different pairs of chromosomes, the genotype diheterozygote recorded as follows:

$$\frac{A}{a}\ \frac{B}{b}$$

If the genes are in the same pair of homologous chromosomes, the recording is performed as follows:

$$\frac{A\ B}{a\ b}$$



Gametes with chromosomes that have undergone crossover is called crossover, not undergone – noncrossover. If gametogenesis, crossing-over occurs between homologous chromosomes, we speak of an incomplete clutch gene which is characteristic for plants and animals. Exceptions are Drosophila males and females of the silkworm. If gametogenesis, crossing-over does not take place, we speak about full linked of genes. Coupling genes as crossover, T. Morgan studied in experiments on Drosophila by inheritance of two pairs of characteristics (gray body and long wings, a black body and rudimentary wings) whose genes are located in a single pair of homologous chromosomes. Based on these results it has formulated the following rule: genes are localized in one chromosomes are inherited by the clutch, and the adhesive force depends on the distance between them.

The chromosomal theory of heredity is characterized by the following provisions:

- genes are located on chromosomes, each of which represents a group of the clutch; the number of linkage groups in each species of organisms still haploid number of chromosomes;

- every gene in a chromosome occupies a specific location (locus), and all of the genes in the chromosomes are arranged linearly;

- between homologous chromosomes occurs chiasm (crossing over) and the exchange of allelic genes;

- distance between genes on a chromosome proportional to the frequency of crossing and expressed in percentage crossover between them.

1.3.3 Interaction of single genes and different alleles.

The analysis took into account the rules of Mendel, a dominant gene that suppresses the expression of the recessive. Analysis of the genotype to phenotype shows that the manifestation of the signs can be determined by the interaction of genes from one or from different alleles. The phenomenon when one characteristic meets several genes (alleles), called the interaction of genes. Distinguish the interaction of both allelic and non-allelic genes. There are the following types of interaction of allelic genes, dominance, incomplete dominance, and superdominance, codominance. Domination is a property of the gene determining the development of a trait in the heterozygous state. This means that the recessive allele is completely suppressed and does not operate. It is not appears. For a large number of symptoms in animals and human is characterized by intermediate inheritance or incomplete dominance.

Incomplete gene expression F_1 hybrid will not play completely none of parental traits. Intensity of feature is intermediate, with more or less deviation to the dominant or recessive condition. For example, when crosses homozygous plants the night beauties with white flowers (aa) and the same plant with red flowers (AA) inherits the first generation hybrids are not red (dominant) color flowers and pink - intermediate (Aa). After hybridization of these hybrids between a second generation splits flower color phenotype and genotype in a ratio of 1: 2: 1, i.e. 25% appears red (AA), 50% pink (Aa) and 25% white (aa) flowers. Thus, the interim nature of inheritance law is not contrary to splitting. Examples of incomplete dominance, a person may be the inheritance of sickle-cell anemia, eyeless.

Superdominance is a strong manifestation of the trait in heterozygous individuals Aa than in any of the homozygotes (AA and aa). Genes appear survivability and lethality in Drosophila. Dominant genes of one allele in the heterozygous state may occur both at the same time. This phenomenon is called codominance. By this type of inheritance can be inherited IV (AB) blood group, MN group and others. Significant deviations from the numerical relationship of phenotypic classes in the cleavage may occur as a result of the interaction between non-allelic gene pairs. The following types of non-allelic interaction of genes: complementarity, epistasis and polymers. Complementary or additional call these dominant genes which together picked up in the genotype (A-B) are

responsible for the development of a new feature in comparison with the effect of each gene separately (A or AA). According to the principle of complementarity inherited yellow and white color of silkworm cocoons has normal hearing and deafness in human. When complementarity frequently observed signs of development of the hybrids, not peculiar to the original forms.

There is interaction between non-allelic genes in which one allele of a single gene inhibits the action of the other of the other alleles: AB, CD, etc. This phenomenon is called epistasis which gene suppresses expression of another is called epistatic, and gene expression is suppressed – hypostatic. Epistatic genes also called suppressor genes. Epistasis can be divided into two types: dominant and recessive.

Under the dominant suppression epistasis understands one another dominant gene action. Horses Ravens suit due to a dominant gene B, red – in the allele. Gene C which belongs to another pair of alleles causes early graying of hair, whereby the color of the horse is gray irrespective of whether it is present in the gene or, for those genes hypostatic with respect to the gene S. In F_2 a splitting 12 gray: 3 Crow: 1 red instead of 9: 3: 3: 1. Under recessive epistasis understands type of interaction, when recessive allele of a single gene, as in the homozygous state, does not give an opportunity to show dominant or recessive alleles of another gene: aa aa B- or centuries. Example, when crossed black rabbits (AABB) with white (aabb) all hybrids (AaBb) are painted agouti and in F_2 is observed 9 rabbits agouti (A-B), 3 black (A_BB) and 4 white (aaB_ and AABB).

Inheriting quantitative trait phenotypes are usually formed under the influence of multiple genes equivalent. This phenomenon is called polygenic inheritance or polymers and polymer called genes. The principle adopted by the unambiguous action of genes on the development of the characteristic. For example, oats, wheat grains coloring polymer is determined by several genes. The development of envy color on the number of polymer dominant genes is gene dosage. Polymeric inherited growth and pigmentation of the skin in human. Thus, it is quite obvious that any hereditary trait is determined by many genes. Each gene may influence the development of many signs and generally the whole body. Consequently, the genotype is not the amount of genes and their complex historically established system. Therefore, the phenotype is the result of the interaction of genotype with environmental factors in the process of individual development of the organism.

1.3.4 Patterns of diversity.

During process of evolution living organisms have developed the ability to respond morphophysiological changes to change environmental factors, because genes control not only the transmission characteristics, but also the limits of their variation, allowing the body to better adapt to environmental factors.

Diversity is a property of living change, expressed in the ability to acquire new features or lose old. There are two types of diversity: phenotypic (non-hereditary) and genotypic (hereditary).

Phenotypic or modification diversity is changes characteristics of the organism (its phenotype), who are not connected with changes in the genotype. An example of such variability can serve as a wheat field which on the one hand, striking uniformity and with another – lack of identical individuals.

Modification diversity is limited to normal reaction of the body is the degree of variability of test for determining the genotype. Normal reaction of different genotypes varies and depends on the environmental conditions. For example, cattle coat color does not change in any conditions. The rate of reaction on the basis is constant. However, milk production varies very widely depending on the conditions of feeding and housing. The rate of reaction is of great importance for the adaptation of organisms to the different environmental conditions and contributes to the conservation of species, and in the practice of agriculture determines the degree of productivity of cereals, legumes, and other solanaceous plants, and the high productivity of animals (Figure 1.35).

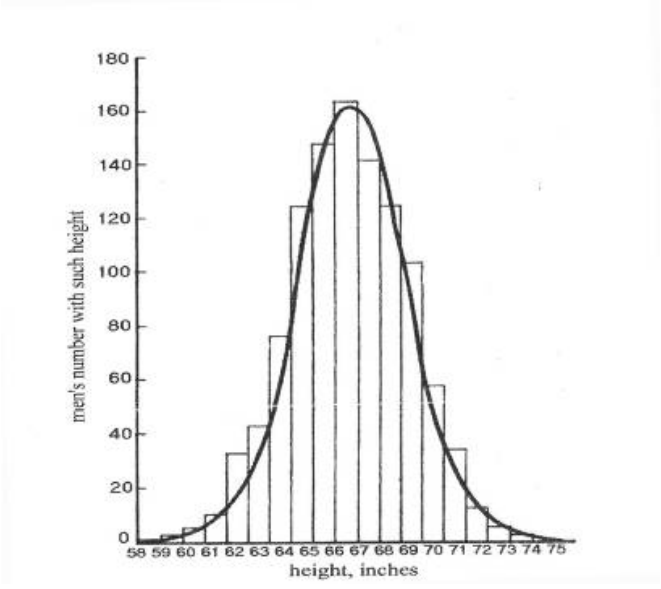


Figure 1.35. The curve of normal distribution of men by height, by K.Willy.

Modification diversity is due to the body's ability to form the specific conditions of the relevant phenotype. For example, arrowhead plant, depending on the external environment may have a different shape leaves: sagittal (surface), heart (floating) and the ribbon-like (underwater). Consequently, it is not inherently deterministic leaf shape, and its ability to change widely. Modification diversity is widely distributed among living organisms. Darwin called it certain diversity. Symptoms of the body can be divided into high-quality (color seed plants, hair and eye color in human and so on.) and quantitative (plant height, number of spikelets per spike, productivity, growth and weight of the human body). To characterize the quantitative traits apply complex statistical indicators, one of which is a variation number, characterizing the variability of the trait. At the heart of the construction of a number of variations based on the following principle. For example, take the 100 ears of wheat and counts the number of spikelets in each. The figures (variants) are arranged in ascending order of feature and counted how many times each version of "x" appears in the number n^1, then grouping them. Compose a variation number.

Table 1.3. Example of diversity number construction

x	17	18	19	20	21	22	23
n^1	6	8	16	27	21	18	4

The data presented in table 1.3, reflect the degree of variability of the trait. Its average value of x is calculated as follows:

$$x = \frac{\Sigma(xn^1)}{n}$$

where x – arithmetic mean; x – option; Σ – sign of the sum; n^1 - rate options; n - total number of version of the variation series. In our example, the average value of the characteristic variation series.

$$x=\frac{17*6+18*8+19*16+20*27+21*21+22*18+23*4}{100} =20,19$$

To characterize the degree of diversity the variational curve is use. To this is plotted in a coordinate system plotting on the abscissa (horizontal) option value in the order of their increase in the ordinate (vertical) – frequency of occurrence of each embodiment. We obtain the curve representing variability in the number of spikelets per spike when connecting the points of intersection.

Genotypic diversity is the type of variation which is caused by changes in the structure of the gene, chromosome or genotype as a whole. It is divided into two types – combinative and mutational. Mutational diversity is the type of variability, in which there is an abrupt, discontinuous change hereditary traits (mutations). In other words, the mutation is a suddenly change occurring resistant genetic apparatus comprising genes transition from one state to the other allele, a change in their structure, various changes in chromosome structure, their number in the karyotype, and genetic structures cytoplasm.

The doctrine of the mutations has been incorporated in the work of X. De Fries (1848-1935).

The main provisions of this theory are the following:

– mutations arise suddenly and are qualitative changes;

– new resistant mutants;

– mutations can be both useful and harmful;

– the same mutation may occur repeatedly.

Mutations are classified according to the modified cells (generative and somatic); the nature of the changes in the genotype (gene, chromosomal, genomic, cytoplasmic), for a reason to call them (spontaneous and induced).

Generative mutations occur in germ cells. If generative mutation is dominant, then the organism shows new characteristic (property) is in the first generation even in the heterozygous state. Recessive mutations manifest through several generations by making it in the homozygous state. Examples of generative recessive mutation may be the presence of hemophilia in some families. Somatic mutations occur in the genotype of the body cells (somatic cells) and are found in the part which developed out of the transformed cells. For species that reproduce sexually, these mutations are not critical, but are important for species that reproduce asexually. Thus, in vegetatively propagated fruit and berry plants by somatic mutations can be plants with new traits.

Gene mutations are mutation of a change in the structure of the gene itself. It is loss, addition or inversion of nucleotide pairs of a DNA molecule in a triplet (Figure 1.36). Such mutations can alter the structure of the enzyme protein, which is encoded by the gene, changing its properties or completely disrupt the synthesis of the polypeptide. Gene mutations occur very often. They can be dominant and recessive, occur in gametes and somatic cells spontaneously or under the influence of a mutagen.

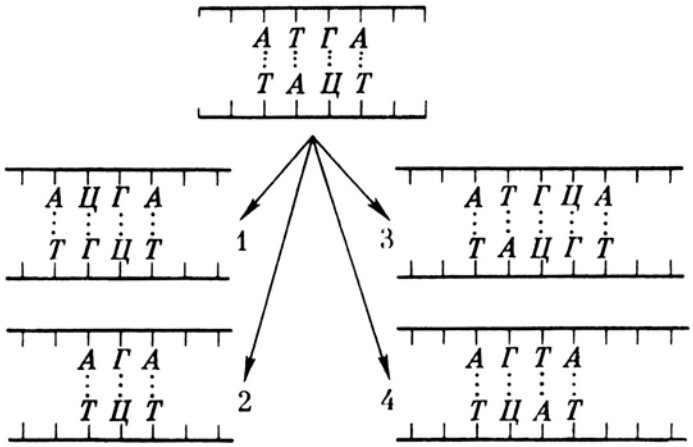


Figure 1.36. The local gene mutation:
1 – the bases' pair interchange in DNA molecule, 2 – deletion of one bases' pair, 3 – insertion of one bases' pair, 4 – miss localization of one bases' pair inside of the gene.

Chromosomal mutations are mutations caused changes in the structure of chromosomes in the karyotype (Figure 1.37). The structure of the chromosome may change due to disturbances in meiosis crossover, resulting loss a part of a chromosome doubling or multiplication of a fragment thereof, changing the linear arrangement of chromosome fragments as a result of rotation of 180°. A special type of chromosomal rearrangement is the transfer of a fragment of one chromosome to another, non-homologous chromosome to her. Most of these mutations are harmful for the body and leads to a decrease in its activity.

Mutations of a change in the number of chromosomes in the karyotype, called the genome. They are of two types: polyploidy and heteroploidy.

Polyploidy is a kind of genomic mutations, at which the increase in the number of sets of chromosomes in karyotype multiple of the haploid. It occurs when the destruction of mitotic spindle during mitosis or meiosis and leads to the formation of gametes with a set of 2n, 4n, 6n, and so on. Polyploidy is common in plants, animals and meets very rarely (ciliates, silkworm and some amphibians). Polyploids are differ by large size cells, leaves, flowers, fruits, seeds. Most of the crop is polyploids: durum wheat is 28 (4n) of chromosomes, soft – 42 (6n) chromosomes, and half-wild species of the genus einkorn wheat or spelled – 14 (2n) of chromosomes.

Heteroploidy is a kind of genomic mutations caused by excess or shortage of one chromosome in a pair of homologous chromosomes. Heteroploidy is due to violation of chromosomes in meiosis after conjugation, which reduces the size of the body, reducing its fertility and so on. In humans, the appearance of an extra chromosome or the lack of it causes severe disease.

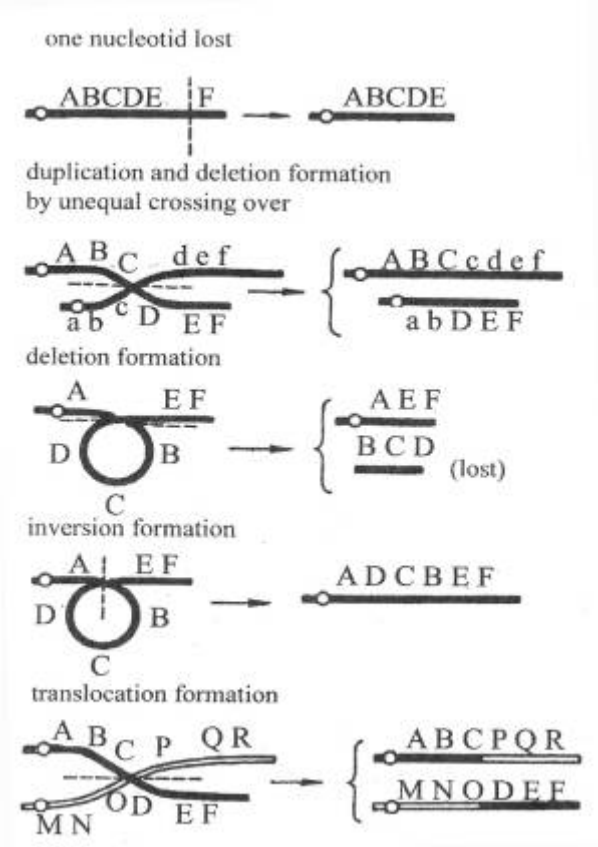


Figure 1.37. The mechanisms of main types of chromosomes' aberration formation, by S.M.Gershenzon.

Cytoplasmic mutations are mutations of a change in the DNA of cellular organelles (plastids, mitochondria). For example, variegation in plants causes mutations in the chloroplast DNA. Cytoplasmic mutations are inherited through the maternal line, as the zygote receives cytoplasm mainly due to the egg.

Spontaneous mutations are mutations that occur naturally in vivo without human intervention directed. In some species, they occur more frequently and in others – less. Vavilov (1887-1943) as a result of the study of spontaneous mutations in plants of different taxonomic groups formulated the law of homologous series of genetic variation that reads: "Forms and childbirth are genetically similar, characterized by similar series of genetic variation with such regularity that, knowing the number of forms within a single species, it can be foreseen to find parallel forms in other species and genera. As examples of this act may be called cases of albinism in vertebrates; blood group, Rh factor in primates and human, and so on. The law allowed a new approach to understanding the principles of mutation in nature. It was found that the genetic variation is programmed in genotype and mutations are considered to be random, when considered individually. In general, they are from the standpoint

of the law of homologous series are a natural phenomenon in the species. Mutations that occur accidentally in different directions in their assessment of the complex make it possible to deduce the general law, allows to predict the presence of a particular trait in different branches of the same family, if at least one of the genera of the family has this feature.

Induced mutation is a mutation that occur in the genotype of the individual under the influence of environmental factors specifically directed, called mutagenic agents or mutagens. Among them distinguish physical (ionizing and ultraviolet radiation, temperature), chemical (mustard gas and its derivatives, analogs of nitrogenous bases, acridine dyes, products and intermediates chemical syntheses, some medications) and biological (some viruses). It was found that mutations can cause in laboratory conditions, affecting the body mutagens. Mutant organisms obtained, for example, G.A. Nadson and G.S. Filipov (1925) when irradiated mushrooms radium, H. Muller (1927) – with Drosophila irradiated with x-rays. Induced mutations are widely used in breeding, since they have a wide range of new features and provide valuable material for artificial selection, as well as spontaneously occurring mutations, - the material for natural selection.

In connection with the development of scientific and technological progress in all areas of the economy are widely used chemicals, radioactive substances and other artificial mutagens. For example, in agriculture, various chemicals as fertilizers, insecticides, pesticides, herbicides, defoliants which are not always harmless to human. All of these agents may cause various mutations. In this connection it is necessary to strengthen the control of environmental pollution mutagens and to take concrete measures to prevent their release.

Combinative diversity is kind of diversity, which is caused by a variety of genotypes and allows the emergence of new combinations of traits resulting from crossbreeding. It is inherited in accordance with the laws of Mendel and rule T. Morgan. It plays an important role in evolution, because it gives new combinations of adaptive traits, arise when crossed. Combinative variability used in breeding for improved animal breeds, plant varieties by crossing.

1.3.5 Genetics and the theory of diversity.

The process of evolution within a species begins in a population consisting of individuals with different genotypes. Every organism possesses common and characteristic features of the species, has its own individual genetic

characteristics. All the genetic information of the population (the complete set of genes) that has developed in the course of its evolution, called the gene pool of a population. The basis of genetic processes occurring in the population, are patterns of inheritance of traits discovered by Mendel, the mechanisms of distribution of chromosomes and genes in meiosis and random combination of gametes during fertilization. Natural populations are heterogeneous and are subject to significant mutations. However, in the absence of external factors pressure population heterogeneity is not changed and stored in certain equilibrium. This is the conclusion of Hardy and Weinberg (1908). They found that a large population, where there is no selection, mutation and mixing with other populations, characterized by constancy in the distribution of homo- and heterozygotes. To bring the law Hardy-Weinberg equilibrium, the frequency of the dominant allele "A" denoted "p", and the frequency of the recessive allele "a» - «q». In the case where the gene has only two alleles, their frequencies p + q = 1. Substituting lattice Pennet dominant frequency (p) and recessive (q) alleles obtain a formula of the Hardy-Weinberg law.

♀ \ ♂	pA	qa
pA	p^2AA	pq Aa
qa	pq Aa	q^2 aa

$$p^2 AA + 2 pq Aa + q^2aa$$

The law states that the square of the frequency of homozygous dominant refers to the product of twice the frequency of heterozygotes and homozygotes to the square of the frequency of recessive. Hardy-Weinberg law is valid only for large populations, where freely exercised and manifested statistical regularities, and there are no factors that may affect the ratio of allele frequencies.

1.3.6 Meaning of genetics to medicine and health.

Genetics is a fundamental biological discipline studying patterns of inheritance in different species, including human. The study of human genetics is difficult for several reasons: a small number of offspring, a relatively late onset of puberty, the lack of accurate recording of symptoms of hereditary traits, the inability to equalize conditions life.

Medical genetic studies human genetic diseases. It was found that more than 5% of children born with hereditary diseases, disorders in the body

structure for early diagnosis in some cases can prevent the development of hereditary disease, appointed a special diet and start early treatment, including operative. Genetic studies have shown undesirable marriage closely, as this increase the probability of hereditary diseases. There are several groups of hereditary diseases: hereditary metabolic diseases, chromosomal diseases and diseases caused by hereditary factors, a change in the cytoplasm. Hereditary metabolic diseases due to changes in the structure of genes responsible for the synthesis of a protein enzyme that controls for a particular chemical reaction. This group of diseases includes phenylketonuria due to lack of an enzyme that converts the amino acid phenylalanine to tyrosine, albinism, and others. Chromosomal disease may be due to changes in the structure as the autosomes and sex chromosomes. For example, if you lose in the meiosis of the short arm of chromosome 5 observed in the newborn so-called syndrome of "cat cry" cry of baby resembles cat's cry. Examples of genomic disease may be the presence in the karyotype extra 21st chromosome. Newborn says Down syndrome which is characterized by towering skull, slanting palpebral fissures, small ears, short and crooked fingers and other symptoms. If there is a man in the karyotype extra X-sex chromosome - Klinefelter syndrome develops. For these subjects was characterized by high growth, hypoplasia of the gonads, lethargy, mental retardation and others.

For the prevention of hereditary diseases in the health care system, there are special institutions of genetic counseling, are engaged in the prevention of hereditary diseases in unborn children. Services Consultations are the person getting married, who have family members with family history. Health care providers should take measures to prevent the development of hereditary diseases. This problem is considered to be particularly relevant in modern conditions due to environmental pollution by radioactive substances, chemical waste which can cause changes in the genetic apparatus of man. Of particular importance is the struggle with bad habits – smoking, alcohol, drugs, which, even in minimal quantities have a detrimental effect on the behavior of the chromosome in gametogenesis, the formation of the zygote, embryo development and cause irreversible changes in its genotype. The study of the karyotype of the fetus and the embryo is carried out in a specially created for this purpose, genetic counseling, and decide where the prevention of hereditary diseases in families with family history.

Chapter 2. Systematic of living organism. Viruses. Monerans. Fungi.

2.1 Systematic of living organism.

The diversity of the organic world of the Earth is characterized by wide variety of species. The number of species is exceeds 2 million. The term "species" was introduced by George Ray (1627-1709). He outlined the main criteria of the form: the number of individuals the same signs of individuals and the possibility of interbreeding between individuals with the transfer of the descendants of its features.

K. Linnei was the first who showed that the form is the main unit of the unit and the actual organic world. Modern taxonomy classifies certain superordinate each other systematic categories – Species, Genus, Families, Orders, Classes, Phylums, Kingdom (Table. 2.1). Each species has a scientific Latin name made up of two words. The first word of the name is the family, the second – the specific epithet as a rule adjective. For example: Ascaris suum – pig Ascaris, Ascaris lumbricoides – human Ascaris letter A, standing to the right of the species name suggests, it is the name given to C. Linnaeus. Phylums are grouped into subkingdoms, kingdoms and superkingdom.

Table 2.1 Principal taxa of morphological classification system.

Taxa	Group	Humans	Black rat
Kingdom	A group of related phyla	Animalia	Animalia
Phylum	A group of related classes	Chordata	Chordata
Class	A group of related orders	Mammalia	Mammalia
Order	A group of related families	Primate	Rodentia
Family	A group of related genera	Hominidae	Muroideae
Genus	A group of related species	Homo	Rattus
Species	A group of organisms capable of interbreeding to produce fertile offspring	sapiens	rattus

In the modern classification of all organisms are combined in two superkingdom – pre-nuclear (prokaryotes) and nuclear (eukaryotes) which include the realm of Monerans, Protistans, Fungi, Plants and Animals (Figure 2.1.). Viruses are not classified as living and therefore are not considered to be

organisms. They have only some of the elements which are necessary for self-replication. Viruses are important biological entities.

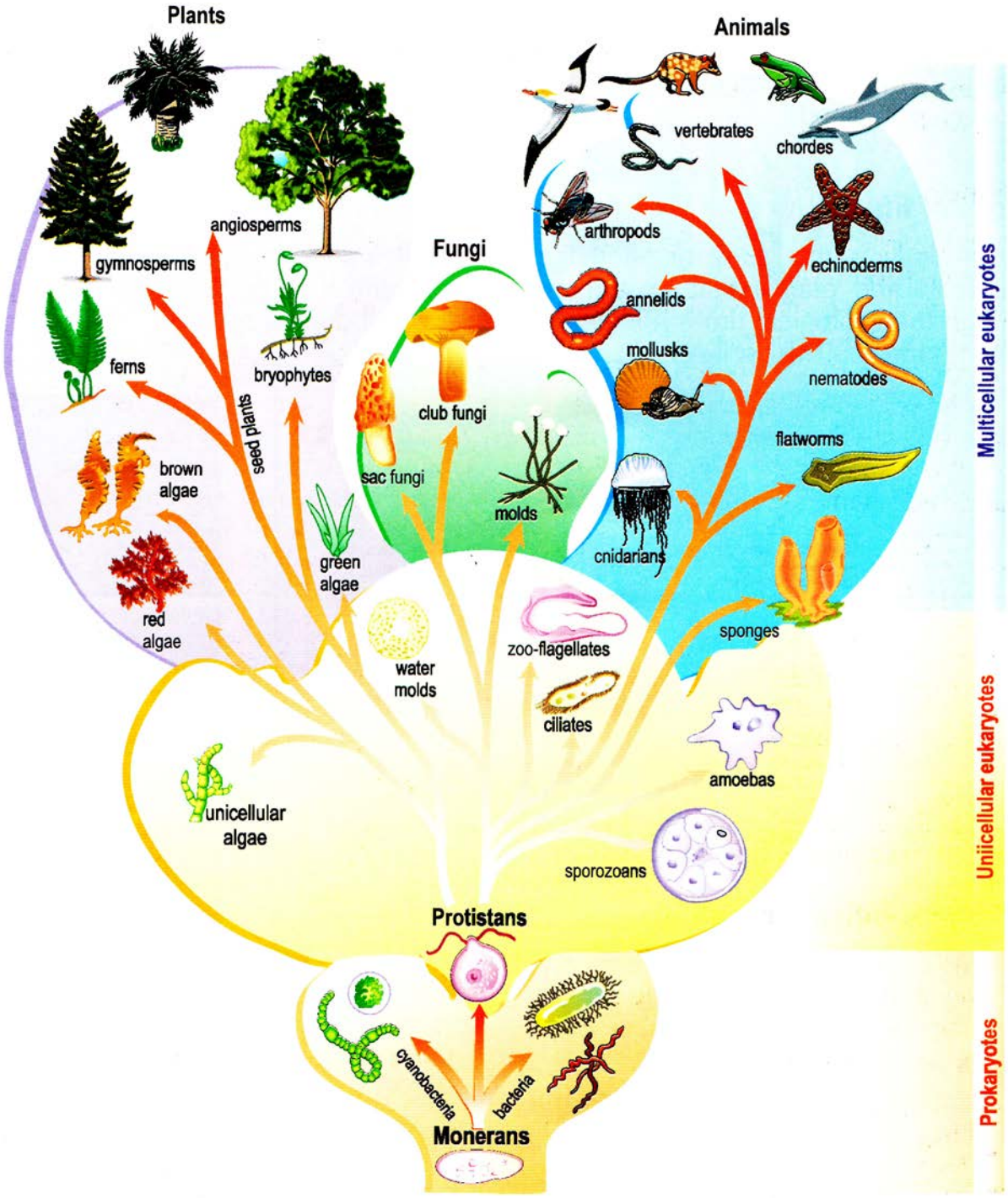


Figure 2.1. The five kingdoms of living things, by Raven & Johnson.

Systematics of the organic world can be represented as follows:

A. SUPERKINGDOM PRE-NUCLEAR ORGANISMS (PROKARYOTES).

I. The Kingdom Monera:

- Subkingdom Bacteria;
- Subkingdom Cyan.

B. SUPERKINGDOM NUCLEAR ORGANISMS (EUKARYOTES).

Unicellular eukaryotes.

II. Protistans.

III. Kingdom Fungi:

- Subkingdom lower fungi;
- Subkingdom higher fungi.

IV. Kingdom of Plants:

- Subkingdom lower plants;
- Subkingdoms higher plants.

V. Kingdom of Animal:

Another classifying of organic world is divided into two empires – precellular (viruses) and cellular (all living organisms). The cellular organisms divide into two superkingdom: pre-nuclear – prokaryotes and nuclear – eukaryotes. Prokaryotes include one kingdom – bacteria, eukaryotes – four kingdoms (unicellular fungi, plants, animals).

2.2 Viruses.

Non-cellular forms of life are viruses and bacteriophages (Figure. 2.2).

Viruses (lat. virus - poison) are non-cellular life forms capable of receiving certain living cells and multiply inside these cells. The virus is always present by one type of nucleic acid – DNA or RNA. All viruses are divided into DNA-containing and RNA-containing. The carrier of genetic information is a nucleic acid. All viruses are divided into simple and complex. Simple viruses consists of a nucleic acid and a protein shell (capsid). Complex viruses may contain besides nucleic acids and proteins of the capsid lipoprotein membrane nonstructural proteins, carbohydrates. Dimensions viruses vary from 15 to 350 and even up to 2000 nm. The molecular weight of viral DNA is 200 x 106, and the viral RNA – from 106 to 15 x 106. The forms of nucleic acids are diverse. The virus was with the two chain-DNA and single-stranded RNA. There are single-stranded DNA and double-stranded RNA. DNA may be linear or annular structure. RNA, generally linear, and some viruses can be represented by a set of fragments, wherein each fragment carries a certain part of the genetic information necessary for viral replication.

Viruses were discovered in 1892 by D.I. Ivanov during the study of mosaic disease of tobacco leaves. A virus does not have cytoplasm, cell organelles. Viruses show no signs of life outside cells. Many of them in the external environment are shaped crystals. Viruses settling in the cells of living organisms, cause dangerous plant diseases (mosaic disease of tomato, tobacco, cucumber and others), domestic animals (swine fever and birds and others) and

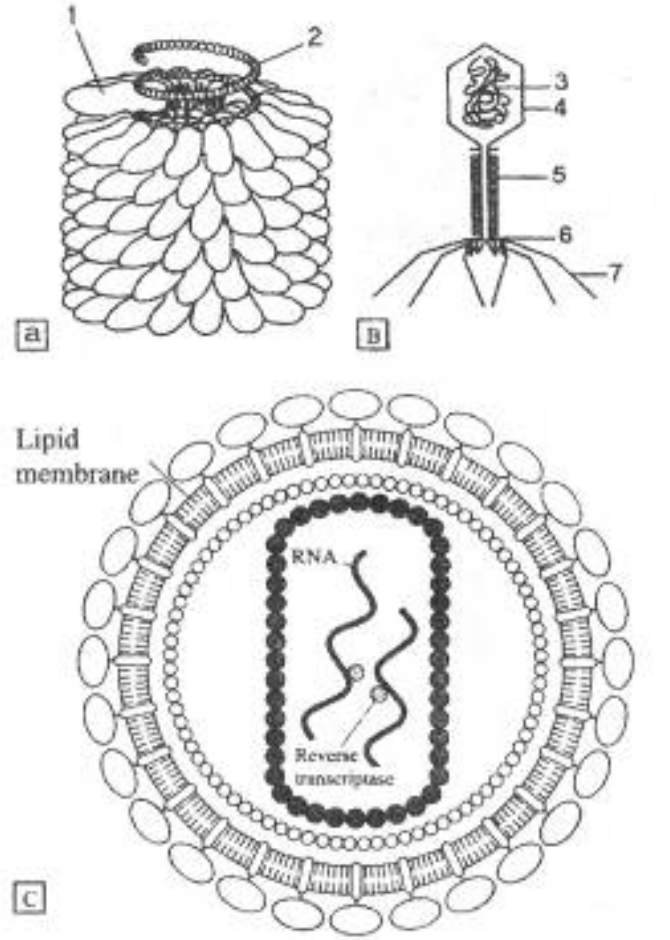


Figure 2.2. The scheme of non-cellular forms structure.

A - tobacco mosaic virus (l - protein coat, 2 - RNA molecule); B - bacteriaphag T4 (3 - DNA, 4 - head, 5 - tail, 6 - base plate, 7 - tail fibers); C – HIV (human immunodeficiency virus), by K. Swenson, P. Webster, and R. Gallo.

human (influenza, measles, smallpox, rabies, syndrome of acquired immunodeficiency and others).

Acquired immunodeficiency syndrome caused by the human immunodeficiency virus (HIV). First HIV virus is officially registered in the US in 1981 and in 1983 it was proved that it belongs to the viruses of the retrovirus family. The HIV genome contains of two identical RNA molecules consisting

of 10 thousand basepairs. HIV isolated from different patients differs from each other by the number of bases, and has a wide variation. The main route of transmission of HIV and the spread of the immunodeficiency syndrome is sexual. Means of non-sterile medical instruments is the way spreading the virus. It is also possible transmission of infection through blood transplantation of organs and tissues.

Infection can occur during pregnancy, while breastfeeding the baby mother's milk infected with HIV. An important risk factor is prostitution. The guarantee of protection against HIV infection is a healthy lifestyle and the use of mechanical contraceptives (condoms).

Bacteriophages are viruses of bacteria. They are able to penetrate into the bacterial cell and destroy it. The body of the E. coli phage consists of a head, tail and tail appendages (Figure 2.3). Inside the head is attaching DNA. Bacteriophage using appendages attached to the bacteria and the point of contact with it dissolves cell wall by means of special enzymes. By cutting head

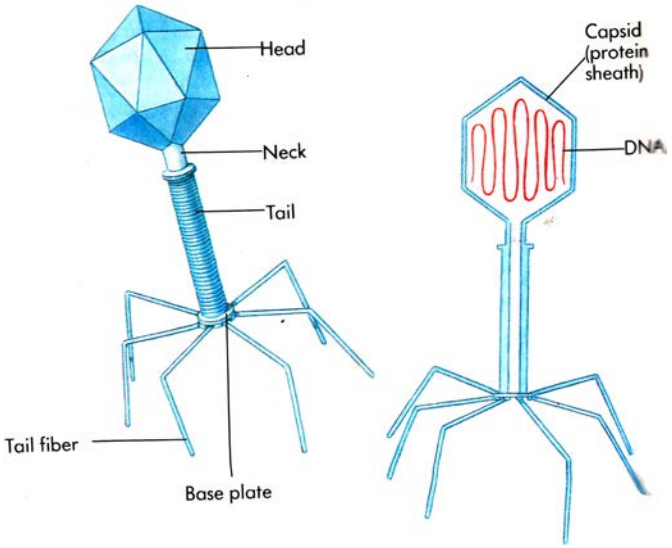


Figure 2.3. Bacteriofage, by Raven & Johnson.

phage DNA injected through the tail into the cell channel. Phage DNA is rearranged by the action of the metabolism of the bacterial cells in 10-15 min. so that it starts to synthesize DNA bacteriophage, but not its own DNA. As a result, the cell dies and goes out of her new bacteriophages 200-1000. Bacteriophages in infected cells are forming new phage particles, resulting in the destruction of bacterial cells. It is found that by injecting DNA bacteriophages may be included in the phage particle of bacterial DNA. In the

case of modified phage infection of bacteria of the donor DNA fragment is transferred to the recipient cell.

2.3 Kingdom of Monerans

Pre-nuclear organisms (Monerans) are characterized by the absence in the cytoplasm of cells issued the nucleus. Hereditary substance cell represented as a circular DNA strand (the nucleoid). Prokaryotic cells are covered with a cell wall, the main component of which is the murein (polysugar associated with amino acids). The cytoplasmic membrane of prokaryotes forms a protrusion, resulting in the formation mesosoma performing the functions of cell organelles.

Prokaryote does not have mitosis and meiosis. The sexual process can proceed in the form of conjugation. Prokaryotes are divided into two subkingdoms Bacteria and Cyan.

2.3.1 Subkingdom Bacteria

Subkingdom Bacteria – lower single-celled organisms (prokaryotes) – appeared 3.5 billion years ago and are active participants in all of the geological evolution of the Earth. About 2 billion years ago, they, along with the plants create an atmosphere similar to today. Molecular oxygen began to accumulate in the atmosphere thanks to the activity of bacteria which was so necessary for the evolution of new organisms – aerobic. The shape of the bacteria may be in the form of beads or cocci (diplococcus, streptococcus, staphylococcus, etc.); sticks, or bacillus (Escherichia coli, tubercle bacillus, etc.); semicolon, or vibrio (Vibrio plague, cholera and others.); spirillae having crimped form. Their sizes depends on the environmental conditions and ranges between 1-10 microns in length and 0.2-1.0 mm in width. Some species of bacteria have flagella or cilia (Figure 2.4). By type of food bacterias are divided into autotrophic and heterotrophic. Autotrophic photosynthetic bacterium is (purple) and chemosynthetic bacteria (nitrifying bacteria, iron bacteria, sulfur bacteria).

Purple bacteria contain a special pigment – bacteriochlorophyll which like the chlorophyll of green plants, provides photosynthesis. Purple bacteria live in the illuminated transparent waters. Chemosynthetic bacteria are used for the synthesis of organic substances is not the light energy, and the energy released

during the oxidation of any inorganic compounds. For example, nitrifying bacteria oxidize ammonia to form nitrous acid which is then converted into nitrogen.

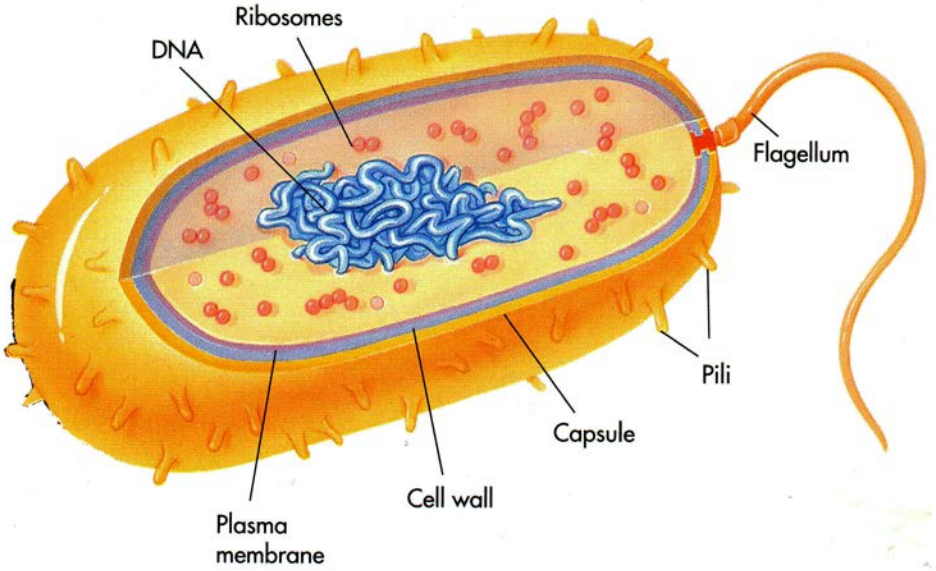


Figure 2.4. Structure of a bacterial cell, by Raven & Johnson.

Iron bacteria convert ferrous iron oxide salt. Sulfur bacteria reduced hydrogen sulfide into sulfur, sulfuric acid and its salts. For heterotrophic bacteria energy source are organic substances. Bacteria-saprophytes produce energy by decomposing organic remains of living creatures, bacteria, parasites feed on organic matter organisms. In general, the bacteria during the life synthesized various amino acids, proteins, organic acids, vitamins, enzymes, nucleotides, DNA. They produce alcohol, lactic acid, butyric acid, acetic fermentation. Bacteria of food industry used for the production of acetic acid fermented milk products, cheese and the like. Bacteria multiply usually direct dividing, and in favorable conditions, every 25-30 minutes. In unfavorable conditions, some bacteria reproduce sexually – conjugation which resulted in the exchange of genetic information, but does not increase the number of individuals. After that, the bacteria multiply direct division. Some types of bacteria (germs mostly) can able to form spores. The contents of the cells are compressed, compacted, covered by a dense shell, which protects the protoplast from harmful influences. The spores are carried by wind, water, animals, and, once in favorable conditions to germinate. The main positive role of bacteria in nature is the mineralization of organic residues. The bacteria are decomposers and make the final, link any food chain. They decompose organic matter to

mineral and thus ensure that the cycling of matter in the biosphere. A special function is performed by Azotobacter rizobium and other families of bacteria that can fix atmospheric nitrogen and convert it into compounds that are available to plants. Because of this soil is enriched with nitrogen, thereby increasing its fertility.

The negative role played by parasitic bacteria. They are the causative agents of plant diseases (phytoftora), animals (brucellosis) and human (cholera, plague, dysentery, typhoid, etc.) and frequently cause their death. For example, Clostridium botulinum can synthesizes Botulinum, 1 g of which can kill 5 million people. In order to combat pathogenic bacteria use a variety of antibiotics and disinfectants (solutions of carbolic acid, mercuric chloride, formaldehyde, alcohol), the impact on them of high temperature, UV, ionizing radiation.

2.3.2 Subkingdom Cyan

Cyan represent ancient morphologically and physiologically group of organisms. Subkingdom includes unicellular, colonial, and multicellular organisms different in morphological structure similar to cell cyano bacteria. The cytoplasm contains lamellar structure and photosynthetic pigments (chlorophyll, phycocyanin, phycoerythrin, carotenoids), which absorb light having 540-630 nm. In filamentous cyano are specialized cells (heterocysts) with strongly thickened discolored bilayer membranes that are involved in reproduction and in the process of nitrogen fixation. Properties such as the cyan in vivo release of organic matter, nitrogen fixation, a special type of photosynthesis determines their important role in soil and water. Multiply cyan cell division in unicellular in half, dividing into separate parts - from the colonies and of thread and disputes. Cyan ubiquitous (in fresh and salt water hot springs, on the surface of the soil, rocks). The value of cyan is determined by their role in enriching the soil with organic matter. They can be food for fish and zooplankton. Be used to produce amino acids, vitamin B_{12} and the others substances. Nostoc and spirulina may be taken for human consumption. In the period of mass reproduction of cyan ("bloom" of water) on the surface of water bodies formed a dirty green film of dead cyan, causing massive fish kills.

2.4 Superkingdom Nuclear organisms

Eukaryotes characterized by the presence in their cells nucleus surrounded by a nuclear membrane, cytoplasm and membrane. The genetic material is localized in the nucleus in chromosomes consisting of DNA and protein. Eukaryotes consist of the three kingdoms: Fungi, Plants and Animals.

2.4.1 Kingdom Fungi

Fungi – lower heterotrophic organisms. Currently, there are about 100 thousand. Species that are found not only in forests, but also in the desert sand, on the rocks, seas and oceans. Mushrooms combine features of plants and animals. With plants brings them together presence in the cells of the cell wall, reproduction spores inorganic growth, food intake by osmosis, immobility, and pets – presence in the cell wall chitin absence cell plastid pigments, glycogen storage, selection urea power heterotrophic means. The body of the fungus mycelium is represented, consisting of interlaced filaments (hyphae). The mycelium can be unicellular or multicellular. The cell is covered with mycelium pectin or chitin shell comprises one or more cores. It stocking carbohydrate glycogen, there are no plastids, so the mushrooms are heterotrophic organisms, use ready-made organic compounds.

Fungi are divided into lower and higher. In the lower mushroom mycelium devoid of partitions and represents a huge portion of the branched cell. Lower fungi are Mouldy fungi, yeasts, fungi, parasites. In higher multicellular fungi mycelia is present. Mushrooms tightly interwoven, forming a false fabric – plektenhimma. Dense plexus of hyphae is called the fruit body. For higher fungi are mushrooms. Reproduction of fungi can occur asexually and sexually. Asexual reproduction occurs by spores (endogenous or exogenous). Endogenous spores are formed in specialized cells. Exogenous disputes or conidia occur at the ends of the mycelium outgrowths, called conidiophores. Perhaps vegetative propagation by parts of the mycelium, the mycelium budding or disintegration into individual cells coated with brownish shell. The latter give rise to a new mycelium. Sexual reproduction is the merging of sex cells (male and female gametes) to form a zygote (Figure 2.5). In higher fungi there is no fusion of gametes differentiated or merging of two cells of vegetative mycelium which occurs through the formation between the

protrusions. Mushrooms are divided into saprophytes and parasites by type of food. Saprophytic mushrooms use organic substances of the host, without causing him harm for example enter into symbiosis with plants. This thread fungus tree roots entwine to form mycorrhiza. The hyphae of the fungus from the soil absorb water and mineral salts, performing the function of root hairs and improving mineral power plants. Mushrooms-parasites feed on organic matter of the host, causing his death. A typical representative of molds is mucor. His body is heavily overgrown multinucleated cells, forming mycelium hyphae which look like fluffy white plaque on the organic remains of plant origin. At the top of the individual vertical threads in particular mature sporangia spores.

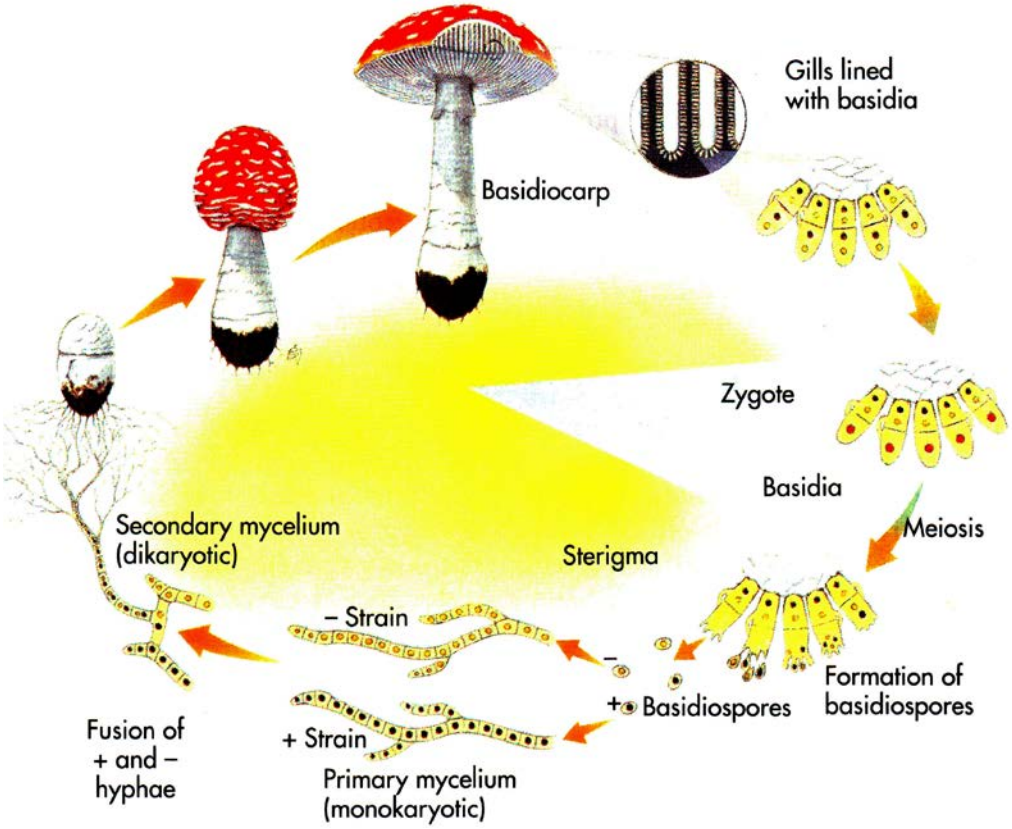


Figure 2.5. Life cycle of basidiomycete, by Raven & Johnson.

Penicillium is also directed to the molds. Its mycelium is multicellular, thrives on organic residues of plant origin, forming a green mold. On the mycelium develop fruiting bodies of a special structure in which the mature spores. The fungus Penicillium is used to obtain the antibiotic penicillin. As a result, selection of highly excretion strains of this fungus.

Yeast – unicellular fungi which have mycelium. Cells of their single-core, oval-shaped have measuring 8-10 microns able to bud. The resulting "kidneys" are not separated sometimes from the mother cell to form a colony. In yeast, the sexual process is possible in the form of conjugation of two cells with the subsequent transformation of the zygote into a bag with 4-8 spores. The yeast causes alcoholic fermentation. The most important are beer and wine yeast are used in brewing, baking, production of alcohol. Wine yeast naturally occurring on the grapes used in winemaking.

Pileate mushrooms are multicellular mycelium which is above the substrate (on the surface of the soil, tree trunks, and so on). Closely intertwined and form a fruiting body, and in the substrate – vegetative body. Fruit body allows sexual reproduction and spore formation, the vegetative – mycelium reproduction pieces. Fruiting bodies of fungi pileate consist of legs, or hemp, and hats, the lower layer which can be a plate or a tube. On the surface of the plates or tubes inside ripen numerous tiny spores that are dispersed by wind, animals, birds, and in the right conditions to germinate. The structure, size and color of hats are different, which is the basis of household differentiation of fungi.

Pileate fungi include eatable fungi (mushrooms, chanterelles, russula and other), tubular (white mushroom, boletus, aspen and other), poisonous fungi (the fly agaric, pale grebe and other) and uneatable fungi (false cep, false greasers and others) mushrooms. A prerequisite for the normal functioning of fungi is the presence of relevant plants, with whom they enter into a symbiosis, a certain temperature, humidity, soil. Great harm crop cause parasitic fungi. Their arguments, hitting the plant germinate in the mycelium, which can only grow at the expense of the host plant tissue. Mushrooms-parasites affect almost all species of plants. The most common of these are ergot, smut, rust, powdery rosyanye mushrooms, Polypore, Chaga and others. Ergot of rye causes disease. On plants affected by it in the ear appear dark purple horns (sclerotia) is a dense interweaving of fungal hyphae. Litter on the ground, these horns winter, and in spring they are formed numerous disputes falling into the ovary of flowers and rye germinating there mycelium. By the fall of mycelium compacted and it re-formed sclerotia.

Smut fungus attacks grains – wheat, oats, corn, resulting instead in ear grain harvest is a huge number of small black spores. Trutovik and Chaga considered conditionally parasitic fungi as their disputes affect only diseased

trees, getting into scrapes, cuts, fissuring birch, pine, spruce and others. Spores germinate into mycelium living at the expense of wood and forming a horseshoe-shaped fruit on the trunk of the body. Some types of fungi cause diseases in animals and humans (scab, mycosis of hand, stomatitis and other). Fungi are important in nature and human life. They mineralize organic remains, improve soil fertility and the living conditions of forest plants are food for animals. A person uses them for food, as a crude drug (Chaga, ergot) for obtaining antibiotics (Penicillium, Aspergillus and others.), alcohols (for yeast), and so on. Fungi used for producing a protein, citric acid, vitamins, enzymes, growth substances. Mushrooms disease in plants and animals, causing them illness, harm the national economy. Developing on food products, industrial products made of leather, paper, and plastics fungi cause spoilage.

Chapter 3. Kingdom Plants

Plants are the most important part of nature. Due to the ability of plants to photosynthesize, they accumulate organic matter, enriching the atmosphere with oxygen and create the conditions for the existence of most organisms. Plants colonize the land surface, penetrate into the depth of the water and climb high into the mountains, forming plant communities that are home to various animals. Currently in the world there are about 500 thousand.

The study of plants is engaged special science – botany. Botany is a science which studies the internal and external structure of plants, especially their ability to live, classification, distribution, relationship with environmental conditions, their significance in nature and human life. Plants are a studied botany objects. Plants are considered from different angles, so separated from the general science independent discipline. Morphology studies the plant variety of external forms of plants, their metamorphosis; anatomy – tissues and their relative positions in different organs of plants; physiology – vital processes and peculiarities of metabolism in plants; taxonomy – the classification of plant; ecology – the relationship of plants to environmental conditions; geobotany and plant geography – laws governing the formation of vegetation distribution of plants in the world; paleobotany – fossil plants, their structure, taxonomy and geography in the past geological epochs.

The main task of botany is a comprehensive study of plants to produce new varieties of high-yield crops and maintaining the ecological balance in nature. Plants are found in all climatic zones. Even the desert is about 1/3 of the land, the poor higher plants, abundant algae, lichens, bacteria. Forests cover 1/6 of the land. There is cultivated land occupied by plants. The vegetation is found at a considerable depth of the seas, oceans, fresh waters. Finally, the Arctic and the Antarctic, snowy mountain peaks, too, are not devoid of plants. Different types of vegetation, characterized by certain phytocenoses formed depending on the climatic conditions on the planet. Kingdom of Plants is divided into two subkingdoms – lower and higher plants.

3.1 Lower plants

Lower plants are algae and lichens. They appeared about 2 billion years ago. A characteristic feature of this group of plants is that their body is

represented by a continuous layer of cells, called thallus or metal. They lack tissue and organs sexual and asexual reproduction, usually unicellular.

3.1.1 Algae

Green algae are lower plants, living mainly in the aquatic environment. They are single-celled (Chlamydomonas, Chlorella, Pleurococcus), colonial (Volvox), with multicellular filamentous (Spirogyra, Ulortiks) or dissected (kelp, hara, undariya, enteromorfa) thallus. The cells of algae are typical of plant structure. They are covered with a polysugars (mostly pectin or cellulose) casing. In the cytoplasm are mitochondria, Golgi apparatus, endoplasmic reticulum, lysosomes, vacuoles. Algal cells are characterized by special organelles - chromatophores of various shapes, which are concentrated chlorophyll a, b, c, d, e carotenoids (carotenes, xanthophylls), phycobilins (phycocyanin, phycoerythrin), and others. The matrix of chromatophore most algae are special in structure to chloroplasts. Pyrenoid destination clusters are replacement nutrients and active synthesis. In addition, the storage substances in algae are starch, oil, polysugar, laminarin, alcohol, mannitol and others. There are more than 30 thousand. Species of algae which are combined into phylums – Green, Brown and others. They can be filamentous, plate, harofitnye. The latter has a multicellular thallus which distinguishes the main escape (axis), leaves and rhizoids. The size of the algae can be microscopic to several tens of meters. Brown algae macrocycts pear reaches a length of 160 m per day, and grows up to 45 cm. Algae reproduce asexually and sexually. Asexual reproduction occurs by dividing protoplast to form spores or zoospores fixed that in the right conditions to germinate into a new individual. Vegetative reproduction in unicellular occurs by cell division in half, and in the colonial and filamentous - the collapse of colonies or filaments into separate pieces, of which develops new individuals. The sexual process is observed in the form of isogamic, anisogamic and oogamic copulations. Green algae live in shallow waters and used for photosynthesis red rays of the solar spectrum. Let us consider them typical representatives.

Chlamydomonas, which lives in stagnant ponds, puddles. This single-celled green alga egg-shaped with two flagella at the front end. Outside covered pectin shell. The cytoplasm is the nucleus, the cup-shaped chromatophores containing pigments. In addition to a large vacuole filled with cell sap, has little

pulsating vacuoles. Chlamydomonas propagated asexually and sexually. When asexual reproduction after dividing cells form four zoospores. They are released from the parent shell and under favorable conditions to germinate. In sexual reproduction under a common parent shell as a result of several divisions formed 8-64 gametes with two flagella (Figure 3.1). In the water, gametes merge from different individuals. The resulting zygote this covered multilayer shell and settles to the bottom. After a period of rest, sharing mitotically gives rise to four new chlamydomonas.

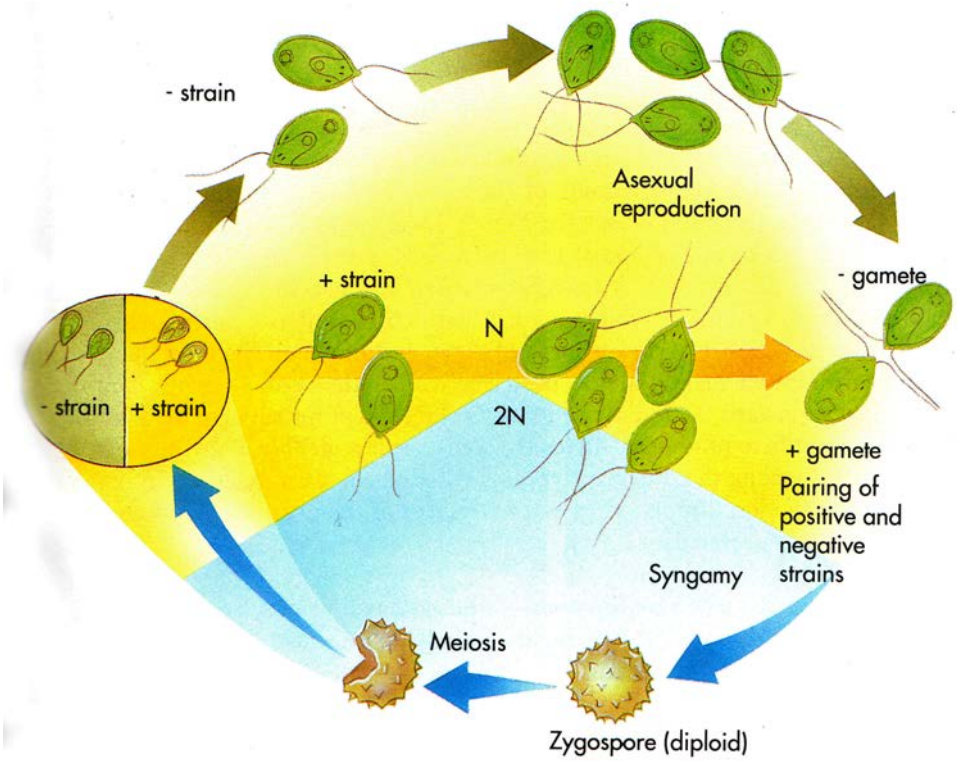


Figure 3.1. Life cycle of Chlamydomonas, by Raven & Johnson.

Chlorella is unicellular green alga that lives in fresh water, salt water and moist soil. It is a small, spherical, and covered with cellulosic cell wall with chromatophores cupped. Chlorella is propagated very quickly nonflagella disputes. Chlorella has actively photosynthesizing and rich in nutrients. Its dry matter discovered proteins, oils, vitamins A, B, C, and K. In this connection, chlorella cultivated and used as feed for cattle, poultry, fish pond. Breeding work is underway aimed at obtaining highly productive kinds of chlorella.

Pleurococcus is terrestrial algae living on the bark of trees and stumps where it forms a green patina. Cells pleurococcus are able to share in two

mutually perpendicular directions, thereby forming multicellular platelets. Therefore pleurococcus it considered one of the transitional forms from single-celled green algae to multicellular filamentous. To carry ulothrix filamentous algae, spirogyra, and others. Ulothrix appendages attached to the substrate bottom (basal) cells. Each cell has belt chromatophores. Reproduction is asexually and sexually. Asexual reproduction is carried out by help of zoospores produced in special cells – zoosporangia. Zoospores are pear-shaped, with four flagella, red eyes and two pulsating vacuoles. Settling on underwater objects, they lose their flagella and by dividing in half to form a new thread. Sexual reproduction occurs through the merger biflagellate gametes from different individuals. The resulting is zygote with four flagella different from the debate the presence of two nuclei and two eyes. Soon nuclei fuse, flagella disappear, the zygote is covered with a thick hull of the about-and in good time grows. It is accompanied by a reduction division of the nucleus and the formation of new species. Spirogyra is a free way of life and forms the mud reservoirs. It is prevalent in standing and slowly flowing waters, often forms large masses of "slime" bright green color. Spirogyra form a thin strand of long cylindrical cells arranged in one row. Outside thread dressed mucous cover. Chromatophores looks helically curved strip. The sexual process is represented by conjugation, in which the contents of a single cell the thread moves to another cell and merges with the protoplast. The resulting fertilized zygote, after a period of rest grows.

The algae blooms are a major producer of oxygen and nutrients, not only to aquatic organisms, but also for human. Nutritional have kelp, porphyry and others. They contain vitamins, microelements. In addition, seaweed is used to produce iodine, bromine, resins, acetone, methyl alcohol, potassium salt, glue. The most valuable product derived from red seaweed, agar-agar is widely used in microbiology and food industry, in medicine. Dead algae form deposits of silt – sapropel that is used in mud therapy and as fertilizer on fields.

3.1.2 Lichens

Lichens – symbiotic organisms composed of algae and fungi (sometimes they settled Azotobacter). Algae are usually single-celled blue-green, sometimes green, mushrooms with multicellular mycelium. Mushroom seaweed provides water with dissolved minerals and enzymes. In the process of

photosynthesis, the algae produces carbohydrates which are used by the fungus and Azotobacter. The latter provides the lichen nitrogen. The body of lichens called thallus, diverse in color, shape, size and structure. Color lichen (white, pink, yellow, orange, gray, blue-green, brown, black, etc.). It is determined by certain pigments are localized in the cytoplasm and membrane hyphae of fungi. The shape distinguish crustose, foliose lichen and bushy. Crustose lichens look like painted brown, tightly fused with the substrate. These include rhizokarpon, hematomma and others. Foliose lichens are attached to the substrate beams fungal hyphae extending from the bottom surface of the thallus. The edges are in the form of thallus notched blades, raised above the substrate. By foliose lichens are Lobar, parmeliya and other. It have branched bushy lichen thallus. It is a shrub or rises above the substrate in the form of thin strands hanging down from the trees. These include Cladonia, Iceland Moss, Everniya, Usnea and others. Thallus of most lichens has upper and lower cortical layers, consisting of densely interwoven fungal hyphae. The inner part of the pre-put loosely woven hyphae, including algae cells are located. The hyphae of the fungus snug against the algae cells or penetrate into it, whereby there is a transfer of substances. Lichens perennials, whose age reaches tens, even hundreds of years. The annual growth of 0.5-7 mm per year since they have a low rate of accumulation of organic substances. Lichens multiply asexually and sexually ways. Sexual and asexual reproduction is carried out by special spores that develop separately from each of the symbioses.

Asexual reproduction also occurs, or pieces of the thallus, or a special outgrowths consisting of algae cells coated with fungal hyphae (Isis). Some species reproduce only their peculiar formation consisting of one or more algal cells surrounded by fungal hyphae (soredia). Lichens are found in almost all terrestrial and some aquatic biogeocenoses, and in the tundra, forest tundra and forests are an essential part of vegetation. Many lichens (parmeliya, cladonia and others) are densely covered with tree trunks and protect them from harmful microorganisms, as lichen acids have antimicrobial activity. Tundra lichens, especially reindeer moss, constitute the main food for the reindeer. Lichens are pioneers of vegetation. They are the primary destroyers of rocks, resulting in a soil for the settlement of other plants. Lichens are used in the national economy for pure glucose, alcohol, gelling and dyes, essential oils. Preparations from Iceland Moss (Icelandic moss) are used in medicine as an antimicrobial

agent. Lichens are sensitive to the oxygen content in the air, and often serve as indicators of pollution.

3.2 Higher plants

Emergence of higher plants is due to the release of plants on land. They were formed to adapt to terrestrial life which led to the emergence of vegetative organs – root, stem, leaf. In this process, it reflected division of functions between the various parts of the body. The emergence of sexual (antheridium and archegonium) and asexual (sporangia) breeding ensured the rapid spread on land. Subkingdom higher plants has no less than 300 thousand species. It is divided into 8 sections: Psilophytes (Rhyniophyta), Moss family, Psilotos, Lycopsids, Horsetail, Ferny, Gymnosperms, Angiosperms (Flowering). According to the program of high medical school departments spread Moss family, Ferny, Gymnosperms and Angiosperms.

The entire organism plant as a living organism is a holistic self-regulated and self-reproducing system which is based on the metabolism. The structural unit of the system is a cell, since it is at the cellular level in plants, chemical reactions of metabolism. Cells are combined according to functions performed in the tissue which in turn generate different plant organs. Each organ of the plant is the result of adaptation of several tissues to perform certain functions. With all the variety of forms of external and internal structure of vegetative and generative organs of plants they function strictly constant. The root provides the mineral nutrition of plants, leaf – organic food, the stem carries introducer and communication function. With the loss of any organ of the plant is disturbed relationship with the environment and it dies. The result of metabolism is all vital functions of the plant (growth, development, reproduction, nutrition, breathing, movement). Height is a quantitative change in weight and size of the plant. There are three phases of growth: fetal characterized by cell division educational tissues; stretching phase cells, during which cell growth occurs, an increase of the biomass; specialization phase cells and formation of plants when cells acquire a structure in accordance with the functions performed.

Development is a qualitative change in the structure of the plant associated with the growth and emerging throughout ontogeny. The development also has several stages. From the moment of fertilization until the embryo germination – the embryonic stage, followed by the seedling stage, the adult plant, budding,

flowering, fruiting age. Depending on the length of the pathogenesis of the plants are annuals (the life cycle – one growing season), biennial (seed formation takes place in the second year), perennial (flowering and fruiting comes on the third or subsequent years). Each phase of growth or development stage proceeds under certain environmental conditions. For example, the germination of seeds of winter varieties is observed at a temperature of 3-5° C, while springs – 10-12° C. Necessary condition for growth and development of plants are eating and breathing. With the growth of movement are inextricably linked plants under the influence of environmental conditions (hemotrophism, phototropism, the present, and others.).

Government flowering plant consists of a variety of tissues with specialized functions. Specialization of cells and tissues reflect the emergence of an important stage in the evolution of plants, opens the preconditions of the individual parts and organs of plants and more efficient adaptation to the conditions of their habitat.

3.2.1. Types of plant tissues

There are formations, cover, basic, mechanical, conductive and excretory types of tissue.

Formation tissue or meristem is a tissue in which cell division occurs constantly. The cells of this tissue consist of cellulosic membrane, a dense granular cytoplasm and a large nucleus. Plastids and vacuoles are not available. Meristem is divided into germ (embryo in the seed), apical (at the growing point of the stem and root), lateral (cambium) and intervening (at the base of interstitial).

Cover tissue is a tissue which protect organs of plants from external influences. These include the epidermis, cork. The epidermis (the epidermis or cuticle) is presented by live and much vacuolated cells which tightly packed together. It covers green plant parts – stems and leaves. It distinguishes itself epidermal cells, stomata and hairs. The shell of the epidermal cells may be covered cuticle which is wet by special ferments, impregnated with mineral salts. In perennials epidermis changes stopper consisting of a uniformly thickened cell impregnated with a special substance. Dead layers of cork with the other tissues form crust.

Basic tissues that make up most of the mass of plants and, depending on the functions are divided into assimilation, suction, reserving, aquifer and pneumatic. Assimilation (chlorophyll) is located in the stem tissue under the epidermis and leaves. It consists of round living cells in cytoplasm which contained many plastids and primarily performs photosynthesis. Suction tissues provided vacuolated cells located in the suction area of the root. At the root hairs, this fabric provides the absorption of water and mineral salts. Storage tissues formed in the fruits, seeds, rhizomes of thin-walled cells, accumulating nutrients. Aquifer and pneumatic tissues arranged respectively in different organs of plants in dry and wet habitats and characterized by the presence of large intercellular spaces containing water or air.

Mechanical tissue is a tissue consists of densely formed contiguous cells possessing thicker shells. They may be dead or alive. Their function is to ensure the strength of the plants. These include bast fibers and wood, stony and other cells.

Conductive tissue is composed of elongated cells penetrated by pores. Water, mineral salts and organic matter are on them. Water and dissolved minerals from the roots (ascending current) enter the plant through the vessels (trachea) and tracheids which are together with the main mechanical and xylitol cloth or wood. Vessels are vertical row of cells in which the transverse walls are destroyed and lost live content and wall thickening in the form of rings, spirals, etc. reticula. The stem at the root is of the inflowing organic substance. He passes through sieve tubes composed of living cells with elongated sieve walls. By the sieve tubes adjacent of cell companion. Sieve tubes, companion cells, along with the main mechanical and tissue forms phloem, or bast. Phloem and xylem elements together represent fibrovascular bundles.

3.2.2. The vegetative organs of the plant

Flowering plants have vegetative organs, providing vital functions of the organism and the vegetative propagation, generative and serving for seed multiplication. Vegetative organs are root, shoot, stem, leaf, and their modification (metamorphosis), a generative – flower, fruit, seed.

Root is underground vegetative body adapted to strengthen plants in the substrate, for sucking and holding water and mineral salts. Furthermore, the root performs other functions: stores nutrients entering symbiosis with nodule

bacteria and fungi hyphae synthesizes nitrogen-containing organic compound (vitamins, hormones, certain amino acids), is used for plant micropropagation (Figure 3.2).

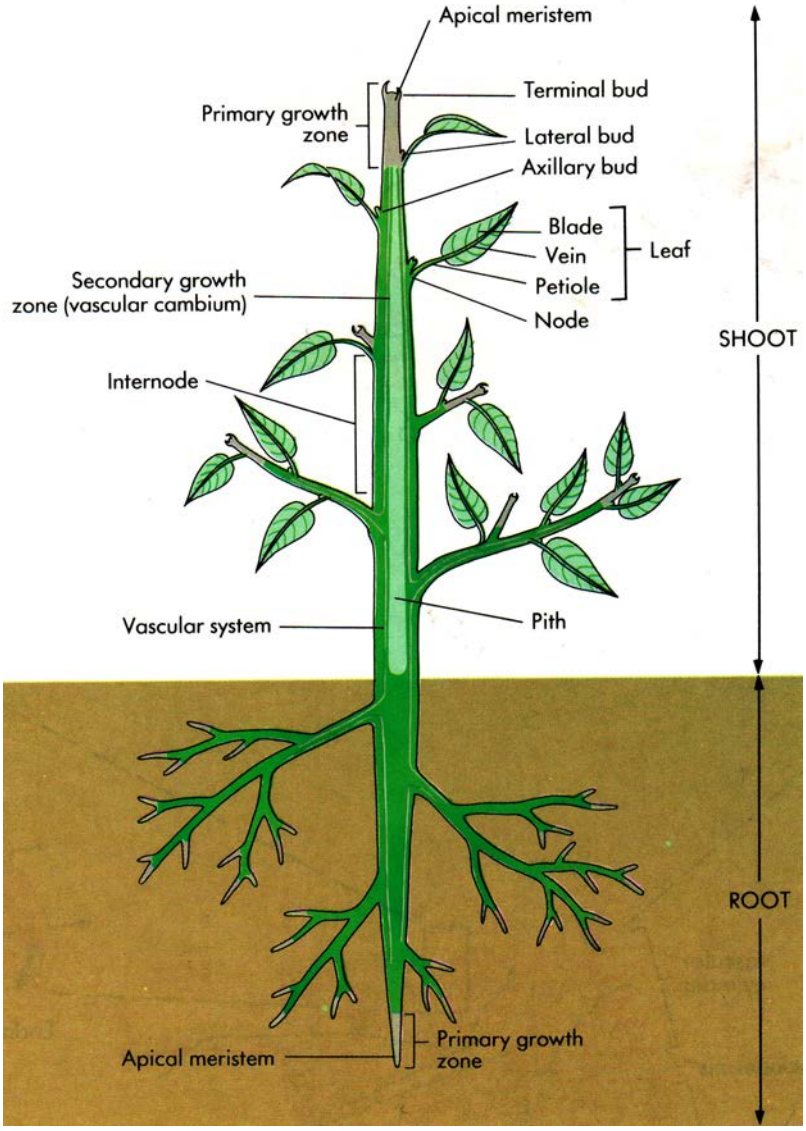


Figure 3.2. Dicot plant body, by Raven & Johnson.

Development starts with the root cell division education embryo tissue root seed. This results in a main root (dicots), the main and 2-6 adventitious roots (monocots). The main root gives rise to lateral roots; from the lower part of the stem or leaves of adventitious roots depart. All kinds of roots in the complex are the root system of the plant. There are pivotal, and mixed a fibrous root system. The tap root system is well defined main root. This root system is inherent in dicots. The fibrous root systems are the main root is different from the paranasal making up the bulk. Fibrous root system is typical for one-part

plants. We mixed the root system is well developed as the main and adventitious roots. It is inherent annual dicotyledonous herbaceous plants. The internal structure of the root is determined by its functions. The growing roots in longitudinal section are four areas - the division, growth and absorption or branching.

Zone of division is composed of cells of the formation tissue, constantly dividing and ensuring the growth of the root length. This area is covered root cap shown living cells from which the outer destroyed. Their contents partially dissolve lumps of soil, which facilitates the promotion of the roots and provide vital functions of soil microorganisms. In the growth zone, cells do not divide and grow and reach a size of cells formed tissue. Suction zone or the area of root hairs, is composed of multiple tissue specific functions. A cross section of the root in this zone the following types of tissues: cover-suction – rhizoderma; primary root cortex tissue and the central axis of the cylinder. Cells cover-suction tissue thin-walled, are outgrowths - root hairs. The latter contain core vacuole, cytoplasm, mitochondria, and is sucked from the soil water and mineral salts. The cells of the primary cortex of the root tissue are as thin-walled living. They carry out the movement of water and mineral salts in the central axial cylinder, which is composed of conductive (vessels and sieve tubes), mechanical (bast and wood fibers), fixed and educational tissues (Figure 3.3).

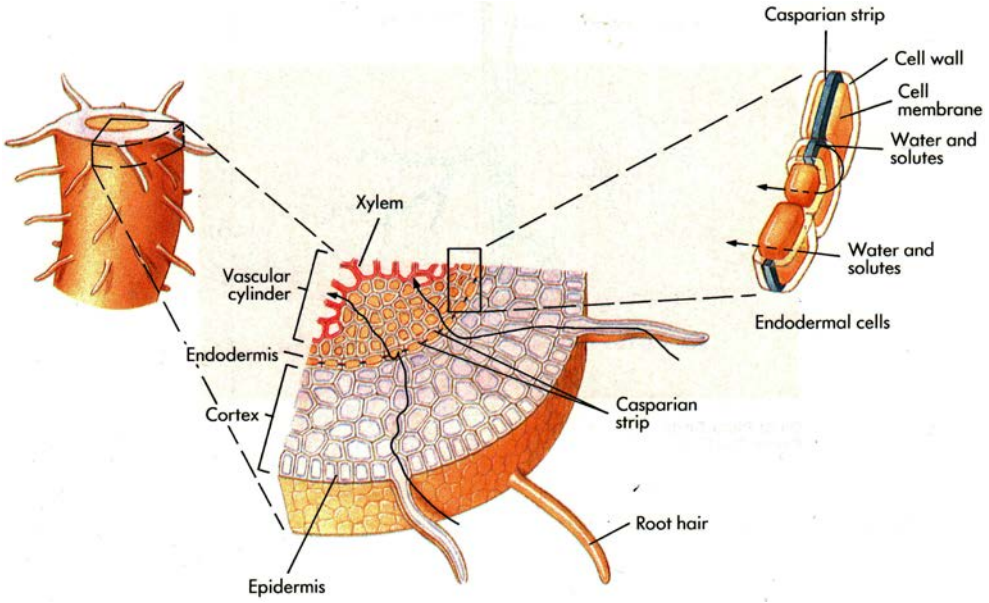


Figure 3.3. Pathways of mineral transport in roots, by Raven & Johnson.

Root uptake of water with dissolved mineral salts is due to the fact that the concentration of mineral salts in the soil is significantly higher than in the root hairs. Further progress on the root hairs to the xylem vessels is also carried out by the difference in the concentrations of water and mineral salts in the cells of the primary cortex. Water and mineral salts from the root hairs come through the primary cortex in the xylem vessels and for them - up to the stems and leaves. Organic substances move from the leaves of the stem at the root of the phloem sieve tubes, which are also located in the central axons. Xylem and phloem of the suction zone of the root pass in the zone of, and then into the stem and leaves, providing a continuous movement of nutrients in the plant. In the zone of the addition have the formation of lateral roots.

The plant root receive from the soil should saline solutions, containing nitrogen, phosphorus, potassium, calcium, sulfur, magnesium and iron for normal development. Since each crop takes from the soil a certain amount of these substances, the soil is gradually depleted.

Nitrogen, phosphorus and potassium in the soil are often lacks. To replenish is the necessary elements to make various soil fertilizer as organic (manure, peat) and mineral (ammonium sulfate, superphosphate, potassium chloride and other). This process is depending on the type and requirements of the plant. Such an organic fertilizer like manure is recommended to apply well before sowing seeds in the autumn tillage (Figure 3.4).

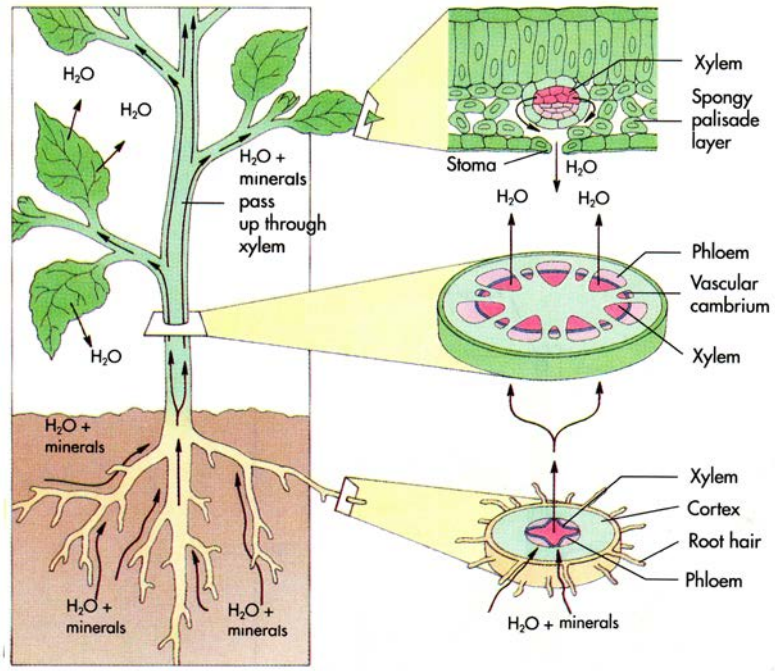


Figure 3.4. Flow of plants materials, by Raven & Johnson.

Mineral fertilizers are applied before or at the time of sowing seeds or in the growing season as a top dressing. Fertilizers containing nitrogen, promote plant growth, containing phosphorus - fruit ripening and containing potassium - an outflow of organic substances from the leaves to the roots. In this regard, fertilizers containing nitrogen, it is recommended to make the seeds before sowing, or early summer containing phosphorus and potassium - in late summer. In connection with the implementation of the various functions of the root can change its structure or undergo metamorphosis. Typical examples of the metamorphosis of the root are the formation of root beets, carrots, parsley, is a modified the main root or root-tuber at Dahlia Liubka, is a modification of adventitious roots, and the symbiosis of the roots with rhizobia (for example, the roots of leguminous plants with bacteria of the genus Azotobacter) or with the hyphae of fungi (for example, the roots of birch, alder hyphae with brown cap boletus); air or breathing roots of aquatic or marsh plants, roots-props (the plants in the area of the tides).

Stem with disposed thereon leaves and buds called escape or escape a body of higher plants, consisting of a shaft (stem) and going away leaves and buds. Escape system with the root system of the body Lycopsida, Horsetail, fern and seed plants. Shoots arose as an adaptation to terrestrial life. It is a single body, the leaves and stems of which are formed from a common array conegrowth escape. It has a single conductive system. The emergence of escape is a largest aromorphosis in the development of flora on earth. The structural element of the escape is the node with the exhaust from a sheet and lying below the interstitial and kidney. Kidney is rudimentary escape. According to the internal structure of the kidney distinguish vegetative and generative (flower). Vegetative bud consists of a shortened stem and placed on it the rudimentary leaves. Root-tuber is inside the buds on the top of the stem. Flower buds contain the rudiments of flowers or a single flower. They are larger, often rounded. Escape from sprouting buds in the period of growth is called an elementary and during the year - one year. In temperate climates, most woody plants have only one increment per year. They coincide with the elementary one-year escape, but oak is often in the middle of the summer was the second increase in the formation of new shoots. Annual escape consists of two elementary. At the tea bush in citrus per year generated from three to seven elementary shoots. Shoot growth occurs due to the apical buds. Each of them has a growth cone at the base of which form the primary tubercles, giving

leaves. In the axils of the leaves are developing secondary tubercles, which are the rudiments of lateral branches. Outside, dense buds covered with scales. This are modified leaves. Also apical buds, an important role in the life of the plant play axillary and adventitious buds. Axillary buds are formed in the axils of leaves and side shoots to develop. Adventitious buds can be put on any organ of the plant and serve as a reserve for the vegetative propagation of higher plants. Branching stem and crown shape depend on the characteristics of the growth of the apical bud. If the kidney functions continuously, the lateral shoots not outstrip its growth and then, as a rule, a so called pyramidal crown. Many of the plants the main escape, reaching a certain length, stops growth and branching proceeds by lateral buds. This feature is used for purposeful formation of the crown.

Lots stem bearing buds or leaves, stem are called nodes, and the areas between the nodes - interstices. Internode can be long or short, and then the shoots are shortened or lengthened accordingly. The angle between the stem and leaves is called leaf sinus. Distinguish stems shaped cross-section, the nature of leaf arrangement and position in space. The internal structure of the stem, as the root is defined by its features: it has a coating tissue, primary cortex and central cylinder axis. Covering tissues of the stem of herbaceous plants is the epidermis. Primary presented photosynthetic bark, basic, mechanical and storage tissues. The central axial cylinder arranged open vascular fiber bundles, as between the phloem and xylem there cambium layer. There are more complicated by the structure of the stems of woody plants. The cover tissue is represented by a stopper - a layer of dead cells with thick woody shell. Gas exchange and transpiration made through lenticels - plug gaps, having a form of bumps or strips. Primary crust consists of partially preserved photosynthetic tissue, mechanical and storage tissues. The central axis of the cylinder is also a member of the phloem, xylem, cambium and core. The beams from the stem wood of dicotyledonous plants there. Cambium form a continuous ring of cambium and outwards from itself creates the elements of the phloem (sieve tubes with companion cells, bast fibers) inside - elements of the xylem (the vessels of wood fibers), as well as cells medullary rays. Cambium unevenly divided by seasons: spring and summer forms have large xylem vessels in the fall - small, in the winter of his activity is suspended. Therefore, every year the annual rings are formed xylem. The inner bark of tree rings can not be distinguished, since its cells are alive and easily dislodged. Due to the growth of

the stem cambium occurs in thickness. The organic matter in the stem is move through sieve tubes. It is part of the phloem and minerals and water for the xylem vessels.

Sheet is aboveground vegetative organs of plants adapted for photosynthesis, gas exchange and transpiration. The sheet can function as reserve nutrients and body micro propagation. The leaves is different way of attachment to the stem, leaf shape, the character of the region, choppiness of the leaf blade, venation, degree of difficulty, and so on.

The internal structure of leaves is rather monotonous at various plants. Leaf covered with epidermis cells which fit snugly to each other and contain the vacuole, cytoplasm, nucleus, leucoplasts. Painted plastids in the cells of the epidermis is not, so it is transparent. In some plants, the epidermis covered with cuticle, hairs, glands, secrete resinous substances and essential oils, which prevent the penetration of microorganisms in the list and to protect it from overheating and the evaporation of water. In the epidermis are stomata, due to which there are gas exchange and transpiration. They are formed by two guard cells bean-shaped and are distinguished from other cells of the epidermis large number of plastids. Between the guard cells is a gap opening and closing of which causes a change in the osmotic pressure inside the guard cells, as well as varying degrees of thickening their shells (concave shell thickened more than convex). As a result of photosynthesis turgor pressure in the guard cells are increases, their thin walls bend towards the epidermal cells, thus delaying the concave shell which leads to increased stomatal slit. Most plant stomata are closed during the night, are open from dawn to noon. Then, during the state of the stomata of the day varies depending on the weather and the characteristics of plant biology. Between the upper and lower epidermis of the leaf tissue is the primary - mesophyll. The upper epidermis adjacent columnar mesophyll consisting of densely located cells with many chloroplasts. Their main function is photosynthesis (Figure 3.5.).

The lower epidermis adjacent spongy mesophyll consisting of rounded green cells with large intercellular spaces. The main functions of this tissue are gas exchange, transpiration and photosynthesis. The mesophyll leaf veins are located, or the vascular fiber bundles composed of xylem, phloem, mechanical and basic tissues. For vessels of the xylem in the sheet supply water and mineral salts, in sieve tubes organic substances are discharged.

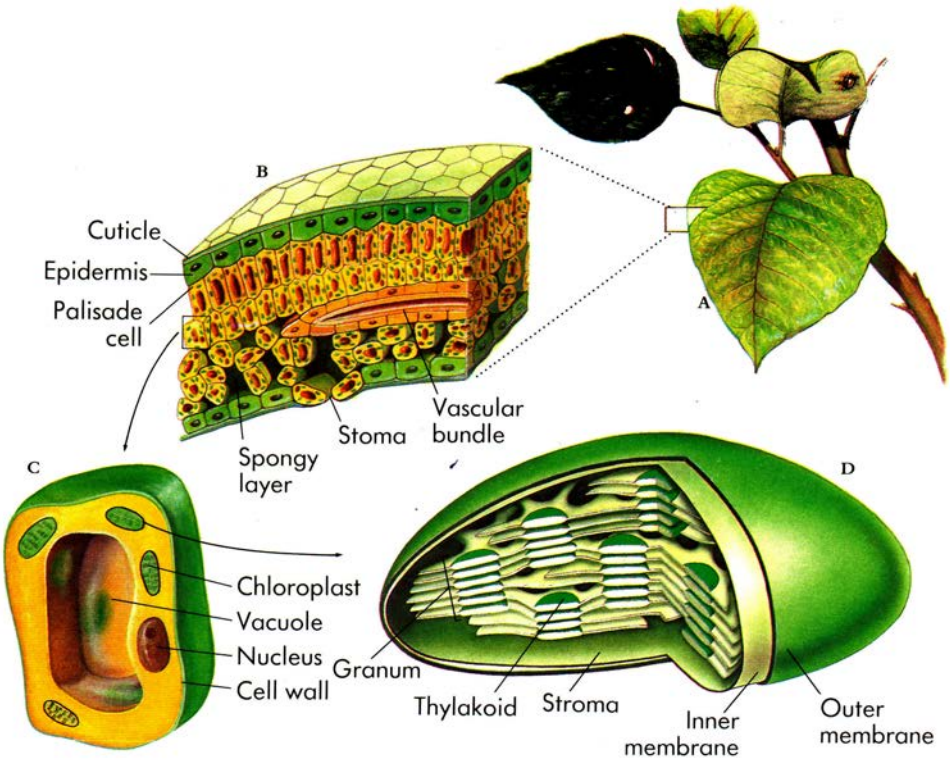


Figure 3.5. Journey into a leaf, by Raven & Johnson.

All green plants are autotrophs because their power is due to photosynthesis. Speaking of the nutritional value of the photosynthesis of plants, it should be noted that the accumulation of plant organic matter depends on the condition of two processes – photosynthesis and respiration. In favorable conditions (good lighting, the optimum temperature and humidity), photosynthesis is more intense breathing, so the synthesis of organic compounds exceeds the collapse during breathing. With the onset of adverse conditions in the autumn it difficult to supply water plants, photosynthesis, transpiration and gas exchange. Leaves themselves by that time age and become ballast for plants, since they accumulate a large amount of unwanted metabolic products, in particular mineral salts. The process of leaf fall due to the separation formation layer, cut the stalk at its base called leaf. Defoliation is of great biological importance in nature. Fallen leaves are good organic and mineral fertilizers because they protect the roots from freezing. In evergreens massive defoliation often timed to coincide with the beginning of the development of new shoots from the buds. In particular, our softwood and summer-grass winter-green mass mortality and defoliation not observed in the autumn and spring. For woody plants, living in a frost-free climate with a pronounced dry period (tropical savannas and savanna forests), defoliation is

also a tool to endure drought. However, lowering the temperature and humidity rarely direct cause leaf fall. The biological clock that signals the approach of autumn plants, is a change in the length of the day.

3.2.3 Generative organs of the plant

Flower is a modified short shoots which formed spores, gametes, occurs pollination, fertilization, seed and fruit development. Pedicel in flower is a modified stem and sepals, petals, stamens and pistils – modified leaves (Figure 3.6.). All the parts of a flower placed on the receptacle which is an extended part of the peduncle. Outside there is a perianth, consisting of calyx formed by the sepals, and the corolla, formed by the petals. The sepals are almost always green, rarely painted; the petals are usually painted in red, pink, blue and other colors. The calyx and corolla can be gamopetalous and section-petal. Sometimes perianth consists of sepals (in cereals, birch), or only from the petals (from lilies, tulip). Perianth is designed to protect the internal parts of a flower (stamens and pistils), attracting insects spread the fruits after fertilization, when it is modified. At the center of the flower are the stamens and one or more pistils.

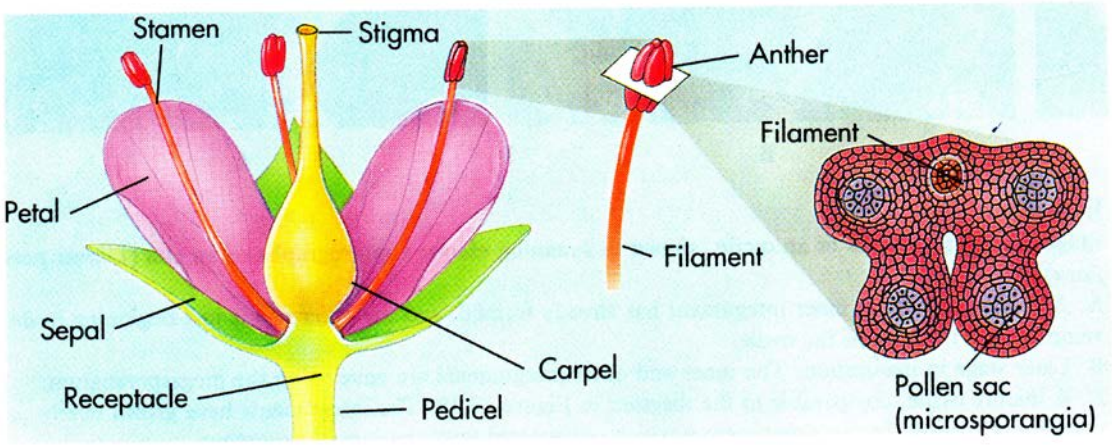


Figure 3.6. Diagram of an angiosperm flower, by Raven & Johnson.

Stamen is the male generative organ of a flower (Figure 3.6.). The stamens consist of filaments and anther four- nest, courier split into two halves. Maturation of pollen in anthers occurs as follows. In the future nests among anther cells educational fabric are four special cells, which through a series of mitotic divisions to form the nutrient tissue of anthers and microspores mother

cells. Last fall meiosis, forming four haploid microspores of which are dust particles. The shell is differentiated on the exine (outer, thick, porous) and intine (inner, thin). Haploid nucleus divides by mitosis to form the vegetative and the generative nuclei. Upon germination of pollen on the stigma vegetative nucleus forms a pollen tube and generative – two sperm.

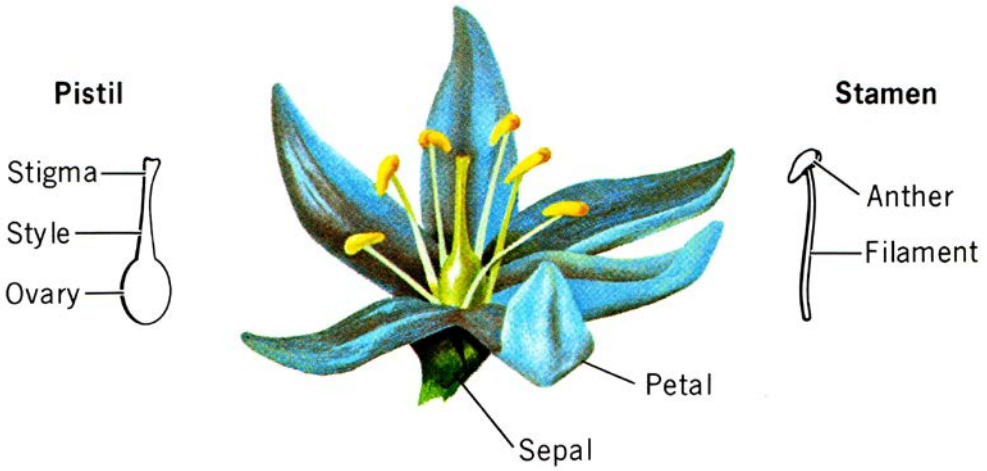


Figure 3.6. The parts of a flower.

Pistil is the main part of the flower, participates in the formation of the flower. The pistil consists of ovary, style and stigma. The ovary is one or more ovules, which mature egg. Each ovule consists of immature embryonic tissue (nucellus) and covers (integument). The nucellus segregated one large cell and divides by meiosis to produce four haploid macrospore. Three of them are absorbed, the rest grows and becomes the embryo sac. The core of it is divided into three mitosis, forming eight cores, which are sometimes referred to as cells, as they are isolated areas around the cytoplasm. One gets the egg, the other two - cells synergids, ranging from pollen-entrance. Three cells are on the opposite end of the embryo sac, form the antipodes. The two remaining at the center of the cell merge and form a diploid vegetative cells.

Flowers with stamens and pestels are called bisexual (from celandine, cherry); flowers, bearing only stamens or pistils only - unisexual, staminate or pestellate, respectively (from nettle, willow). When staminate and pestellate flowers are on the same plant, it is monoecious (watermelon, walnuts). If staminate flowers are on the same plant, and pestellate on the other, the plant is dioecious (hemp, poplar). The flowers of different plants vary in size, color, structure (the number of parts of the flower, the degree of fusion and location on the receptacle).

Therefore, a brief description of the flower often use a formula – the letter of its structure. Calyx designated by the letter H, petals corolla – A, stamens – T, pestle – P. The number of parts of the flower is a diagnostic feature and is designated corresponding digit, for example floral formula cruciferous written letters of the Russian alphabet: $H_4A_4T_{2+4}P$. Typically, floral formula is denoted by Latin letters. Inflorescence is a group of flowers, placed on a common peduncle.

The inflorescences are classified according to the type of branching of the main peduncle on indefinite and definite. In uncertain (botric) inflorescences main flower growing for a long time, flowering is in ascending order: the latter revealed apical flower. Certain (cymose) inflorescences have limited the growth of the main peduncle, flowering goes from top to bottom. Inflorescence emerged in the evolution of leafy shoots in different groups of angiosperms. The biological significance of them in Entomophilous plant is that smaller flowers, which consumes little plastic material collected in the inflorescence and clearly visible to insects, which accelerates their pollination. In wind-pollinated plant inflorescences are usually found at the ends of the branches, the leaves are not covered, which contributes to better returns and capture pollen.

Pollination is a process that provides the pollen on the stigma of getting an appropriate pestle. In nature, we formed two types of pollination: self-pollination and cross (Figure 3.7.). Self-pollination is the process by which occurs in bisexual flowers when pollen from the anther to the stigma of his poured the pestle. It is usually carried out in a closed bud while maturation stamens and pistils, and there have bisexual flowers. It is characteristically for peas, beans, barley, flax, tomato and other plants. Cross-pollination - the process of transferring pollen from the stamens of one flower to the stigma of another. It is can be carried by the wind, insects, water, birds, mammals, man. The most common is wind and insect-pollination. Wind-pollinated plants produce a large number of small, light, smooth pollen bloom before leafing, have reduced perianth, stamen anthers on long filaments, or feathery hairy stigmas. Pollen their large, rough, often glued to lumps. By entomophilous plants are cells, milkweed, daisy, viburnum and others. The plant is very important artificial pollination to produce new varieties and increase crop yields. Artificial pollination is a targeted transfer of pollen from the stamen of the flower of one plant to the stigma of other flowers. In order to prevent accidental pollination, remove the larvae on the flower to be pollinated, or put it

in a gauze bag. However, cross-pollination is preferable as there is a connection of gametes with different hereditary; offspring is a more diverse, with a large amplitude adaptability to different conditions of existence. It is known that self-pollinated crop plants gradually degenerate. Therefore, in the nature of a small number of self-pollinated plants sometimes appears cross-pollination, which contributes to the development of the species.

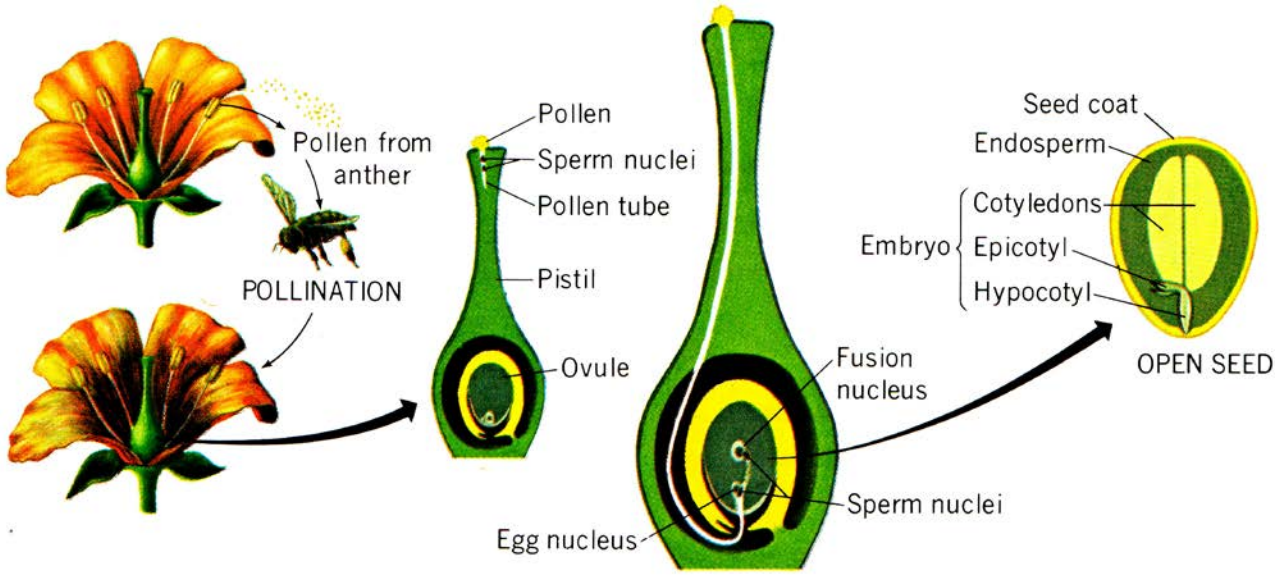


Figure 3.7. Pollination and seed formation.

Double fertilization is a type of sexual process of typical flowering plants. Once the pollen reaches the stigma begins its germination. Through time exine pollen tube bulges, which are promoted by two sperm and vegetative cell creates a breeding ground. Pollen tube penetrates the embryo sac through pollen-entrance where it dissolves the shell. One haploid sperm fuses with the egg to form a diploid zygote, the other with a diploid cell, forming a triploid endosperm cell center. This process, which has universal significance for the angiosperms is called double fertilization. After fertilization synergids and resolve opposites. Thus, as a result of double fertilization, the diploid zygote embryo of the seed produced from the central triploid cells – endosperm, ovule integument peel give seed. From the walls of the ovary pericarp is formed which together with the seed of the fruit forms, called true. If the pericarp is formed from receptacle or other parts of flower, fruit called false.

Fruit is a reproductive organ of flowering plants, growing of flower seeds and enclosing. The fruits vary in shape, the structure of the pericarp, seed number, color, size, origin. There are several classifications of fruits, but is

more commonly used morphological, based on various external signs of the fruit. The consistency of the pericarp of the fruit is divided into dry (open, indehiscent) and juicy. It reveals dry fruit can be a box (poppy, henbane), the pod (cabbage, radish), silicle (shepherd's purse), bean (peas, beans), leaflet (marigold). To dry indehiscent fruits are achene (sunflower) weevil (wheat, barley), walnut (oak, walnut). Juicy fruits are: berries (grapes, watermelon), apple (apple, mountain ash), drupe (cherry, plum), melon (pumpkin, cucumber). By the number of seeds fruits are divided into one-seeded (plum, peach), two-seeded (pear) and seeded (tomato, potato). By origin, the fruits are divided into simple (nuts, peas) and complex (magnolia, mulberry), the true (cherry, plum) and false (strawberry, rowan). An interesting group of origin are complex fruits produced from the flower that has some pestels (leaflet team from Magnolia), or inflorescences (stem from raspberry, mulberry). Fruits function is to protect the seed from adverse environmental conditions and distribute them in nature.

The seed is an embryo with a supply of nutrients enclosed in the rind that develops from the ovule. Seeds of mono- and dicotyledonous plants differ in the number of cotyledons in the embryo at the place of laying the nutrients (Figure 3.8.). Consider a bipartite structure of the seed (bean) and monocotyledonous (wheat) plant. Seed bean consists of a germ and seed coat. Outside, on the concave side has a scar - a place of attachment to the wall of the seed of the fruit. Under the skin is visible embryo which is formed by embryonic roots, stalk and gemmule with two cotyledons.

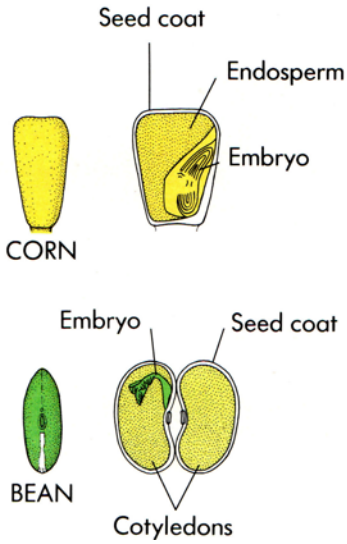


Figure 3.8. Endosperm in corn and a bean, by Raven & Johnson.

Cotyledons are these are the first modified leaves of the embryo. In beans and some other bipartite (beans, asteraceae) in the cotyledons is the supply of nutrients, which is spent on seedling growth and has a protective function in the plumule.

Much dicotyledonous supply of nutrients is in the endosperm, but not in the embryo. Seed wheat is also the seed coat, tightly fused with a dry pericarp, germ and endosperm. The germ contains the embryo root, stem, and one cotyledon gemmule, modified to shield separating the embryo from endosperm. During germination of the seed cotyledon this (shield) promotes the flow of nutrients to the fetus from the endosperm. The composition includes organic seed (proteins, fats, carbohydrates, vitamins), and inorganic (water and mineral salts) substance. Vegetable protein (gluten) contained in the form of protein (aleurone grains) in the endosperm or cotyledons. Vegetable carbohydrates (starch, inulin) are stored in the form of starch grains. Fat accumulates in the form of fat droplets in the cytoplasm of the cells of the endosperm or cotyledons. The content of proteins, fats and carbohydrates in the seeds of various plants is not the same, such as the seeds of beans, peas, soybeans are rich in protein, wheat, rice, rye – carbohydrates, sunflower, flax, walnut – fats. Mineral salts usually in the seeds are salts of potassium, calcium, phosphorus, sodium, as well as minimal amounts of salt of copper, iron, magnesium and others.

Germination is a stage of plant life associated with the activation of enzymes and nutrients replacement seed. Seeds need a certain temperature, humidity, the presence of air and a living embryo for germination (Figure 3.9.).

Germination begins with swelling of the seed while actively dividing cells of the embryo tissue educational and embryonic root appears first. He goes deep into the soil and begins to ensure that the mineral nutrition of the germ. Pro-buildup of the stem is due to the nutrients that are in the cotyledons or endosperm. With the advent of the first ground of leaves begins independent organic food seedling. Taking into account the different conditions of seed germination, set the time of sowing and the depth of their termination. Time of sowing depends on the ratio of seeds to temperature. In most plants the seeds germinate best at a temperature of + 10-15° C (spring crops), in others - at + 1° C (winter crops). Planting depth related to the amount of nutrients in the seed and their relation to the characteristics of the soil and humidity. Large seeds are

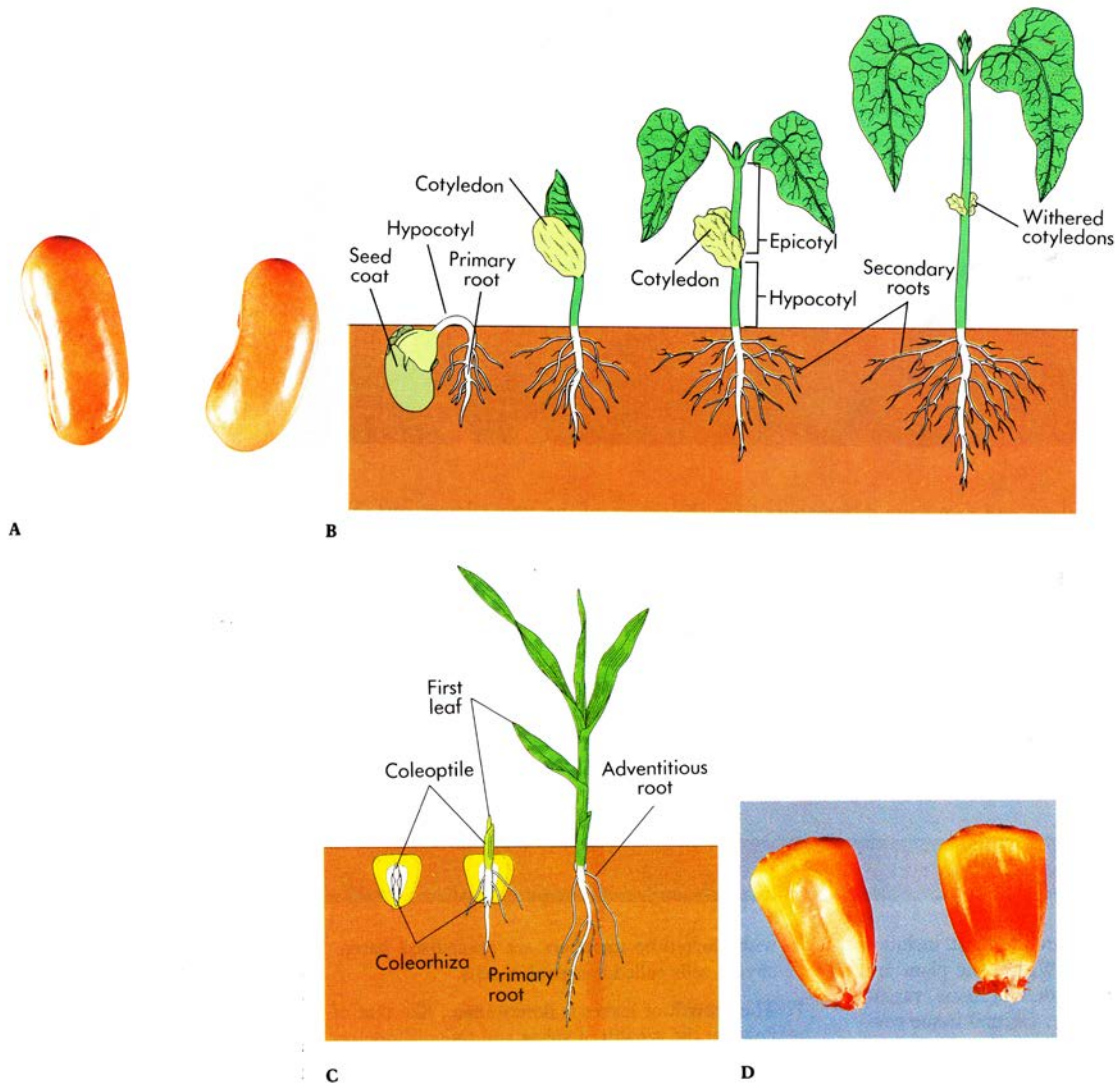


Figure 3.9. Seeds and stages of germination in a dicot (A and B) and a monocot (C and D), by Raven & Johnson.

planted in sandy soil to a depth of 3-4 cm in clay and black earth - 2 cm; small seeds respectively, to a depth of 1-1.5 cm and 1 cm.

3.2.4 Plant reproduction

Plant as a whole organism is capable of reproducing itself. Reproduction of plants can be asexual (vegetative, sporulation) and sexual. Vegetative (asexual) reproduction is characterized by an increase in the number of individuals of this species by separating the viable parts of the vegetative organs of plants. It is based on the ability of plants to regenerate. In unicellular organisms, cloning is carried out by dividing the parent cell into two daughter. Many algae, fungal mycelium, the thallus of lichens break up into parts, each of which may be an

independent body. Higher plants reproduce by parts of the vegetative organs. The nature and practices of crop spread reproduction bulbs (onion, tulip, lily, hyacinth), tubers (potato, artichoke), rhizomes (iris, lily, peppermint, wheat grass), a division of shoots (cactus), whiskers (strawberries), root-tuber (dahlia, sweet potato), dividing the bush (rhubarb, sorrel). In horticulture is widely used vegetative propagation using cuttings and with grafting. Sharing is the length of the stalk (stem stalk), root (root stalk) and leaf (leaf stalk), serving for artificial breeding. Like pieces of cuttings of tubers and rhizomes, bearing "eyes" – the kidneys. Stem cuttings are planted in soil morphological lower end, which formed appendicular roots, and at the top of the kidney grow shoots (Figure 3.10.). Stem cuttings propagated geranium, rose, jasmine, elderberry and other plants. Root cuttings after planting are formed from the cambium adventitious buds, giving the runners (from cherries, plums, rose hips, chicory). With the formation of adventitious buds on the roots is due reproduction root (from rowan, blackthorn, aspen), which occur when the root system injury. Leaf stalk is a leaf petiole or part of the leaf blade. In this way, multiple copies far fewer plants than stem and root cuttings, often in floriculture (begonias, hyacinths, violets).

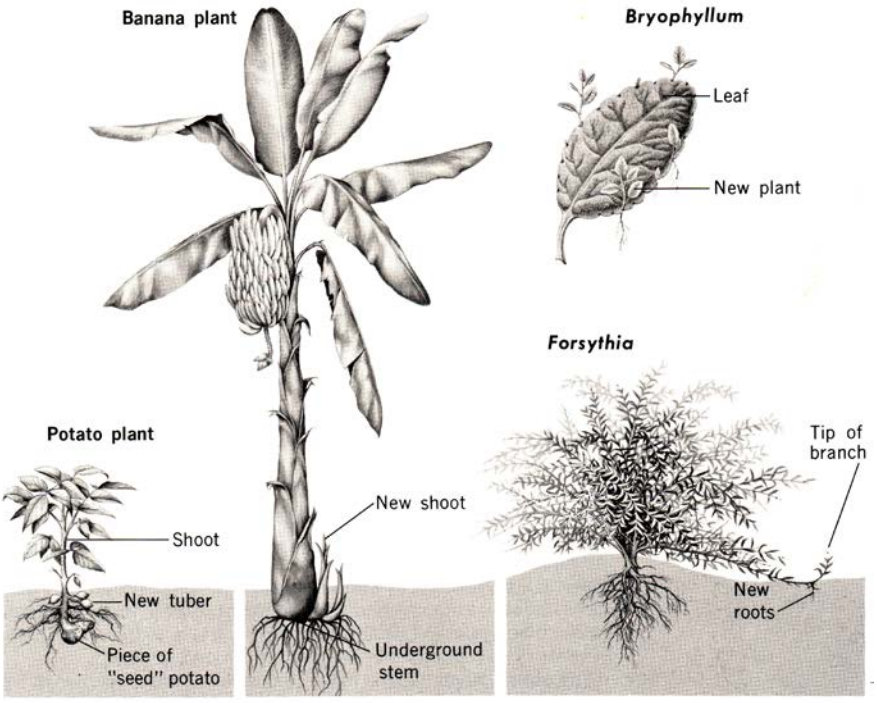


Figure 3.10. Asexual reproduction in four flowering plants.

A variation of propagation is propagation of plants by layering. In this part of the shoot is pressed against the ground to take root, then cut entrenched strains. In the natural state of layering breeding tree species capable of taking root lying on the ground branch (fir, linden, bird cherry, and others.). In horticulture, the vaccine is widely used as a method of obtaining new varieties or directional change existing ones. The ability of plants to vegetative reproduction allows them to keep the signs of the type in a long line of generations, since the subsidiaries individual genotype is a copy of the parent. However, to adapt to ever-changing environmental conditions plants need periodic updating of genetic information, so the same type of plant reproduces through all methods of reproduction. Asexual propagation of plants by means of dispute representing haploid cells coated with durable protective coating. Some plants have debate flagella for movement and called zoospores. The spores (zoospores) are formed on the plants in special bodies of sporangia (zoosporangia). In lower-celled plants sporangia, the higher - multicellular. The body on which are formed sporangia spore called sporophytes. Once in favorable conditions, spores germinate to form haploid organisms – gametophyte. According to the structure and characteristics of gametophyte of life is different from the parent plant. Only fungal spores during germination of form are similar to the parental individuals. When asexual reproduction hereditary characteristics are transmitted without change and are fixed in a number of generations. Sexual reproduction in plants is the appearance of new individuals from the zygote formed by the merger of male and female gametes. Sperm from spore-bearing plants are formed in special genitals - antheridia and egg - in archegonia. In flowering plant male gametes (sperm cells) mature in the anthers and ovules - in the embryo sac of the ovule. In sexual reproduction ensures genetic variability of organisms from one generation to another, as the individual child are different genotype from both parental forms.

Plants in the development cycle there is an alternation of sexual and asexual generations (Figure 3.11). Sexual generation represented haploid organisms - gametophyte, which formed antheridia and archegonia happens sexual process. Asexual reproduction is a diploid organism, which has grown from a zygote. It formed the ACT-rank disputes. At moss sporophyte develops on the green gametophyte; in ferns, horsetails and moss gametophyte exists independently and separately from the sporophyte; gametophyte in seed plants greatly reduced and never leaves the sporophyte. Thus, the alternation of gene-

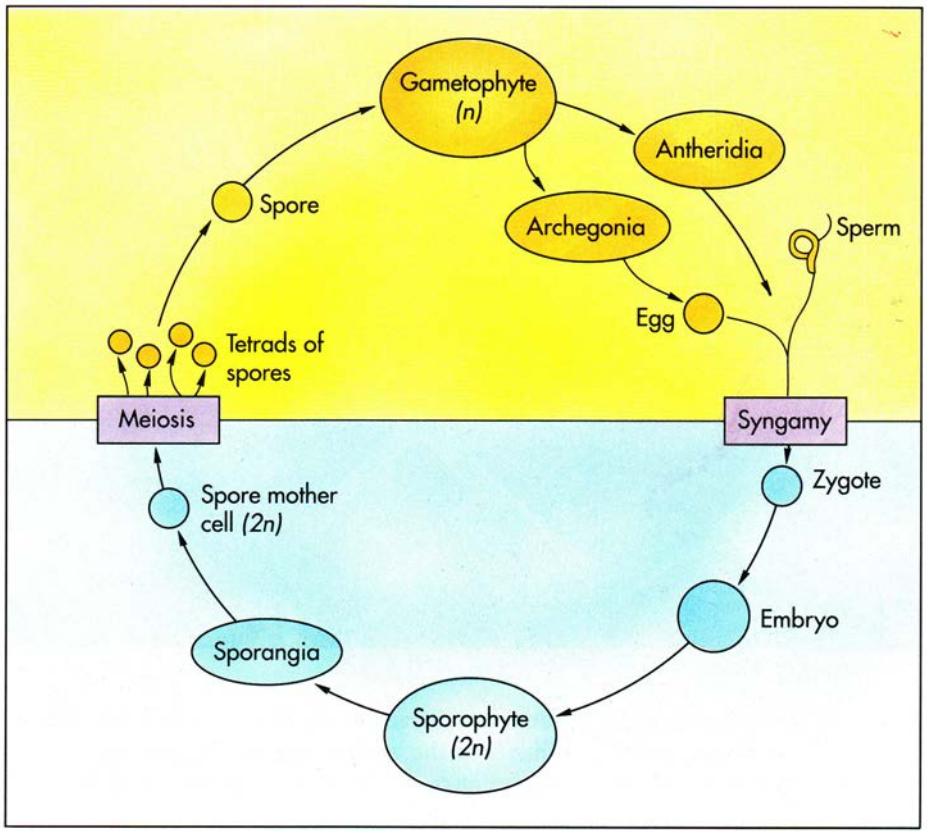


Figure 3.11. Generalized plant life cycle, by Raven & Johnson.

rations in the development cycle of plants is associated with the change of haploid and diploid stages: the sporophyte begins at fertilization and is a diploid, gametophyte – with the formation of the dispute as a result of meiosis is haploid. The alternation of generations, and provides plenty of different – quality offspring, which allows the best view to adapt to environmental conditions.

3.2.5 Moss family

Moss family consists of higher plants, the body of which is differentiated into stem and leaves. The function of the roots performs rhizoids. Moss family is relatively simple internal organization. They have the assimilation tissue, poorly specialized mechanical, conductive, store and coating tissues. In a series of mossy gametophyte sporophyte dominates. Moss family is found on all continents of the globe, often in places with adequate or excessive moisture. Leafy mosses are especially prevalent green sphagnum and others. A typical example of a green moss is cuckoo flax – a perennial dioecious plant, up to 40 cm in height. Stalk him erect, the leaves are short, narrow-linear. Propagated cuckoo is flax as follows. At the top of males formed saccate education –

antheridia, which develop be greater than the number of biflagellate sperm, and on top of females - archegonia with flask-shaped eggs. Sperm with drops of rain or dew reach archegonia then fertilization occurs and the zygote is formed, which immediately divided. The result is a box on a long stalk – sporogony. In the box are formed as a result of meiosis small haploid cells (spores), covered with a dense shell. Then the box is opened and poured controversy. Once on the moist soil, they germinate in embryo representing extensive green thread – Proton. It formed buds, giving the new shoots of moss. Cuckoo flax is a change of ways of reproduction: sexual and asexual gametophyte – sporophyte. Gametophyte is formed with the adult plant it gametes, sporophyte – box with the stalk develops from a zygote (Figure 3.11.).

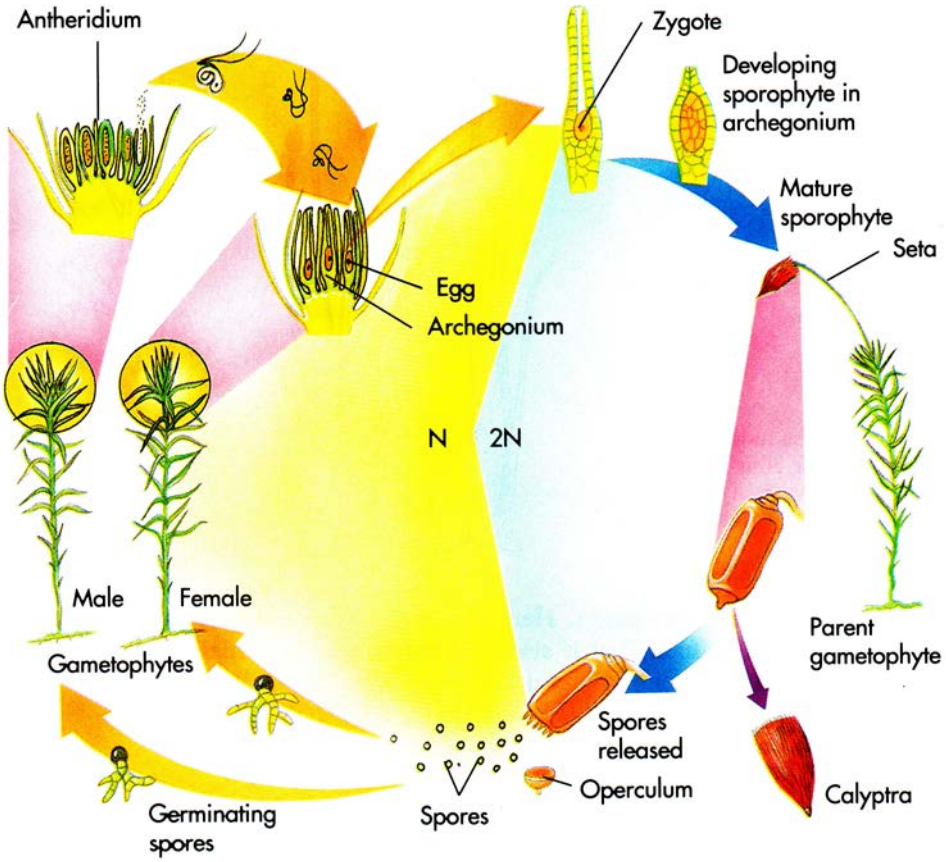


Figure 3.11. Moss life cycle, by Raven & Johnson.

Consequently, the sporophyte as it is an organ of the gametophyte, as it relates to him, not only morphologically, but also physiologically. Sphagnum mosses include 300 species belonging to the genus Sphagnum. They are well represented in the temperate zone of the northern hemisphere, dominating the rest of the plant species. In contrast to the genus Sphagnum mosses has no rhizoids. The stem is not conductive beam. The core occupies the central part,

and then the fabric is manual, and the outside is a multilayer tissue, cells which do not have a live content can absorb water and transfer it to other cells through pores in membranes and Antheridia archegonia can be formed either on the native specimens, or on different branches of the same plant. For fertilization a drop of liquid is need. After fertilization, the zygote is formed from a box on a false leg. The box spores are formed. After maturation poured on the soil and germinate forming a plate of protons with rhizoids. On protonemal kidney grows leafy shoots. Sphagnum mosses growing tip and the lower part gradually die.

Representative of sphagnum moss is sphagnum or peat moss. In the dry state it has a whitish color, due to the structural features of its leaves. They distinguish two layers of cells. One form narrow, elongated cells containing chlorophyll grains. The other layer consists of large polygonal cells hulls have transverse thickened. These cells lack the live content and are usually filled with water, and dried state - air. Dried sphagnum mosses can absorb large amounts of water, at 30-40 times their own weight. Stem branched from sphagnum, the lower part of his strengthens the soil and takes over the function of rhizoids. So at last sphagnum mosses do not develop, but the lower part of the stem gradually die off, but not completely rot, as moss synthesizes special substances - humic acids. Recent putrid kill bacteria and thus delay the process of decay. In those places where the sphagnum mosses grow, over time, accumulate a large amount of organic residues that turn into peat. This process is very slow - 10 years, a layer of peat not exceeding 1 cm. Peat, known to be used as fuel, fertilizer, the raw material for wood alcohol, carbolic acid, resins, plastics, physiologically active substances, medicines. Sphagnum moss can be used as a dressing since they possess antiseptic properties.

3.2.6. Fern order

Fern order is the oldest group of higher plants which was formed in the Devonian period of the Paleozoic era. They account for about 10 thousand. Species live in the damp dark forests, ravines, boggy meadows, deserts and tropical forests. Most of fern is land plants, but some forms are aquatic. In the tropical forests of tree ferns are found 20-25 meters in height, trunk diameter up to 0.5 meters. Ferns have typical of the strong development of leaves. Pinnatisect plate which having a common stalk, which is attached to the

underground stem, which is a rhizome. Leaves in addition to its core functions (photosynthesis, transpiration) perform the role of spore formation.

The most widespread fern is Dryopteris male. He shortened the stem with the convergence of interstices, which runs long (1.5 m) leaves, performing the function of photosynthesis and sporulation. The lower part of the stem turns into a powerful rhizome bearing adventitious roots (Figure 3.12.). On the under-

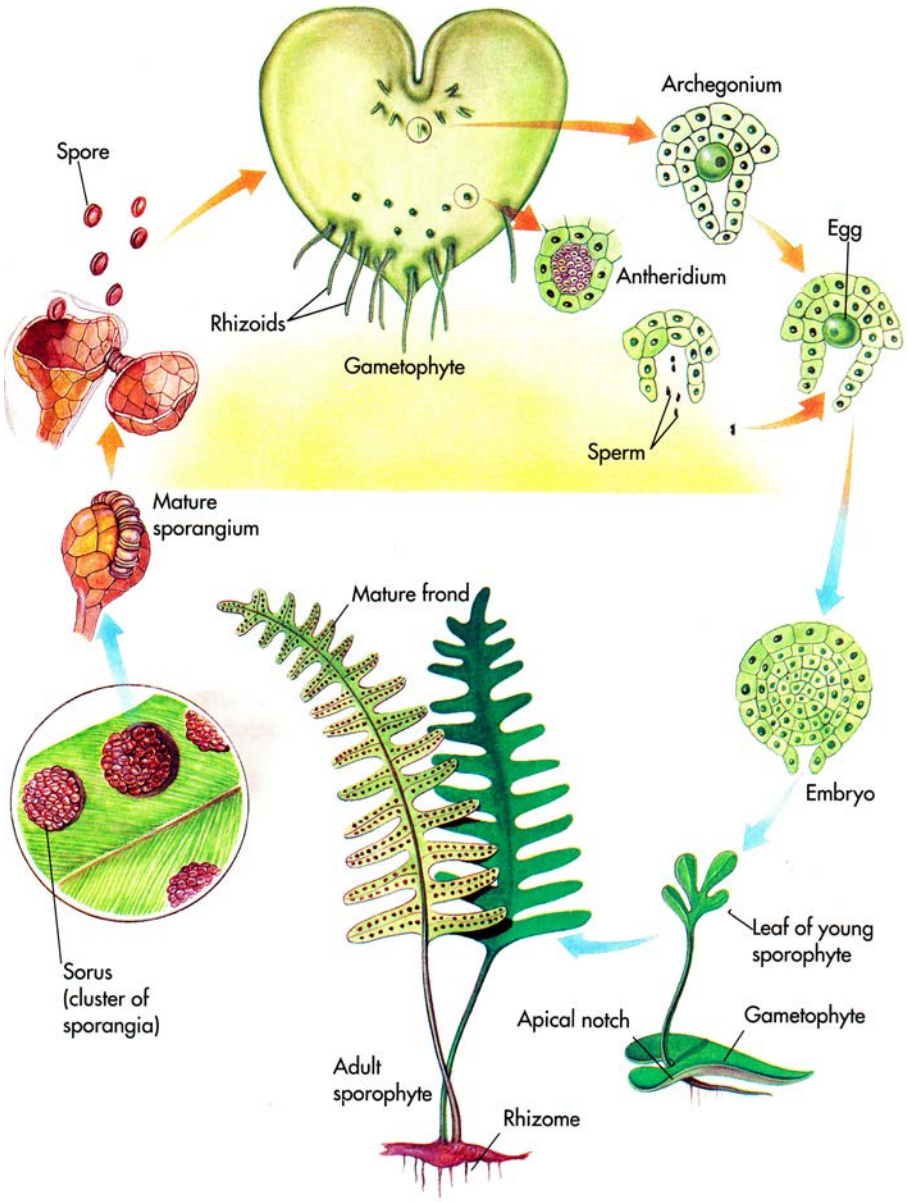


Figure 3.12. Fern life cycle, by Raven & Johnson.

side of leaves former brownish bumps in summer. It is sitting on short legs sporangia. They are formed haploid spores. Once in the favorable conditions, the spores germinate in the small green heart-shaped platelets with a diameter of 1 cm zarostok. It is attached to the kidney rhizoids. On the downside prothallia in antheridia and archegonia develop sperm and eggs. Fertilization

takes place in the presence of the past wet environment. The result is a zygote, which develops from the embryo. It has a primary root, stem and leaf, but some remains on prothallia and eats at his own expense, and then strengthened in the soil and is transformed into an adult plant. When individual development fern have asexual reproduction alternates with sexually. And asexual generation (sporophyte) presented a powerful perennial, in which spores are formed, and sexual (gametophyte) – small prothallia in which eggs and sperm are formed.

Dryopteris male is equal spore plant, because it has the same size and spores during germination bisexual prothallia form. However, it should be noted that a number of fern (Selaginella, Salvinia) in a spore-bearing spikelet forms and small microspores that give men during germination prothallia with antheridia and large megaspores giving women during germination prothallia with archegonia. Such plants are called heterosporous and their prothallia (gametophytes) – same sex. On the role of ferns in nature should be said that in the Carboniferous period of the Paleozoic era, they were presented with a tree view, and after the death of formed coal. Currently, the rhizome of Dryopteris male is used in medicine as an anthelmintic.

3.2.7. Order Gymnosperms

Gymnosperms are higher seed plants which occupy a higher position in the evolutionary than ferns. It is heterosporous plants. Microspores (pollen) ripen in microsporangiums located in the male cones and megaspores in megasporangy ovules, which are located in the female cones. Male gametes (spermatozoa) are fixed they are produced in the anthers and delivered to the egg via pollen tube during germination of pollen. Megaspores germination and formation of female gametophyte with archegonia is happening inside the ovule. After fertilization of the ovule seed is forms. This is the main advantage of biological seed plants before spore, as seed propagation is more reliable than the controversy because it contains a multicellular embryo and the supply of nutrients necessary for its growth. Spore is the only haploid cells.

There are about 800 species of gymnosperms, native to temperate regions of the globe. All of them are woody plants and shrubs are well developed stem, strong root system consisting of main, lateral and adventitious roots, leaves in the form of needles. The most commonly found in gymnosperms conifers, such as pine, fir, larch, juniper, cedar, yew, redwood, cypress, arborvitae and others. Consider the most common ones. Pine is widespread in our country in the

European part, Siberia and the border of its range to reach the coast of the Sea of Okhotsk. This light-requiring, not exacting to soil conditions tree species. On sandy soils it forms a forest. There she developed tap roots, penetrate into the soil, as well as lateral roots, which are located close to the surface. Having grown up in a forest of pine reaching a height of 40 m., has a straight trunk, covered with red-brown bark. The branches are located high up, making krone gains often umbellate form. Meets pine and sphagnum bogs, limestone slopes. On the pine swamps are low, with shallow root system and thin trunks spaced close together whorls of branches, which indicates a slight increase of the tree. The narrow, needle-like leaves of the pine - needles - are arranged in pairs and are covered with a dense skin with cuticle. The stomata are deeply embedded in the fabric leave and relatively few in number. All this allows the economical use of pine to withstand moisture and lack of it in the soil. In the process of reproduction pine one plant produces both male and female cones. Male cones are made up of axis and covering her small scales and are located at the base of shoots. In the axils of the scales are arranged on two microsporangium where formed haploid microspores, mature in pollen. Each speck of dust covered by two membranes: the outer (exine) and internal (intin). In two places between the exine and intini are pneumatic cavities, thereby providing the volatility of pollen. The core of a speck of dust when ripe divided by mitosis to form two cells: one in the future generates two sperm, the other - the pollen tube. Consequently, the male gametophyte formed during germination microspores is a speck of dust. Female cones are formed on the tops of young shoots. They are painted in a reddish-brown color and are made up of axes and scales. However, these scales are different from scales of male cones on the structure and purpose. They are divided into dry and juicy. Dry – sterile, opaque, juicy – fertile, or seed. Their base formed by two ovule consisting of a nucellus (tissue megasporangiya) and covers. The nucellus stands one large cell which divides by meiosis, so that there are four haploid cells – macrospory. Three of them are absorbed, and the rest here in the nucellus grow into women zarostok, which produces two archegonias with eggs. Zarostok of archegonia consist of a female gametophyte. Wind spring pollen is transferred to the female cones and gets on pollen ovule. Scales pollination cones glued gum. Egg matures within a year, and only after this period, fertilization occurs. Speck grows into the pollen tube, which are promoted by two sperm. The fertilization is involved only one spermatozoon, the second die. From zygote formed embryo consisting of root,

plumule and embryonic leaves. Fabric female prothallia becomes endosperm, and the ovule integument - skinned seed. Thus, the ovule turns to seed almost a year after fertilization. The development cycle of the pine lasts 2 years (Figure 3.13.).

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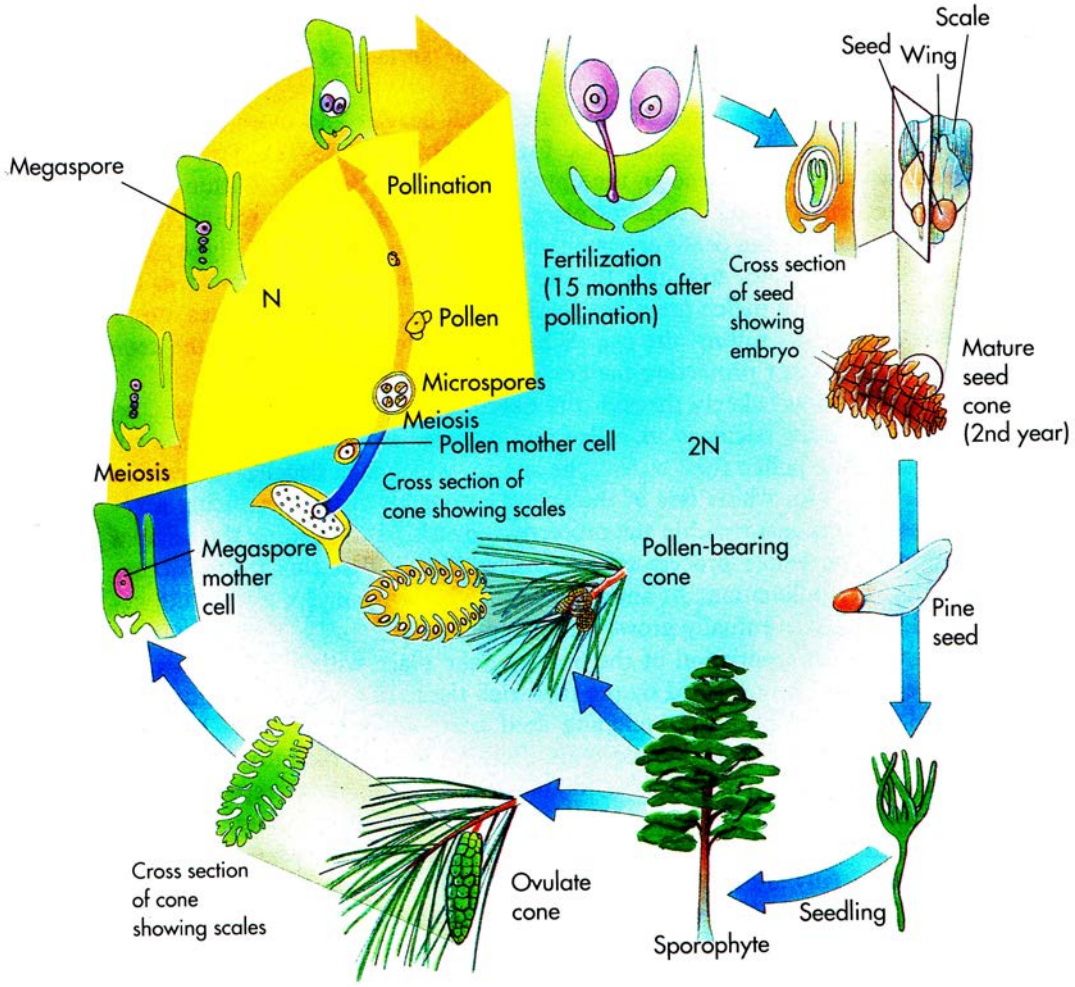


Figure 3.13. Pine life cycle, by Raven & Johnson.

Spruce is found in the temperate zone of the Northern and Southern hemispheres. Under its canopy of undergrowth and grass cover almost do not develop. Spruce - shade-tolerant species. A dense pyramidal crown it reaches almost to the ground. In such circumstances, survive only green mosses. Spruce is more demanding to the environment than pine. It grows in the fertile and fairly moist soils. The root system of spruce located in the surface layer of soil, so strong winds can turn a tree with roots. Leaves her as pine, needle, prickly, quadrangular in outline. Located on the shoots alone, hold 7-9 years. Cones of spruce larger than the pine (10-15 cm), developed in the course of the year. It is propagated spruce as well as pine. Siberian spruce differs from spruce cones by

smaller size and shape scales. It is distributed in southern Siberia. Larch got its name due to the fact that its needles fall off in the winter, like the leaves of deciduous trees. This is one of the most winter-hardy tree species. It can withstand even the most severe frosts of Siberia and Yakutia (Daurian and Siberian larch). Juniper grows in the undergrowth of pine and mixed forests, on dry hills and slopes. It is an evergreen shrub with needle-like leaves, which is located three in a whorl. Cones in juniper not look like pine cones and spruce. They are small, indehiscent, fleshy scales them, bluish. Such bumps resemble berries and are sometimes called cone-berry. There is used as a medicament. In some countries, coniferous forests are the main source of building material. Spruce wood is used to make furniture, musical instruments, paper and rayon. From pine needles get turpentine, scented oil, vitamin C, as well as rosin. Pine highlights the volatiles - volatile, harmful effect on many germs, so the air, where it grows, always cleans. From 'branches conifer vitamin flour is prepared, which is used to feed animals.

3.2.8. Order angiosperms or flowering angiosperms

It is the most modern and the largest group of plants which has more than 250 thousand species. They occur in all climatic zones, on all continents, occupying a dominant position on the ground. For a typical angiosperm flower availability of which is adapted to reproduce. It takes sporulation processes, the formation of gametophytes, gametes and fertilization, and seed formation, the prisoners inside the fruit. Unlike the gymnosperms ovules in angiosperms are enclosed in a closed cavity of the ovary, so no pollen falls on pollen entrance, and stigma. The shell of pollen grains is new structural elements, complicating its structure. For angiosperms characterized by further reduction of gametophytes how women and men are formed by a minimum number of mitotic divisions and develop faster than gametophytes gymnosperms. They have not formed antheridia and archegonia. One of the characteristic features of angiosperms - double fertilization in which one sperm cell fuses with a haploid egg to form a zygote, the other - with diploid central cell, forming a triploid endosperm primary cells (Figure 3.14.).

Angiosperms are divided into two classes - Dicotyledonous and monocotyledonous. Dicotyledones originated from seed ferns, and gave rise to the monocots, which have evolved in parallel with the latter. Class Dicotyledo-

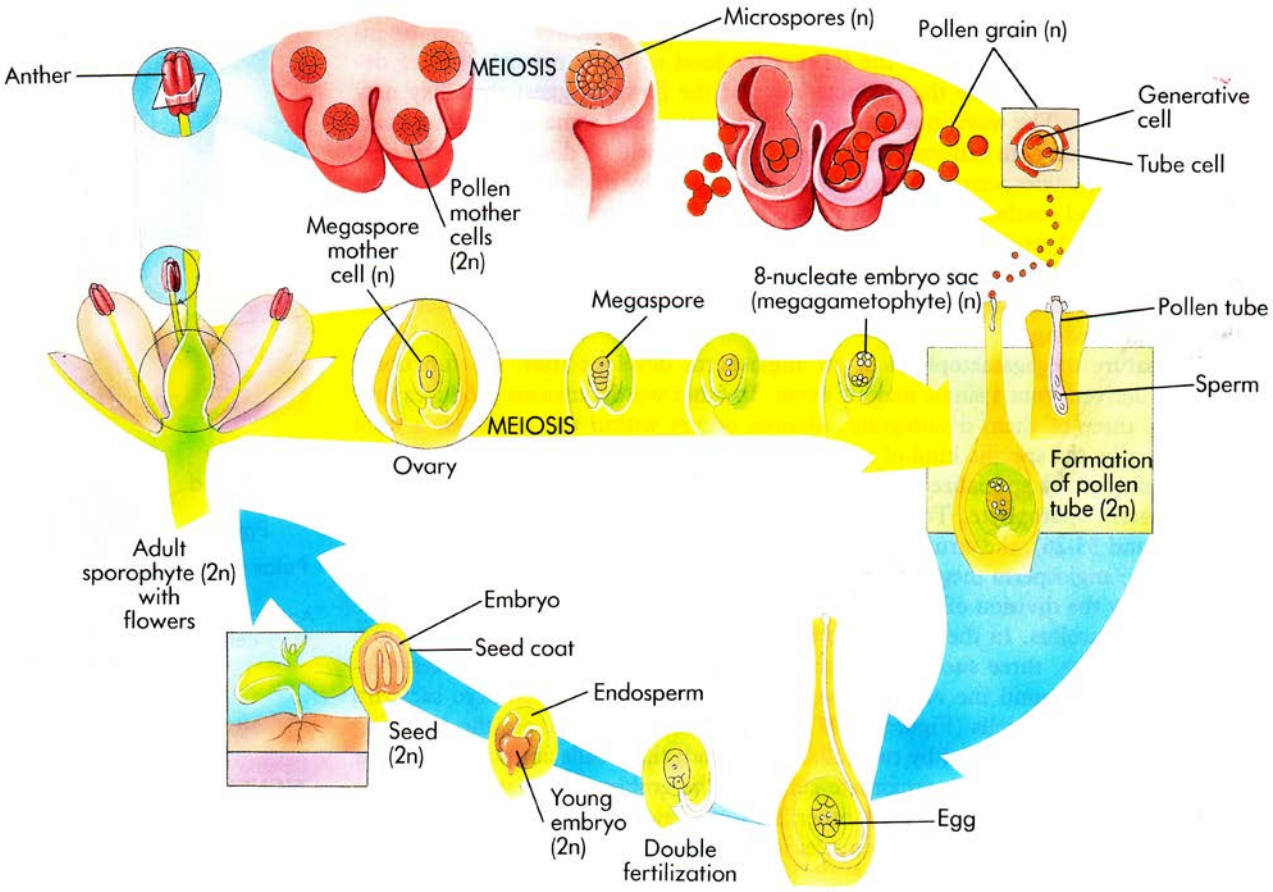


Figure 3.14. Angiosperm life cycle, by Raven & Johnson.

nes include about 325 families (Rosaceae, cruciferous, nightshade, umbrella, buttercup and others.) and the class Monocotyledonous – about 65 families (grass, lily, irises, orchids, sedges and others.)

Chapter 4. Animals

Zoologyis a science that studies the structure and the life of animals, their diversity and distribution, relationship with the environment, patterns of individual and historical development. Cytology, histology, embryology, anatomy studies external and internal structure of animals. Physiology studies vital functions (the processes occurring in the body): nutrition, digestion, respiration, excretion, blood circulation, the nervous system.

Zoogeography describes animal patterns of distribution across the globe depending on habitat conditions. Ecology explores animal relationships with the environment, as well as accessories to it, to ensure their growth, survival, reproduction and dispersal.

Zoology is a complex of biological scienceswhich are closely related to each other. Studies in zoology conducted by the following methods: historical – allows to understand the course of evolutionary development of the animal world from lower to higher organisms; comparative – based on data of comparative anatomy; embryology, physiology shows the unity of origin of the animal world; paleontology – reveals the connection between the extinct and currently existing organisms; experimental – it gives the opportunity to study the physiological functions of the body, to understand the role of environmental factors in the development of the body and mathematical – allows for biometric processing experimental data. Currently, it is described about 2 million species of animals that differ in structure, lifestyle origin.

They consists of microscopic organisms (protozoa) and very large individuals (mammals, such as elephant, a whale). Animals are divided into invertebrates and vertebrates. Invertebrates do not have the axial skeleton (Table 4.1). These includes protozoa, coelenterates, flat, round and annelid worms, mollusks, arthropods. Vertebrates have the axial skeleton and unite all chordates. There are also cold-blooded animals are not able to regulate body temperature (all invertebrates and vertebrates – fish, amphibians and reptiles) and warm (birds, mammals). Animals settled soil, land, water and air protection. The relationship of animals with other organisms is complex and is determined by food connections. Animals can be herbivorous, carnivorous (predatory) and omnivores. Sometimes animal relationships are symbiotic or parasitic.

Table 4.1. Characteristic differences of animals and plants.

Sign	Animals	Plants
Type of food	Heterotrophic	Autotrophic
Way of nutrition	Food swallowed actively enters through the mouth into the digestive cavity	Through osmotic, no digestive system
Growth of organism	Thegrowthis limited	The growth of the organs of the body are not limited
Irritability	Irritability as taxis (in the absence of the nervous system) and reflections (in the presence of the nervous system)	Tropisms
Abilitytoactivemovements	Usually capable of active motions, not attached to the substrate; if attached, it is a secondary phenomenon	Absence. Most of the plants is attached lifestyle structure
Cellsstructure	In the simplest, there are more small vacuoles performing digestive and excretory function of the cell center has to be involved in the division of plastids no reserve carbohydrate glycogen	Dense shell consists of cellulose are large vacuole with cell sap cell center plastids are no reservecarbohydrate starch

Zoology is the scientific basis of wildlife protection and use, for the development of the regulation of the number of measures to protect species, damaging agricultural and forest plants. The value of the animals in nature and diverse economy is multiply. They play a positive role in plant pollination, seed dispersal, soil formation, remnants of dead plants. Pets are of great importance in human life. Many of them are used as food, as raw material for the industry, about 40 species who are domesticated by man. Some species (frog, mouse, rat, rabbit, dog, etc.) are used for scientific and educational purposes. The accumulated knowledge of the structure of animal organs principles formed the basis for the development of new technical designs in the construction of airplanes, submarines. However, the number of animals brings harm to a

person. For example, some kinds of simple, flat and round worms, arthropods are pathogens of humans and domestic animals, and blood-sucking arthropods serve as their vectors.

World of animals that inhabit our planet, diverse, it belongs to the nuclear superkingdom organisms (eukaryotes), Animal Kingdom. In the animal kingdom are two subkingdoms - the simplest (monocellular) and multicellular. Animal kingdom divides into types, types into classes, classes to on the orders, orders to on the family, the family – on species. When you select a group of animals in a particular type are taken into account certain features of their structure (the number of cells forming the body, the number of germ layers; the symmetry of the body type, the presence of a body cavity, chords, etc..), as well as their degree of kinship.

4.1.Subkingdom protists(monocellular)

Simple are eukaryotic unicellular organisms of various shapes, ranging in size from 2-3 to 50-150 mm and even up to 1-3 mm. The body contains a simple structure as the cell (nucleus, cytoplasm, membrane, mitochondria, etc.), and organismic (digestive and contractile vacuole, the light-sensitive eye, etc.) levels. The organs of movement they serve pseudopodia, flagella, cilia. Power simplest effected either by ingestion of solid organic particles through a special cell throat (ciliates) or solute (whole body surface). They have irritability, manifested in the form of taxis. Multiply asexually or sexually simplest way. In some species, there is an alternation of sexual and asexual reproduction. Under adverse conditions, most just grow into cysts (covered by a protective sheath).

There are over 40 000 speciesin the type. Protozoan are found in the seas and oceans, fresh water and in the soil. They perform a variety of functions: actively participate in the circulation of substances, purify water from bacteria and decaying organic matter, affect the soil formation processes, serve as food for larger invertebrates. Among the simplest can be parasitic species which are the causative agents of human and animal diseases (dysentery amoeba, balantidium, trypanosomes, leishmania, malaria plasmodium and others.) The simplest subkingdom is divided into four classes: Rhizopod, Flagellates, Ciliates, and Spores.

4.1.1. Class Rhizopod

Class Rhizopod includes single-celled animals which is characteristic of an unstable form of the body. This is due to the formation of prolegs serving to re-capture the movement and food. Many rhizopods have an internal or external skeleton in the form of shells. After their death, these skeletons settle to the bottom ponds and form silt, gradually evolving into the chalk. Most rhizopods are the inhabitants of the seas, but among them there are freshwater, soil and parasitic species. The class includes about 1100 species.

Amoeba Proteus is a typical representative of this class. She lives in fresh water, in soil, has the form of cytoplasmic lump the size of 200-700 microns (Figure 4.1). The body consists of its cytoplasm and nucleus does not sink,

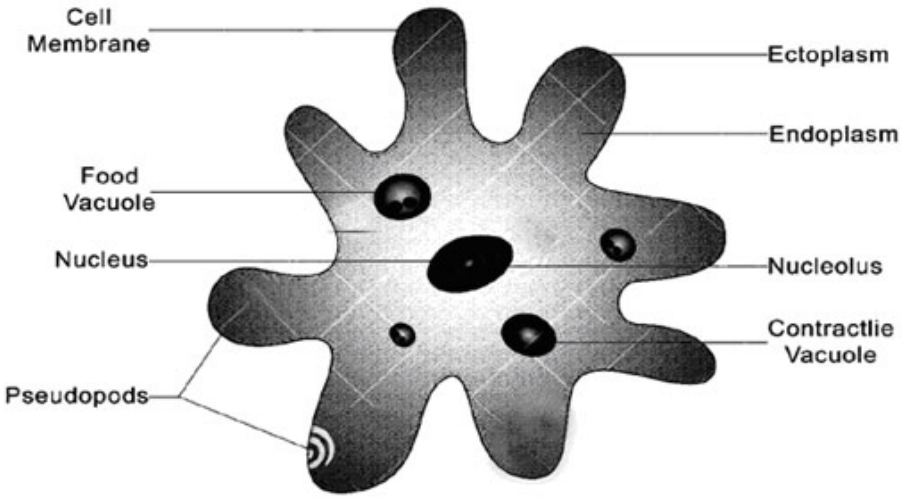


Figure 4.1. Structure of Amoeba Proteus, by Dreamstime.com

permanent shape.The protoplasm is allocated outer, more viscous (ectoplasm) and an inner granular, more liquid (endoplasm) layer. The amoeba is able to form pseudopods in any part of the body of different shapes and move. Bumping with food objects (bacteria, unicellular algae, etc.), it covers them pseudopodium that they are inside the body. Around ingested a piece of digestive vacuole is formed and begins the absorption of nutrients. Amoeba does not have special organelle of breathing. The required oxygen for life it absorbs the entire surface of the body. The final waste products (carbon dioxide and other harmful substances and undigested food debris) are allocated to the water through a pulsating vacuole. When exposed to external stimuli (light, change in chemical composition of the medium), is responsible amoeba motor

reaction (taxis), which depending on the direction of movement can be positive or negative. Amoeba propagated asexually (mitosis). Under unfavorable conditions it encysted.

Among other representatives of rhizopods is intestinal dysenteric amoeba living in the human colon. Intestinal amoeba is harmless, feeding on bacteria and the intestinal contents may form large eight-cysts. Dysentery amoeba is a parasite of the intestine, can cause canker colon wall. A person infected with it used of unwashed fruits and vegetables, unboiled water, which contain small cysts quad. Of the latter, the body located in small parasites, turning then to the large form. They are introduced in the intestinal mucosa, destroy blood vessels, resulting in ulcer formation and manifested in bloody nose.

4.1.2. Class Flagellates

Class Flagellates consists of single-celled animals with an elongated oval or pear-shaped body, a characteristic feature of which is the presence of specific organelles of motion – flagella (thin cytoplasmic outgrowths). His base flagellum is attached to a special formation – the basal body. Number of flagella in different species varies from 1 to 8. The cell nucleus vesicular form comprises one or several nucleoli. In many species there are contractile vacuoles. Flagellates divided into autotrophs (chlorophyll) and heterotrophs. Some combined autotrophic and heterotrophic methods of nutrition which allows to classify them as transitional forms from plants to animals. Propagate by dividing the longitudinal flagellates. There is not only a single and colonial form. Flagellates play an important role in the life of reservoirs in the cycle of matter in nature.

Class includes more than 6000 species. A typical representative of the single form is Euglena green (Figure 4.2). Her body is spindle-shaped, thanks to constant sealing outer layer of cytoplasm. At the front end of the body there is a thin green euglena flagellum, due to the rotation which it moves. In the cytoplasm of the cell nucleus are arranged, pulsating vacuoles and a few chromatophores containing chlorophyll, bringing to light euglena can eat autotrophic as a plant. Euglena illuminated space by using the photosensitive retrieves eye, also located at the front end of the body. In the absence of light euglena proceeds to heterotrophic nutrition ready-made organic substances,

sucking their entire body surface. The processes of respiration, excretion, reproduction, irritability, cyst formation is similar to those of an amoeba.

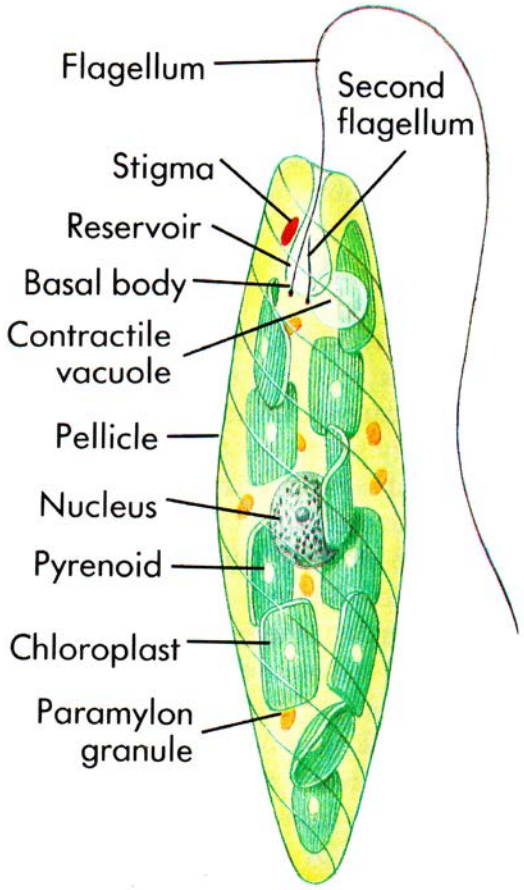


Figure 4.2. Diagram of an individual of the genus Euglenaeus, by Raven & Johnson

The representative of the colonial flagellate species is volvox (Figure 4.3). It has the shape of a spherical body composed of several hundreds of small pear-shaped cells, each of which has two flagella, 2.1 mm diameter balloon. The cavity is filled with its gelatinous substance. All cells of volvox cytoplasmic interconnected by bridges which provides the possibility of coordinating the motion of flagella. In volvox colony is observed separation of cell function. Thus, at one extreme of the colony in which it moves forward, the cells have more developed light-sensitive eyes, and in the lower part of the colony (where eyes underdeveloped) arranged cells capable of division (cell multiplication). The colonial flagellates (volvox, pandorina, evdorina and others) are considered as transitional forms from unicellular to multicellular

organisms. Some flagellates (trypanosomes, leishmania, giardia, trichomonas, etc.) Are parasites of human and animal pathogens severe diseases.

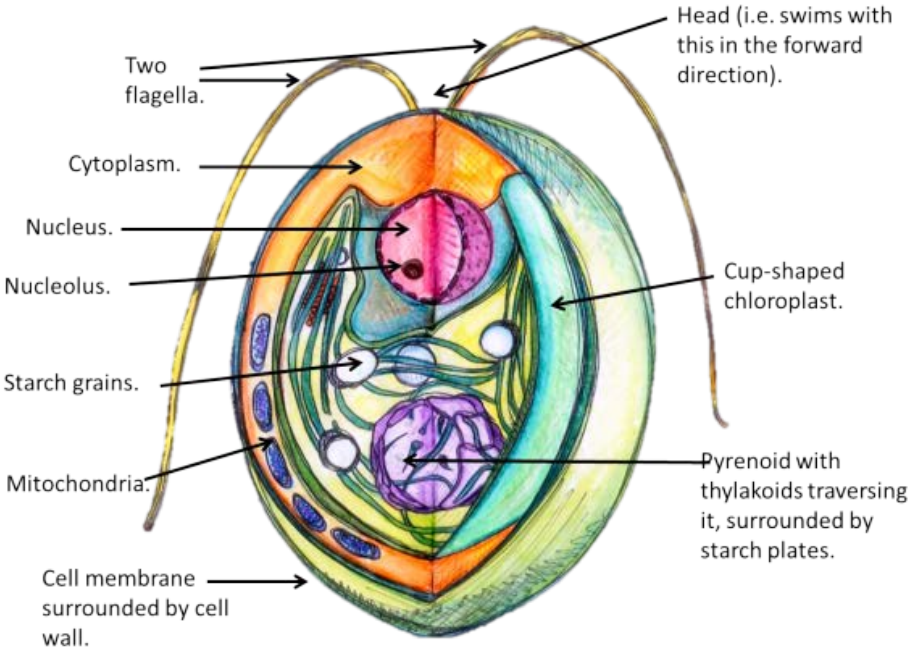


Figure 4.3. Structure of volvox

4.1.3. Class Ciliates

Class Ciliates are the most highly organized protozoa that live in fresh and marine waters, in moist soil. Some species are parasites of human and animals. In ciliates different kinds of diverse shape of the body, but more elongated and streamlined. Organelles of their movement are cilia. Ciliates characterized by the presence of at least two different size cores that perform different functions. Ciliates multiply asexually and sexually ways. Class includes over 5 000 species. A typical representative is ciliate-paramecium, living in fresh water (Figure 4.4.). In body shape, it resembles the sole of paramecium, long reaches 0,1-0,3 mm, covered with uniform rows of cilia which due to fluctuations moves. The cytoplasm of ciliates has the ectoplasm and endoplasm. The ectoplasm located organelles attack and defense (trichocysts) in endoplasma – two cores (large and small), and the digestive system, as well as the secretory organelles. On the ventral side of the paramecium is a small depression, leading to the mouth, which is surrounded by cilia, pounding it with current water food particles (bacteria, unicellular algae). The mouth is in the throat - a short canal,

lined with cilia. Food particles enter the endoplasm where formed digestive vacuole around them, which begins to move slowly through the body ciliates.

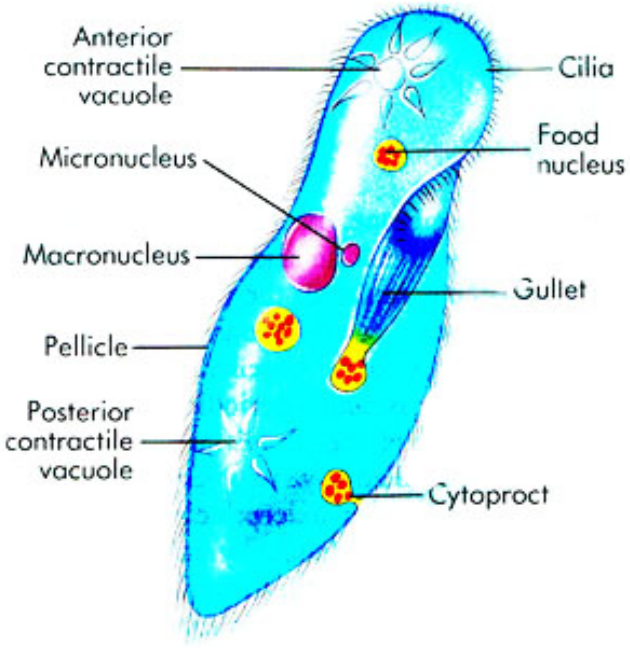


Figure 4.4. Diagram of Paramecium, by Raven & Johnson.

The undigested food goes out by a special time in the ectoplasm. Paramecium have two contractile vacuole. The contractile vacuoles have osmoregulation function, isolation and breathing. Ciliates slipper reproduces both asexually and sexually. In asexual reproduction cell devides in half along the equator. The sexual process is represented by conjugation, consisting in a temporary connection of two individuals of the mouth opening and the exchange of parts of the nuclear apparatus with a small amount of cytoplasm. During the conjugation of each individual large core collapses and small divided by meiosis into four parts. Three of these parts is also time violates both, and the fourth divided mitotically and thus produces two haploid nuclei. One of them (stationary) remains in the mother's body and the other (migration) goes on the cytoplasmic bridge partner in the body. Then migratory nuclei fuse with stationary and ciliates diverge. The new core is divided into two unequal parts, resulting in the formation of large and small core. Conjugation, as already mentioned, does not increase the number of individuals, and provides for the exchange of genetic material of two individuals, and thus increases the vitality of the organism, its adaptability to the environment.

Balantidium is parasitic ciliates inhabiting the human intestine, pig. The ulcerated mucosa, broken blood vessels is as a result of its ability to live. The disease is manifested by bloody diarrhea. Under unfavorable conditions the parasites turn into cysts that a person becomes infected with poor personal hygiene.

4.1.4. Class Sporozoa

Class Sporozoais a group of simple organisms who leads parasitic way of life only in the cells of human and animals. The body consists of small oval or elongated cells, organelles devoid of movement and digestion. Nutrition, respiration, excretion are carried throughout the body surface. Reproduction occurs or only sexually, or with alternating sexual and asexual generations. Often during reproduction, the formation of spores (nuclei surrounded by a dense shell) that was the basis for the name of the class that includes about 4000 species. Class Sporozoa are agents of human malaria – plasmodium, known four species.

The cycle of plasmodium is very complicated and is carried out with the change of two owners: intermediate (the person) and final (the Anopheles mosquito female). At the same time there is an alternation of asexual pathogen (in the body) and sexual (in the body of the female Anopheles mosquito) breeding. In the human body Plasmodium fall under the bite of the female Anopheles mosquito saliva. They initially penetrate into liver cells, and then to erythrocytes which develop and reproduce asexually. At the same time a large number of red blood cells are destroyed. A person with malaria, is dangerous to others as a mosquito bite him, swallows along with blood immature germ cells of the parasite. In the stomach of the mosquito, they are transformed into male and female gametes, which after fertilization form a zygote. The latter is introduced into the stomach wall of a mosquito and is subject to multiple divisions. Formed in the process of cell division, so-called sporozoites enter the salivary glands of the mosquito. The last by the bite can infect human malaria Plasmodium. In people who are suffering from malaria develops anemia. Periodically, every 2-3 days (depending on the pathogen), chills appears increased temperature (40° C). In some cases death occurs. Malaria is widespread throughout the world. Every year, it occurs up to 350 million people.

4.2. Type Coelenterates

Coelenterates are lower multicellular animals living in the sea and fresh water. They are characterized by radial symmetry of the body. The wall of the body is formed by two layers of cells: outer - and inner ectoderm - endoderm, which is located between mesoglea. The body's cells are differentiated depending on the function they perform. In the gastro-cavity first appears nervous system. This is scattered in the body of the nerve cells that come into contact with each other processes. Sacciform body have one mouth opening leading into the intestinal lumen, where under the influence of enzymes, digestion takes place. Small food particles can be trapped and endoderm cells and digested intracellular. Through the mouth occurs, and the ejection of undigested food residue. Coelenterates multiply both asexually and sexually. It can be also dioecious animals, and hermaphroditic (organisms with male and female reproductive organs). Sex cells are displayed in an aqueous medium, where fertilization takes place. Many coelenterates make change of asexual and sexual generations. Asexual generation is attached to the bottom of polyps, sex – free-jellyfish. Several types exist either as a polyp or a jellyfish. Many coelenterates can easily restore lost parts of the body (regeneration). Type is divided into three classes – Hydroids, Scyphoids and Coral polyps. It brings together about 9000 species.

4.2.1. Class Hydroids

Hydroids are lower class, which includes polyps and jellyfishes. They are characterized by the fact that the endoderm directly adjacent to the oral cavity, and germ cells forms in the ectoderm.

A typical representative of the class is a hydra (Figure 4.5). It has the form of a cylinder length of 1-2 cm, the lower part of which narrows in stem. Hydra basis stalk attached to underwater objects. At the free end of it there is the elevation where is surrounded by tentacles mouth opening. The mouth is in the digestive cavity, the continuation of which comes in the tentacles. The wall outside the hydra body is formed by epithelial cells of the ectoderm of a cylindrical or cubic shape. Some of them extend in the length protoplasm thinnest differentiated contractile fibers. This epithelial-muscle cells which have cover function and muscle cells. Stinging cells also represent a modified

ectodermal cell. They serve as a means of offense and defense. Between the base of epithelial-muscle cells are located small with long processes of nerve cells that make nerve plexus. Breathe hydra entire surface of the body. Hydra eats small animals. Food enters through the mouth into the intestinal lumen, where under the influence of enzymes secreted by glandular cells of the endoderm, the digestion takes place. Endoderm cells are able to produce pseudopods that hydra captures small particles of food, digesting them in the digestive vacuoles. Coelenterates have the intracellular digestion, continuing along with cavitary. Moving food in the intestinal lumen carried flagella epithelial-muscle cells of the endoderm. The undigested food ejected through the mouth. Endoderm cells perform and excretory function. During warmer months, there is a protrusion (kidney) in the wall of the body of the hydra, which increases in size, it becomes adult contours, and then detached from the mother's body and begins to lead an independent life. Sexual reproduction usually occurs in the fall.

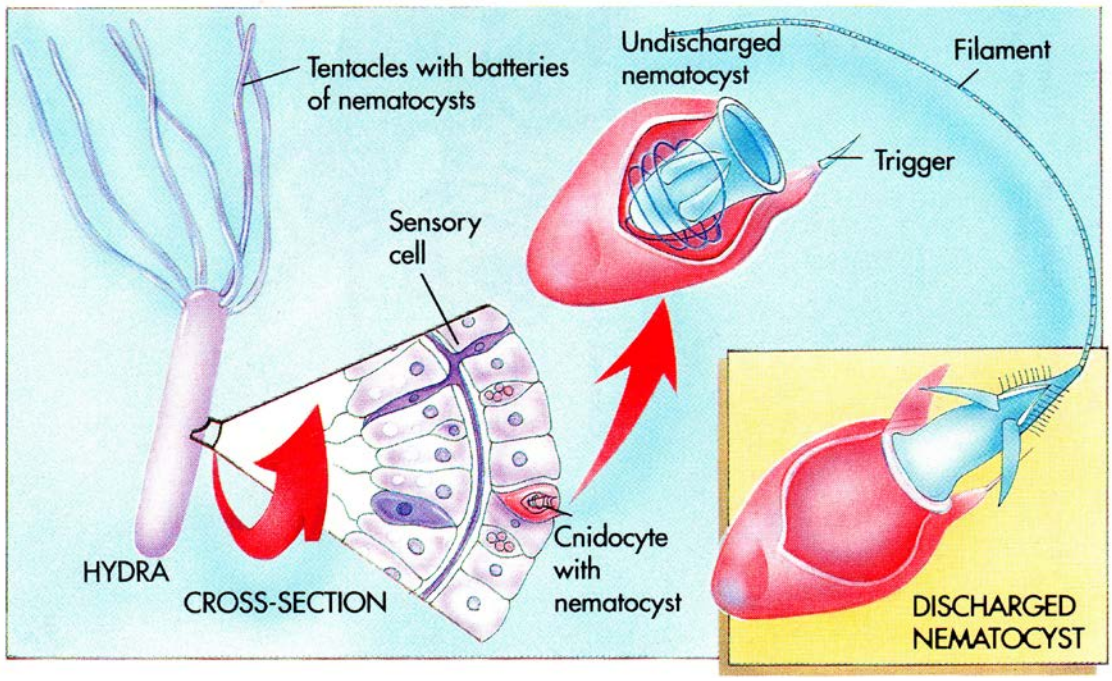


Figure 4.5. Basic hydra structure.

Sexual reproduction usually occurs in the fall. Hydra is a hermaphrodite. She's in the ectoderm, closer to the end of the oral, sperm accumulate, and at the bottom – the single large egg. Since the male and female gametes mature at different times, then merge the egg and sperm of different species (cross-

fertilization). The embryo is covered by a dense shell and separated from the mother's body, it falls to the bottom, and spring turns into a young hydra.

4.2.2. Class Scyphoids

This class includes large marine jellyfish, reaching in some cases huge sizes (up to 2 m in diameter, for example, the Arctic jellyfish). Their body has in the form of a convex bell or umbrella, double layer, with a strong gelatinous mesoglea which constitutes the bulk of scyphozoan. Many jellyfish have a bright color and some glow in the dark phosphorescent light.

Scyphozoan has a more complex structure than hydroids. Mouth surrounded by long tentacles, which are arranged in a large number of stinging cells. After mouth scyphozoan have pharynx (the beginning of the intestine), leading to the stomach cavity, divided by the camera. In the nervous system, neural cell clusters appear in the form of nodules – ganglia. At the edge of the body arranged organs of equilibrium and light-sensitive eyes.

Scyphozoan is dioecious animals. Germ cells are formed in the endoderm in special gonads. The gametes are removed through the mouth. After their merger from the zygote formed larva (planula) is converted into a single polyp. Single polyp has cross-ligation on young jellyfish.

After contact with the stinging cells of human develop of scyphozoan burns. Severe burns with serious consequences may cause Rhizostoma, Gonionema and others. In China and Japan are some scyphozoan target species as food.

4.2.3. Coral polyps

Coral polyps are class inhabitant of warm seas and oceans that make up the largest group of coelenterates. We present only the polypoid forms, leading exclusively attached lifestyle. For coral polyps are characteristic signs of all coelenterates. Mouth surrounded by tentacles lead into the throat. Digestive cavity is divided into chambers that increase its surface. Nerve cells accumulate more near the mouth. Coral polyps were dioecious and hermaphrodites. Asexual reproduction occurs by budding or, or by longitudinal division of the polyp. In sexual reproduction gametes develop from the endoderm. Fertilization takes place inside the body. The larvae go through the mouth into the environment. The cells of the ectoderm of coral polyps produce keratin, or emit

calcium carbonate (calcium carbonate), have built an external or internal skeleton. The ectoderm has the muscle fibers that allow the polyp to change the shape of the body. Among the coral polyps are found built on the principle of eight-(red and white corals, sea pens) or six-rayed (actinium) symmetry. There are single corals, but most organisms colonial colony formation due to the fact that when there is no budding polyp organisms subsidiary branch (kidney) from the mother. Coral colonies form reefs, barriers and atolls (coral islands). The most powerful barrier reef is located along the east coast of Australia, extending to 2000 km. Certain types of coral polyps (coral red and black) are used for making jewelry.

4.3. Type Flatworms

Type flatworms are the most lowly threelayers bilaterally symmetrical animals. Their body is a bag of skin and muscle, flattened in dorsoventrally and elongated. At the front end of the body there is a mouth opens, which passes into the throat and intestine, which consists of two sections – the front and middle. The midgut is often branched and ends blindly. First appears excretory system of protonefridial type. Breathing is carried throughout the body surface. The nervous system consists of near-pharynx units and exhausts them in nerve trunks. Flat worms are mostly hermaphrodites. The reproductive system is represented by the gonads (ovaries and testes), ducts, and copulatory apparatus. However, they have cross fertilization. All the spaces between the bodies are filled with loose connect tissue in the body cavity flatworms.This type is divided into three classes – Turbellarians, Flukes and Tapeworms which consists about 12 500 species.

4.3.1.Class Turbellarians

Animals of this class are characterized by the presence of ciliary epithelium that covers the body from the outside. This free-living marine and freshwater organisms, some of them live on the ground. Ciliated worms are hermaphrodites, but some species reproduce by transverse fission and they exhibit a high capacity for regeneration.

The most typical representative of turbellarians is Lactic Planaria who lives in slow flowing streams, ponds (Figure 4.6). Her body has leaf-shape, 15 mm in

length. Front part has sensory organs (eyes, tentacles, organs of equilibrium). Planariya is predator, moved through the reduction of skin-muscular sac. On the ventral side of her body is mouth and pharynx through which protrudes outwards, penetrates into production and sucks its contents. Digestion occurs in food branched intestine. Undigested remnants are ejected through the mouth.

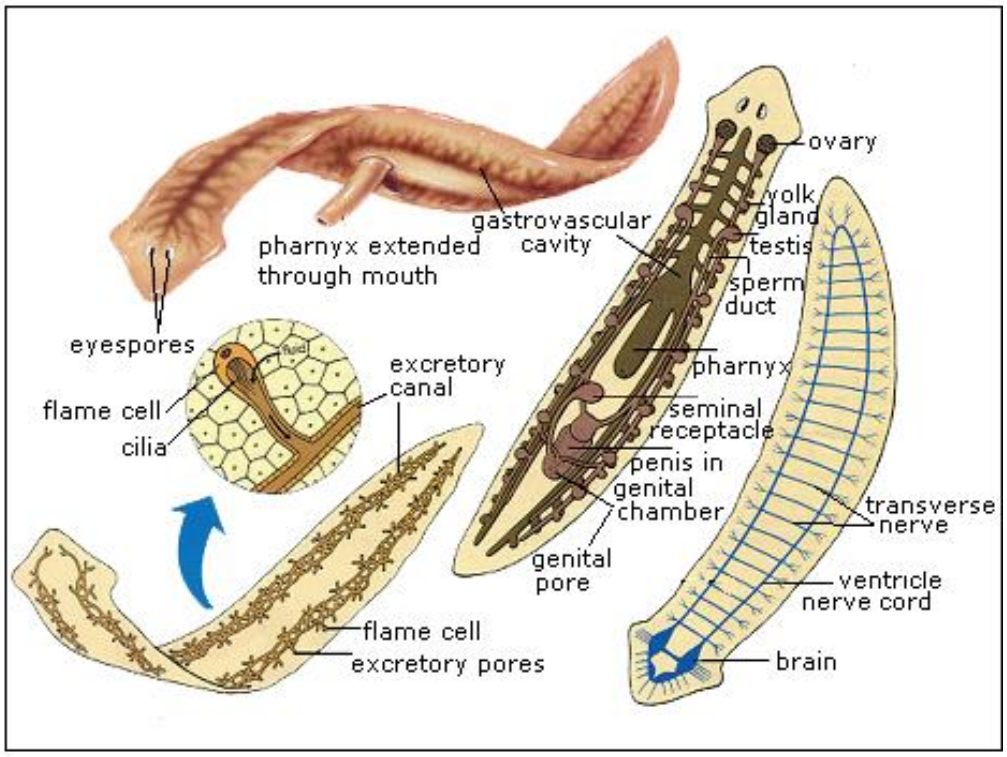


Figure 4.6. Lactic Planaria structure

Authority's releases (protonephridia) are branched tubules, the ends of which are closed end cells carrying a bundle of cilia. Sipes are on the sides of the body and opening to the outside excretory pores. The waste from the two peripharyngeal ganglion nerve trunk is sent to end of the body, but their side branches to the internal organs. Planarians have cross fertilization, thereby increasing the viability of offspring. At the same time it is also capable of asexual reproduction by dividing the cross.

4.3.2. Class Flukes

Class Flukes are parasitic flatworms. They are found in the tissues and organs of human and animals. Their body is of leaf-shaped, covered with cuticle. To tissues of host attached suction cups. In flukes digestive and

reproductive systems are well developed. The cycle of development is carried out with the change of owners.

A typical representative of this class is the liver fluke, a parasite in the liver herbivores, less human (Figure 4.7). In length it reaches 3.5 cm, held in the host liver via the abdominal and oral suckers. Liver fluke is hermaphrodite. Fertilized eggs of its output through the host intestine out and for further development have to get into the aquatic environment. Exiting the larvae covered with cilia, introduced in the intermediate host's body - in a small pond snail mollusk. There they multiply and become tailed maggots. Recent leave mollusk lose a tail attached to the plant and covered by a protective sheath. The final host (cow, sometimes people) can be infected through grass or water and in their bodies parasites transformed into mature individuals. In addition to liver fluke in humans and mammals can parasitize other species.

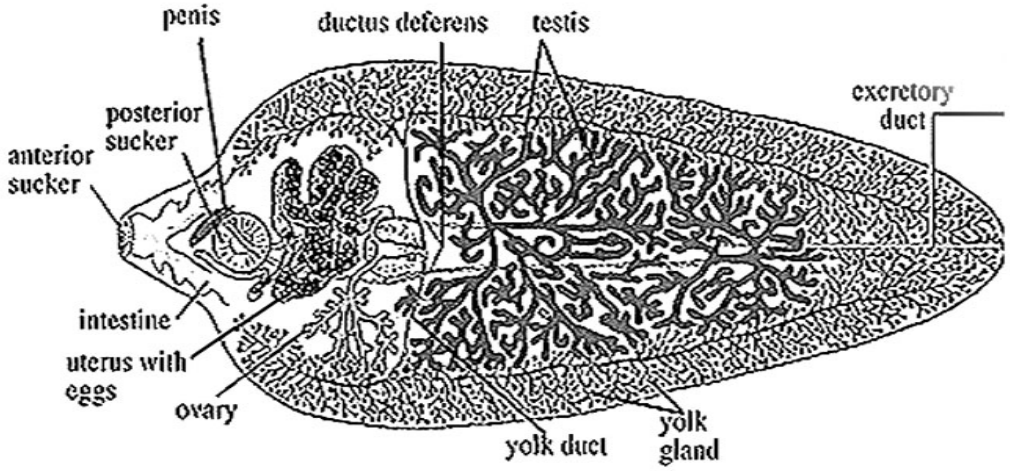


Figure 4.7. Liver fluke structure

Lanceolate fluke settles in the liver of sheep, sometimes human. Infection occurs by invasion of the second intermediate host which containing larvae. Cat fluke parasite in the liver, pancreas and human carnivores, eating raw fish (cat, fox, fox, bear, dog). Infection occurs by eating meat from fish carp family, containing the larvae of the parasite.

4.3.3. Class Tapeworms

All animals of this class have adapted to live in the intestines of the host. They have ribbonlike body, from 3 mm up to 10-12 m in length, is divided into

a head with the attachment bodies (suckers, hooks), the cervix, which is the area of growth, and proper body composed of segments. In the host intestine parasite sucks nutritious substances throughout the body surface. In each segment has excretory and reproductive system androgynous, reminiscent in structure similar system of flukes. The cycle of tapeworms goes with the change of owners.

A typical representative of the tapeworms is bovine tapeworm – the human intestinal parasite (Figure 4.8). His body reaches 4-10 m in length, divided into 100 or more segments. The head is equipped with four suckers. The hermaphrodite segments have a bi-lobed ovary and testes. After fertilization in the segments begin to mature the egg in the uterus, which is highly branched, and all other organs gradually atrophy. The segments are mature, detached from the body and, together with the faeces come out and fall to the grass. Cattle that eat the grass, swallow the eggs, and become the intermediate host. His stomach from fertilized eggs into larvae, which pierce the intestinal wall, enter the bloodstream and entered into the muscles, where it is converted in the Finn (screwed into the vial head and neck). During eating meat from an infected person finn in the gut develops the adult parasite.

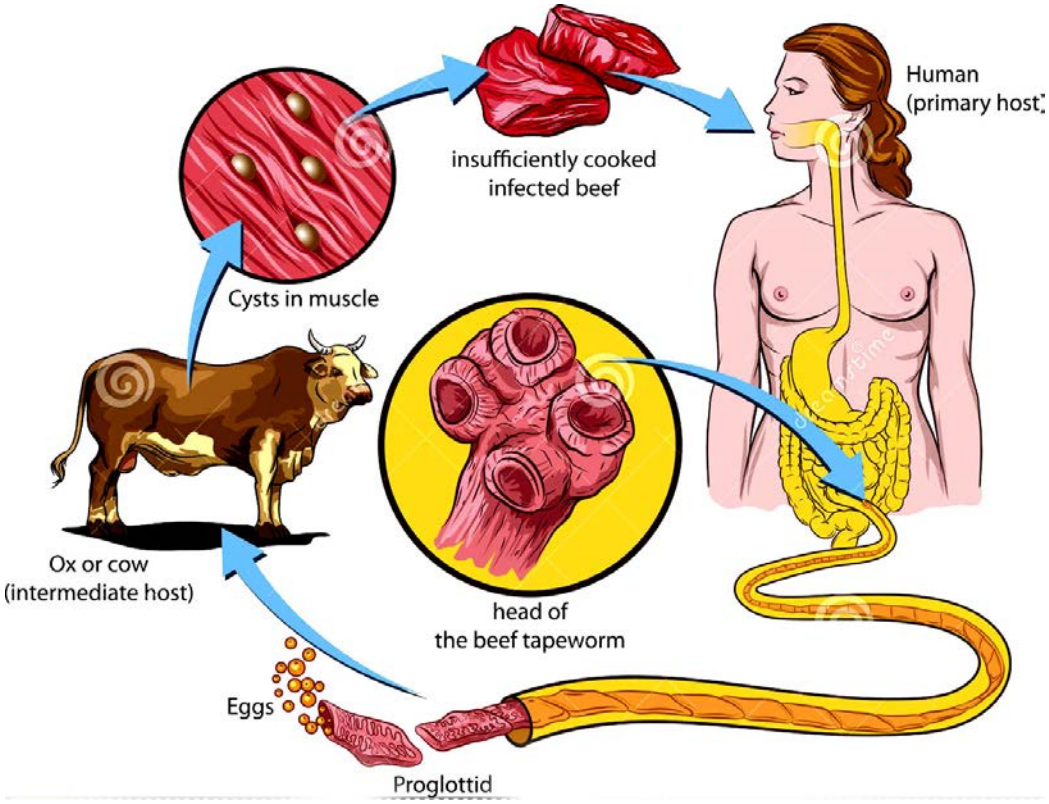


Figure 4.8. Bovine tapewormstructure, by Dreamstime.com

From the class of tapeworms in human can also parasitize pork tapeworm, Echinococcus and others. A person infected by pork tapeworm by eating raw or undercooked meat of pigs (intermediate host), which contains the larval stages of the worm (the Finns). Danger to human health is echinococcus. Adult forms of the worm parasite live in the intestine of dogs, wolves, jackals (final host). Man, domestic and wild cloven-hoofed are intermediate hosts. They are in the liver, lungs, kidneys and other organs of living larval stage of the parasite in the form of a bubble filled with liquid, with many of the parasite heads. A person infected when entering into the mouth of the worm eggs, which can be on the dog's coat.

4.4. Type Roundworms

Roundworms are type of primary cavity animals in which for the first time in the evolution of the body cavity appears (the distance between the body wall and intestine, devoid of epithelial lining and filled with fluid). It brings together a large group of animals as a free-species and parasites of plants, invertebrates and vertebrates. Roundworms have typical cylindrical, non-segmented, elongated body (from 1-2 mm to 30-40 cm or even 8 meters), sharpened at the ends, devoid of cilia. It is a skin-muscular sac covered with cuticle, a protective function. Under the cuticle lies the epidermis and strands of longitudinal muscle, consisting of a single layer of cells. The digestive system is pre-put the front, middle and posterior intestine, ending anus. Excretory system is protonefridial type such as one or two channels lying on body side and one whole opening outward. The nervous system consists of a nerve ring and peripharyngeal, of which the most developed ventral and dorsal rays of several nerve cords.

Roundworms are dioecious animals. The sexual apparatus has a tubular structure. In the female, it is doubles (two ovaries and two oviducts, two of the uterus and the vagina is one), the male have unpaired (testis, vas deferens, ejaculatory duct). Male is smaller than female. Type includes only one class Roundworms and has about 15,000 species. Typical representative of roundworms is a human Ascaris, a parasite in the intestine (Figure 4.9). Female parasites are long reach up to 40 cm, males – 20-25 cm. Females laid their eggs after fertilization, together with faeces are released into the environment. The larvae develop under certain temperature and humidity (25-30° C) for 2-3

weeks. These eggs may enter the human body through unwashed vegetables, fruits, and water. The human gut larvae hatched from the eggs, pierce the intestinal wall and enter the blood vessels. Since the bloodstream they first entered in the liver, heart, lungs, then to the lung alveols, bronchi, trachea, into the mouth and then into the intestine, which are turned into adults.

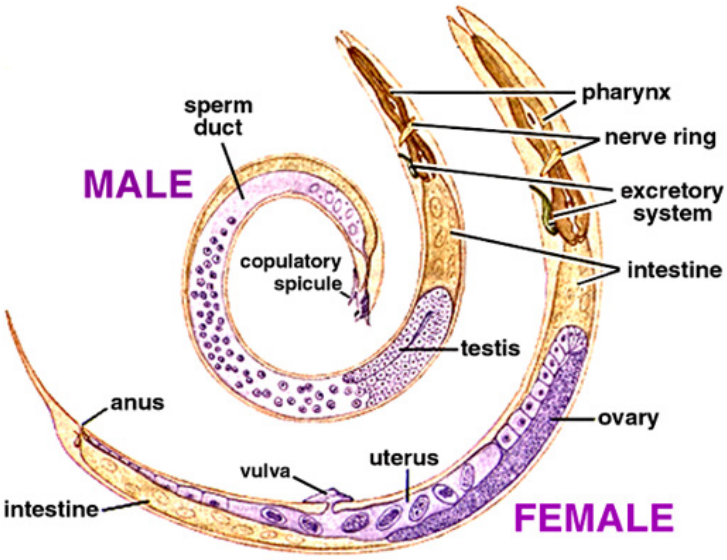


Figure 4.9. Human Ascaris structure

Pinworm is widely distributed in all geographic areas of the world, parasitizing the human intestine. Its females do not exceed 10-12 mm, males - 3.4 mm in length (Figure 4.10). The fertilized female night out through the anus and lay eggs (up to 12 ths.) on the skin. In these eggs in 4-7 hours larvae develop. A person with skin brushing can inadvertently capture the eggs and bring them into his mouth because of strong itching caused by fluid secreted by the female. Infection can occur through household items. The new generation of female lays eggs after 2-4 weeks after infection.

A person can also be the host of parasitic whipworm and other Trichinella roundworm. The fight against parasitic worms in nature, animal parasites are found widely in the types of flat and round worms. There are more than 10,000 species of worms that are parasites of plants, wild and domestic animals, human. They cause great damage to agriculture and human health. A parasitic way of life of the tapeworm has led to a reduction of the digestive system, the emergence of organs of attachment in the form of suction cups, hooks. For all types of flat and round worms is characterized by increased fertility due to the

complexity of life cycles, involving massive loss of larval stages in intermediate stages of development.

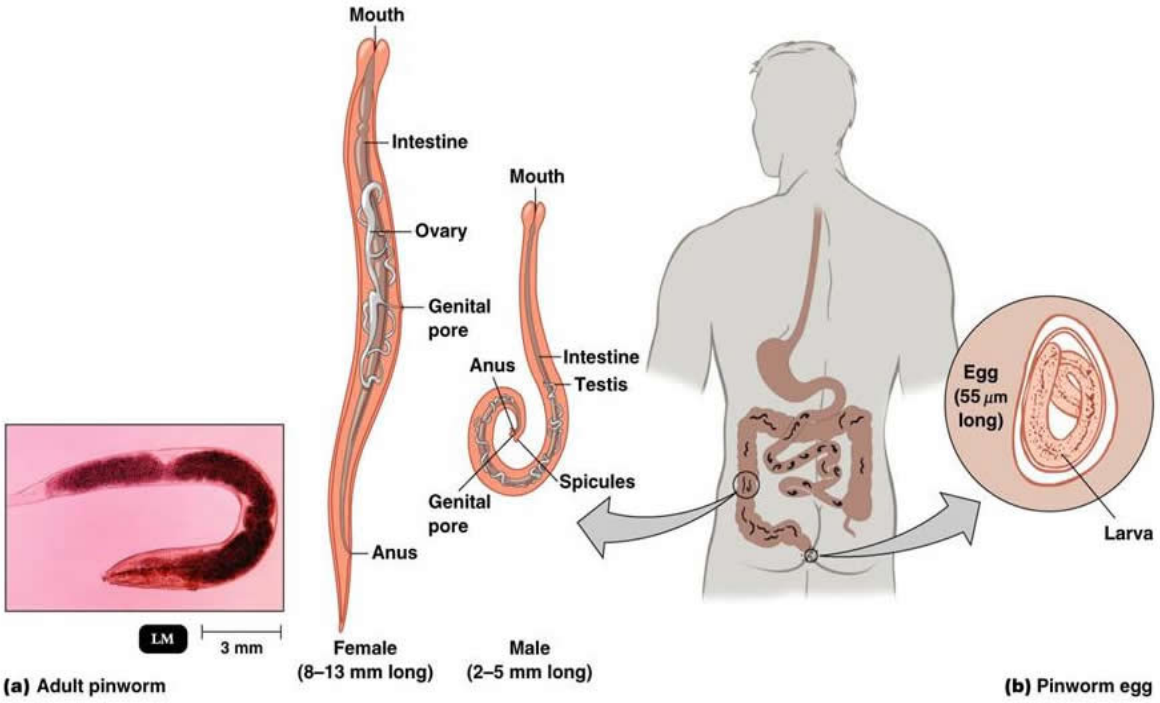


Figure 4.10. Human Pinworm structure

Parasitic worms cause severe human disease, sometimes with death of pets. The main ways to combat parasitic worms have been developed by Academic K.I. Skryabin (1878-1972). Hepaid attention on prevention measures of infections which are derived from features of the parasite life cycle and focus on his break. To prevent infection of feline trematodeis need able not to eat raw meat of freshwater fish. To prevent infection with swine and bovine chain is not recommended to use heat-treated meat of pigs or cattle.

To prevent infection of Ascaris vegetables, fruits, berries must be thoroughly washed with water before use and wash hands before eating. An important role in the fight against parasitic worms belong to sanitary control over the protection of water sources, soil, butchering animal carcasses to meat cooking technology in the dining rooms, the strict observance of rules of personal hygiene staff kitchens, shops and food sellers each person individually.

4.5. Type Annelids

Annelid compared to flat and round worms more highly organized animals. Their body is divided into head, torso and anal lobe, is skin-muscular sac, and segmentation is expressed not only in the foreign, but also in the internal organization. In annelids first appears the secondary body cavity (the space between the wall of the body and internal organs with epithelial lining that separates the cavity fluid from all the others, tissues and organs). It is divided into the chamber in accordance with an external segmentation. In most species, except leeches, there is a closed circulatory system. They breathe through gills, and in their absence – the entire surface of the body. Authorities release them bymetanefridial type arranged in segments. The nervous system consists of the pair above and subesophageal ganglia associated with peripharyngeal nerve ring and ventral nerve cord. The latter is a pair of longitudinally contiguous trunks forming in each segment ganglia. Among annelids found both animals are dioecious and hermaphrodite. Type is divided into three classes (Oligochaete, Polychaetes, Leeches) which consists about 9000 species.

4.5.1. Class Oligochaete

Oligochaete is a group of annelids, the vast majority of whom live in the soil or on the bottom of freshwater. They feed mostly plant food, mostly decaying plant parts.

A typical representative is the earthworm, living in moist, humus-rich soil (Figure 4.11). The front third of the body he is thickening - belt. On the ventral and lateral sides are elastic short bristles, promoting their movement. The worm body from the outside is covered with cuticle. Underneath the skin sequentially arranged two layers of circular and longitudinal muscles. On the inner side wall of the body is covered with a layer of epithelial cells. The digestive system begins from mouth, leading to intestinal tube which distinguish the front, middle and back offices. Anterior differentiated into the pharynx, esophagus, crop, gizzard. In the esophagus cavity opens special gland, which produced lime which neutralize acid humus food. With the reduction of the muscular walls of the stomach the food is ground, it enters the midgut and digested by the action of digestive juices. Digested food is absorbed into the bloodstream. The remains of undigested food are thrown out through the anus. Circulatory system

in earthworms is closed and presented by dorsal and ventral vessels. These vessels are interconnected annular vessels, the number of which is equal to the number of the segments. Seven circular vessels located around the esophagus, pulse and perform the role of "heart". From the main and circular vessels originate smaller vessels and capillaries that reach every organ. There are no special respiratory organs in the earthworm. They breathes through the skin, penetrated by a dense network of capillaries. The body protects the mucus covering with continuous layer, contributing to gas exchange. The excretory system is represented in the metanephridia form convoluted tubules, which are located on two and each segment. One end of the tube has the form of a funnel, the edges of which are covered with cilia. The tube passes through the partition and opens the excretory times on the ventral side of the adjacent segment. The nervous system consists of a nerve ring peripharyngeal and ventral nerve cord.

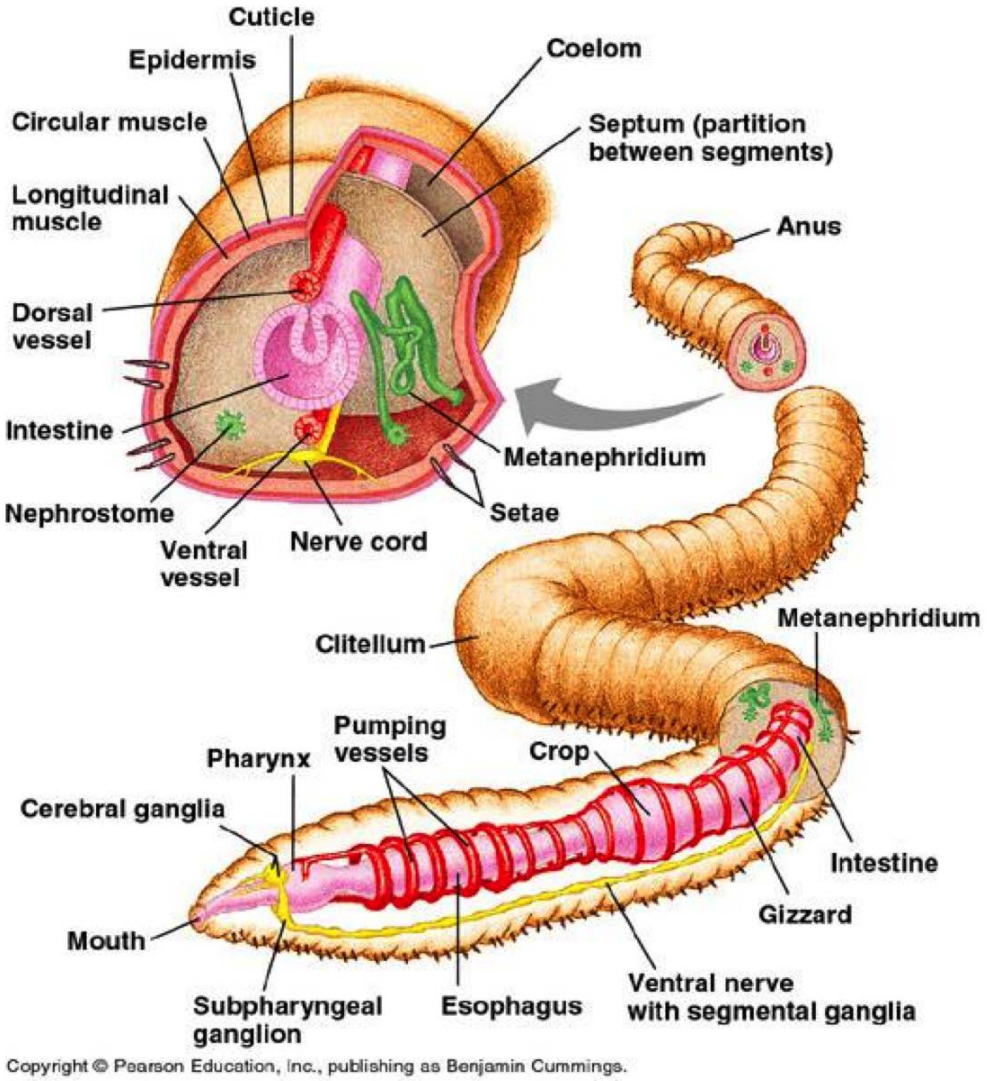


Figure 4.11. Earthwormstructure

The earthworm does not have specialized sensory organs. There are only different kinds of cells sensitive to the perception of irritation. Earthworms are hermaphrodites. They have cross fertilization. Earthworms are useful animals as contribute to loosening the soil, enriching it with air and humus.

4.5.2. Class Polychaetes

This class includes marine worms. Each segment of the body they have paired appendages (parapodium) serving for the movement, and is the prototype of arthropod limbs. Some worms have parapodium gill apparatus which provides gas exchange. The head office in polychaete well aside and brings the senses (tentacles light sensitive eyes, olfactory fossa). Polychaetes serve as food for marine animals. For example, the Nereid specially acclimatized in the Caspian Sea as feed for sturgeon.

4.5.3. Class Leeches

Representatives are free-predators or most external parasites which are found on the skin of other animals that feed on their blood. The body somewhat flattened in dorsoventrally. By the tissues of the victim leech attached two suckers (front and back), with which it also feeds on blood. They has respiratory and movement systems. The secondary cavity of the body is reduced. The circulatory system is not closed. Leeches are hermaphrodites.

A typical representative of the class is the medicinal leech that lives in ponds, lakes and marshes. It feeds on the blood of various vertebrates and highlighting the wound a special substance that prevents blood clotting. Therefore, the wound bleed for a long time. Medical leeches are bred and used in the treatment of a number of human diseases.

4.6. Type Mollusks

These aquatic animals that inhabit fresh water, oceans, seas, few of them (lung mollusks) have adapted to life on land. Mollusks body, as a rule, consists of a head, on which the organs of touch in the form of tentacles, torso and legs, which is a body movement, non-segmented body, bilaterally symmetrical, with the exception of gastropods, who is due to the symmetrical bodies bias. The

base of the trunk is surrounded by a fold of skin – mantle. The mantle delimits with the body cavity in which gills bodies chemical senses are situated, as well as the opening of the hindgut, kidney, sexual apparatus. The dorsal side of the body is covered with a mantle allocated protective shell of various shapes, consisting of three layers: the outer (stratum corneum), medium (limestone and porcelain) and internal (pearl). Secondary body cavity in most species of shellfish represented pericardium and oral sex glands.

The digestive system begins from mouth which follows by a sip of the machine to crush food, called float. Throat goes into a loop-like intestines, which is a number of shellfish permeates the pericardial cavity. The ducts of the salivary glands open into the pharynx and liver ducts of the liver - in the stomach. Shellfish have not closed circulatory system, heart consists of ventricle and atrium. It comes from his blood washes authorities directly. Authorities release mollusks make up kidney of metanphridial type. The nervous system consists of ganglia, interconnected processes. A number of species of the front ganglia fused together in a "brain."

Among mollusks could be found both dioecious and hermaphrodite individuals. Embryonic developments of shellfish is close to the development of the annelids. Mollusks are divided into three classes – Snails, Bivalves and Cephalopods and unite about 130,000 species. The number of species of this type takes the second place after the arthropods. Shellfish are considered dead end in the evolution of invertebrates.

4.6.1. Class Snails

Snails are found in marine and fresh waters, as well as on land. Their sizes range from 2.3 mm to 60 cm. Their sink is in them or conical spiral (Figure 4.12). Class includes over 90,000 species. Typical representative of this class is the common pond snail. He lives in ponds, lakes, quiet backwaters of rivers. His body is divided into head, trunk and leg, covered with a mantle and is enclosed in a spirally twisted shell. Moves ordinary truncatula is by reducing the leg muscles. The digestive system begins from mouth which located on the head, passing in the throat with a muscular tongue planted with numerous teeth. With their help truncatula scrapes the soft tissues of plants. Through the throat food enters the stomach. Digestion of food takes place in the liver and the

intestine ends. Truncatula breathes by atmospheric air that enters the special gown pocket - easy.

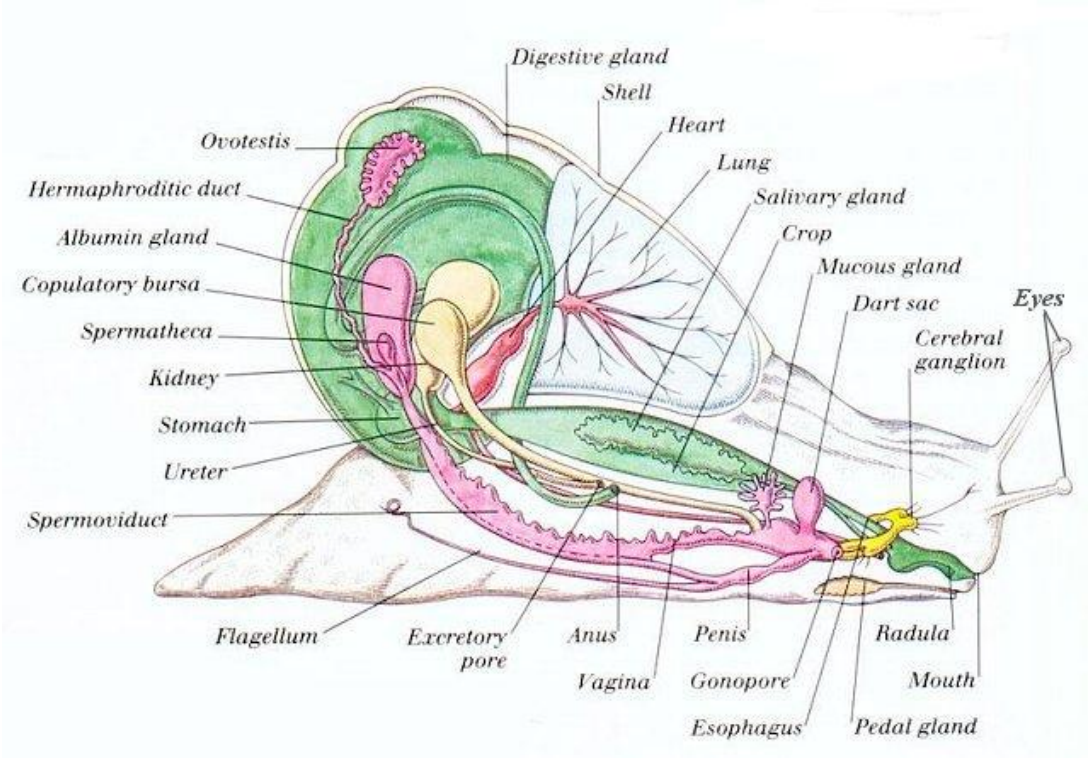


Figure 4.12.Snail structure

The walls of lightweight braided are network of blood vessels. In connection with pulmonary respiration truncatula periodically rise to the surface of the pond. The circulatory system of the pond is not closed and submitted heart which consists of atrial and ventricular wall which in turn reduced, pushing blood into the vessels. Arterial blood which is light oxygenated enters the atrium, then into the ventricle from which it is pushed into the vessels, capillaries disintegrating. The blood enters the space between the bodies. From the body cavity venous blood is collected in a vessel for its easilest carrying. Authorities release submitted by the kidneys (modified metanephridia). The nervous system consists of five pairs of ganglia, which are located in different parts of the body and connected with each other with the help of nerve trunks. From components to all organs depart nerves. Senses presents by color touch bodies in the form of two tentacles and eyes located at their base. Truncatula is hermaphrodite. Zygote covers with slime and becomes a cocoon, which is attached to underwater plants. It once formed the young truncatula (direct development).

Some representatives of the gastropods, such as snail, slugs, are agricultural pests. Some species are intermediate hosts for parasitic worms (small-truncatula for liver fluke; Bithyniidae snails-for feline fluke). Many gastropods are edible and are target species (snail, sea saucer trubkorogi, abalone). Conch series of gastropods are used to produce nacre.

4.6.2. Class Bivalve

Class Bivalve consists of bilaterally symmetrical animals. They live in the sea, sometimes in fresh water. Head reduced, the body consists of a torso and legs. The body is enclosed in a bivalve shell, casement allied special elastic ligament, located on the dorsal side of the animal. It flaps shells attached muscles, contactors, which, cutting, contribute to the connection flaps. Bivalve is combine more than 20 000 species and largest in the class in second place.

A typical representative of the class is mussel (Figure 4.13). It lives in fresh water, half burying into the mud. Her body is made up of the torso and legs, covered with a mantle, which is on the sides of its forms two folds. The folds are separated and the body cavity communicating with the outside through two siphon (holes) arranged one above the other, which are formed in the rear as a result of clam shell clamp and loosely mantle. Lower (introductory) siphon water flows to the gills and brings the suspended food particles, male sex cells. Decomposition products are derived through the top (pin) with water trap. The digestive system begins with the mussel in the mouth, surrounded by two pairs of blades, followed by a short esophagus, the stomach turns into a rounded, and the last - in the midgut, which passes through the pericardium and ends, the anus in the mantle cavity. Breathing is by mussel gill. The circulatory system is not closed. The heart includes two ventricle and atria, located on the dorsal side. Blood flow is the same as that of the pond - from the heart through the arteries in the body cavity, and from them through veins back to the heart gills. Excretory organs are the kidneys (modified metanephridia). The nervous system is poorly developed, consists of three pairs of ganglia, interconnected nerve trunks. The organs of the senses are the organs of equilibrium, the chemical senses and touch. At the edge of the mantle or siphons sometimes develop eye.

Mussel is dioecious animal. Gonads are paired, their ducts open into the mantle cavity, where fertilization takes place. The zygote develops into the gills

of the mother's body. Here, it turns into a larva enclosed in a bivalve shell which current water is removed from the mother's body is attached to the sticky

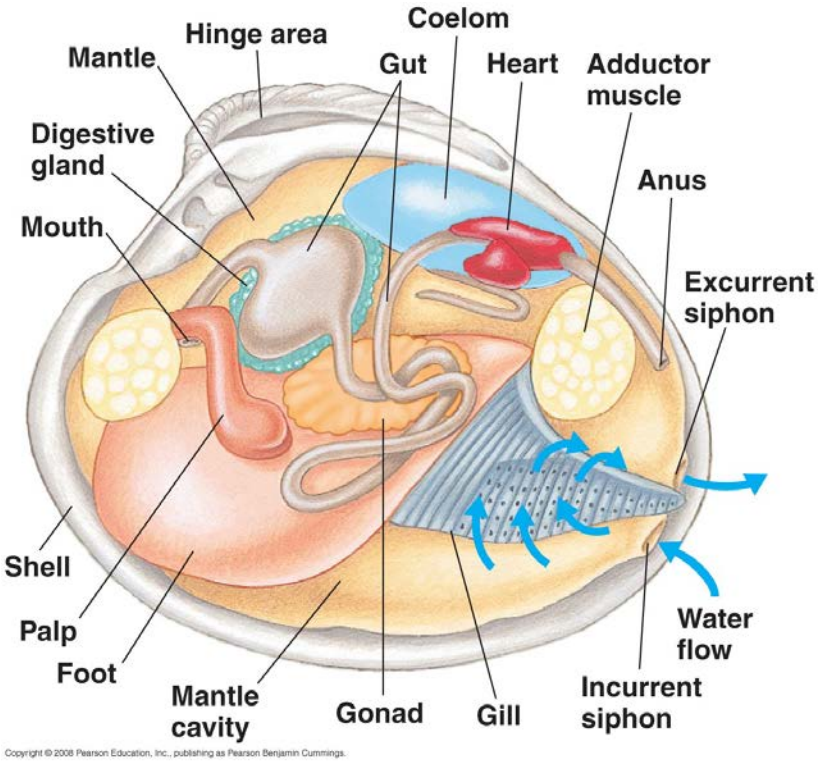


Figure 4.13.Musselstructure

thread fins, skin or gills of fish and temporarily lead a parasitic life. Two months later, the larvae develops. It settles to the bottom and begins to live independently. Thus, there is an indirect edentate's development (zygote - larva - adult individual). For bivalve molluscs are perlovitsy, mussels, scallops, oysters, pearl oysters and other species. Bivalves have great commercial value. From their shells prepared ground limestone, this goes to feed cattle. Mussels, oysters, scallops are eaten. Pearl and perlovitsy bred for commercial production of pearls and mother of pearl. Among bivalves there are pests. Thus, the ship worm corrupts wooden bottoms of ships, piers piles, etc.

4.7. Type Arthropods

In the animal world Arthropods type contains 1.5 million of species, living in the air, in water, on land. In many ways arthropods are similar to annelids, but have a number of specific features. They are like annelids, the body is divided into segments, but they are not the same in structure and form the body

sections – head arranged with complicated mouthparts, thorax and abdomen. The body is covered by chitin which has a protective function and role of the exoskeleton. The development of the latter is due to the advent of jointed limbs. Chitin cover hinders the growth of the arthropods, and therefore they are subject to periodic molting. Muscles are bundles of view, reducing their mobility allow certain parts of the body. Limbs of arthropods phylogenetically derived from parapodial annelids. They are connected with the body by means of a joint and consists of movably articulated joints. The limbs can perform different functions - capture and grinding food, movement and breathing. Along with the remains of the primary cavity of arthropods are the rudiments of the secondary. The digestive system consists of the intestinal tube, divided into a front, middle and hindgut. The circulatory system is not closed, is located on the dorsal side of the heart. The structure of the respiratory system depends on the environment (the gills – aquatic, lung and trachea bags – in terrestrial animals). The nervous system is composed of suprapharyngeal node ("brain"), peripharyngeal ring and ventral nerve cord, which often merge nodes, resulting in a reduced number compared with the number of body segments. Arthropods have well-developed sense organs. Excretory system is represented as modified metanephridia or Malpighian tubules. Arthropods are usually - dioecious animals and reproduce only sexually.

The type of Arthropods consists of three classes: Crustaceans, Arachnids and Insects.

4.7.1. Class Crustaceans

Class Crustaceans are mainly inhabitants of the seas, lakes and rivers - the crayfish, lobsters, crabs, shrimp and other species. The class has about 20 000 species. A typical representative of the class is crayfish. He lives in fresh flowing waters, nocturnal. The body is divided into cephalothorax and abdomen. Cephalothorax has five head segments and eight - breast. The chest is covered with chitinous shield, segmentation is only visible on the ventral side. Each segment bears a pair of cephalothorax biramous jointed limbs that perform different functions. First and second pairs of limbs head card and the antenna are antennules senses, three couples – jaw which are situated on the sides of the mouth and involved in keeping the food. The first three pairs of thoracic legs called mouth feet and are used to capture and supply of food in the

mouth; fourth-eighth pair of walking legs perform the role, the first of them, the most massive, called claws. The first five pairs of abdominal limbs perform shipboard functions, and the sixth pair, together with the seventh segment forms the tail fin. The digestive system begins from mouth, leading to a short esophagus and stomach is divided into two parts. In the first using chitin teeth food is crushed, and the second - through the strain off hanging from the walls of chitin filaments. Then the food mass enters the midgut, which is digested and absorbed via the liver secrets, representing a tubular gland, located between the stomach and midgut. Undigested food residues are removed through the hindgut out. The excretory system is represented by a pair of modified metanephridia. It is the so-called green glands located in the brain department. The organs of respiration in the gills of crayfish are occurring in special gill cavities formed side folds cephalothorax shield. The circulatory system is not closed. Heart is located on the dorsal side and has pentagonal shape with three pairs of hole. Rays of the vessels open into the body cavity. Blood gives oxygen for organs and tissues and then blood vessels going to the gills, it is enriched with oxygen and returns to the heart.

The nervous system is presented above and subesophageal nodes and ventral nerve cord; senses - mustache, performing the function of smell, touch, and chemical senses. The bodies of compound eyes are sitting on movable stalks.

Crayfish are dioecious animals (Figure 4.14). In male reproductive system is presented by unpaired testis with outgoing long crimped vas deferens, ejaculatory duct ending. The female sex gland is steam, oviducts are short and tubular. Fertilization is external and is performed as follows. Male sperm throws and it in the form of lumps is glued to the festival of the Protection of the female near the female genital opening. Then the female lays eggs. Eye-catching with eggs secret dissolves lumps sperm and the sperm fertilize the egg. They are glued to the abdominal legs of females and here undergo development (direct). Juveniles remain for some time in the mother's body. The value of shellfish is ambiguous. On one hand, some species, particularly crab, crayfish, lobster, are of great value for the food industry.

In addition, crustaceans have an important role in the purification of bodies of water. Cyclops and daphnia are food for fish. On the other hand, crayfish, crabs, cyclops can be intermediate hosts of human parasites (lung fluke, guinea

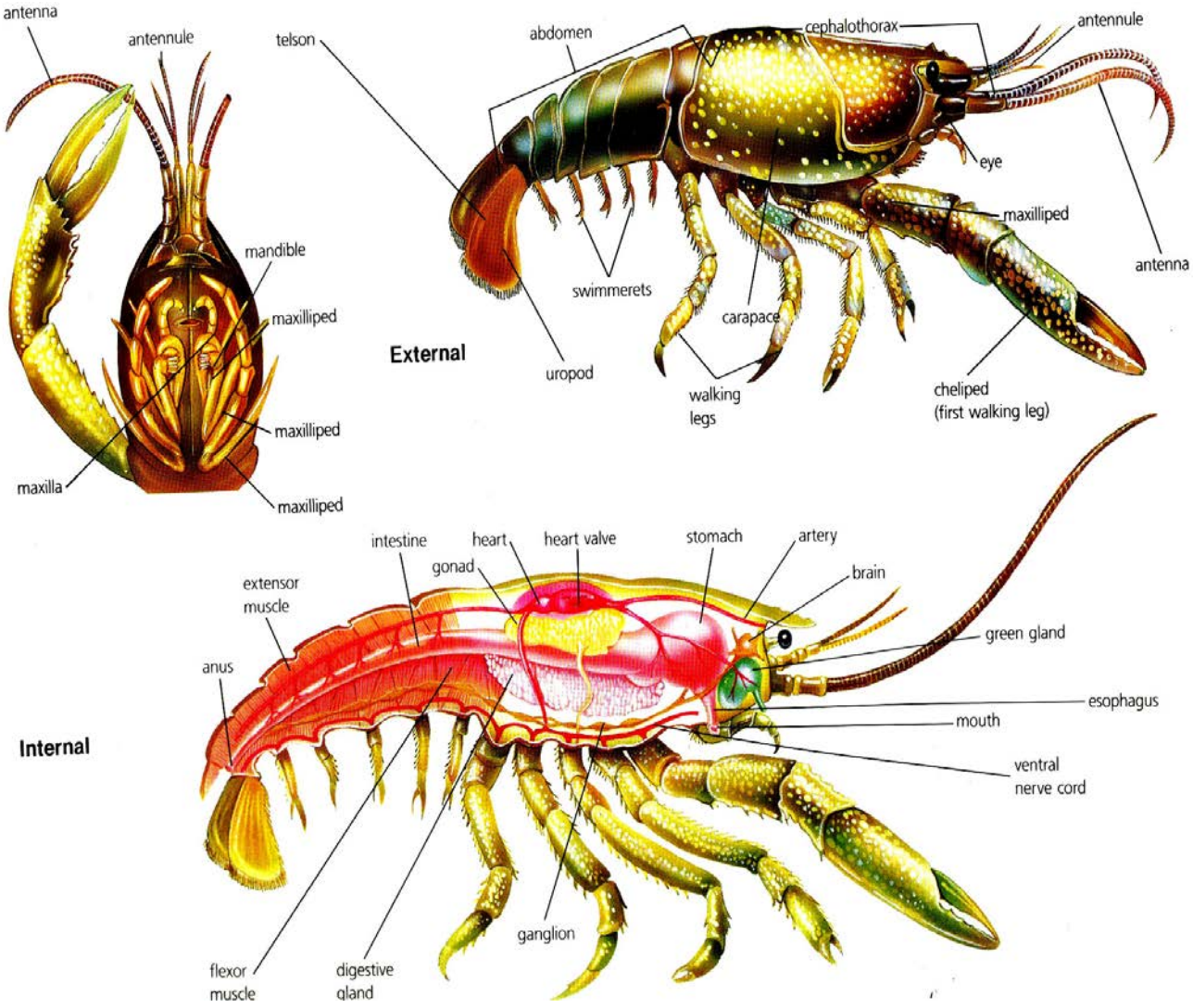


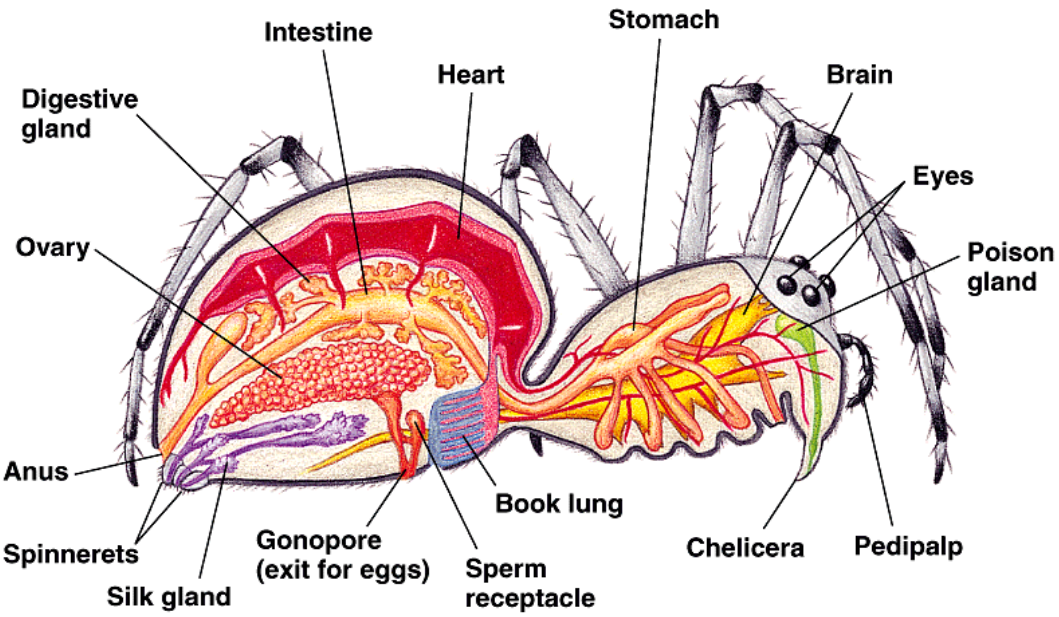
Figure 4.14. Crayfish structure

worm, tapeworm wide). Copepods (carp lice) cause the death of fish. Crustaceans carpenter destroy wood structures in the sea.

4.7.2. Class Arachnids

This class consists a group of exclusively terrestrial animals. They consists of 36 000 species which are divided into several groups. The most important of them are spiders and mites.

A typical representative of the detachment is spiders spider Araneus dwelling on land (Figure 4.15). His body is divided into two parts – the cephalothorax and abdomen. There are six pairs of limbs on the cephalothorax.



(b) Anatomy of a spider

Figure 4.15.Spider structure

The first two pairs (chelicerae and pedipalps) are used to capture and grinding food and the remaining four are walking legs. The abdomen is larger than the cephalothorax; all his segments are fused together on the dorsal side of the drawing is expressed in the form of a cross. Spider's body is covered with epidermis which have cellular structure. In the hypodermis on the abdomen are arranged spinnerets. Some of them emit a sound and non-adhesive web, from which the spider builds a skeleton trapping network (polygonal frame), the other a sticky web, going to build a concentric circles inside the frame. The result is a more agile network. The third type of gland secretes a soft silky web, from which the female builds a cocoon for oviposition. Spider Araneus, as well as other species is a predator and feeds on insects and other arthropods. Once in the network trapping the victim he first wraps sticky webs, and then injects it through ducts cheliceral saliva that dissolves tissue semi fluid weight (extracavity digestion). Digestive system of spider Araneus basically has the same structure as that of cancer, but is different in that it is adapted to the power supply semi food. This contributes to a well-developed muscular pharynx to suck the victim of solutes. Authorities release constitute special tubes (Malpighian), located on the border of the middle and posterior intestine. One end of their blind is closed and the other opens to the intestine. Metabolites which are contained in blood tubes penetrate through their walls, are then fed

into the intestine, and ejected to the outside. Respiratory system of spiders form is a light (located at the base of the abdomen and opening to the outside two small slits) and trachea – two bundles of respiratory tubes that open outwards common breathing hole.

The circulatory system in spider Araneus is unclosed and the structure is the same as that of cancer. The heart is located on the dorsal side of the abdomen. With its reducing blood through the vessels sent to the head part which is poured into the cavities between the authorities and returned to the abdominal. Washing the lungs and trachea, it is enriched with oxygen and supplied to the vessels, and then in the heart. Nervous system of spiders is characterized by the appearance of the brain. It is formed by the merger of the supra-oesophageal unit and is located in the department cephalothorax. Nerves go from the brain to the organs. Araneus Spider is dioecious animal. The female is larger than the male. Fertilized eggs female lays in the fall in a cocoon, from which spring develop direct by young spiders.

From a practical point of view, in the class of arachnids the greatest interest makes ticks – small and more often microscopic animals. Their body is not segmented or divided into cephalothorax and abdomen. They have breathe by trachea. Oral limbs in most species turned into a piercing-sucking or piercing-biting apparatus.

The development of mites in ontogenesis occurs indirectly. From the fertilized egg comes out the larva, not similar to the adult, which gradually turns into an adult mite. Ticks are mainly parasitic way of life is eating plant tissues, attacking animals and human. So, red spider mite infests cotton leaves, flour mite - in the flour, grain.

Dangerous parasites of mammals are the itch mite. Fertilized females are introduced into his thin tender skin, and burrow into their moves than irritate nerve endings and as a result - severe itching. Here they lay their eggs which develop a new generation of ticks. To prevent the disease is necessary to observe the rules of personal skin care products. The greatest danger is posed by blood-sucking ticks (dog, taiga), living in the forest undergrowth and parasitic on birds, mammals, and humans. For a man, they are dangerous because they are carriers of the causative agent of encephalitis. To prevent encephalitis persons working in the natural focus of disease, making immunization.

4.7.3. Class Insects

Arthropods are the most highly organized animals that populate different environments. The body they clearly demarcated on the head, chest and abdomen(Figure 4.16). At the head of the antennae are located, employees bodies smell and touch, as well as the eyes and the jaw apparatus. The jaw apparatus may be piercing (mosquitoes), licking (flies), sucking (in butterflies), chewing or biting (cockroaches).

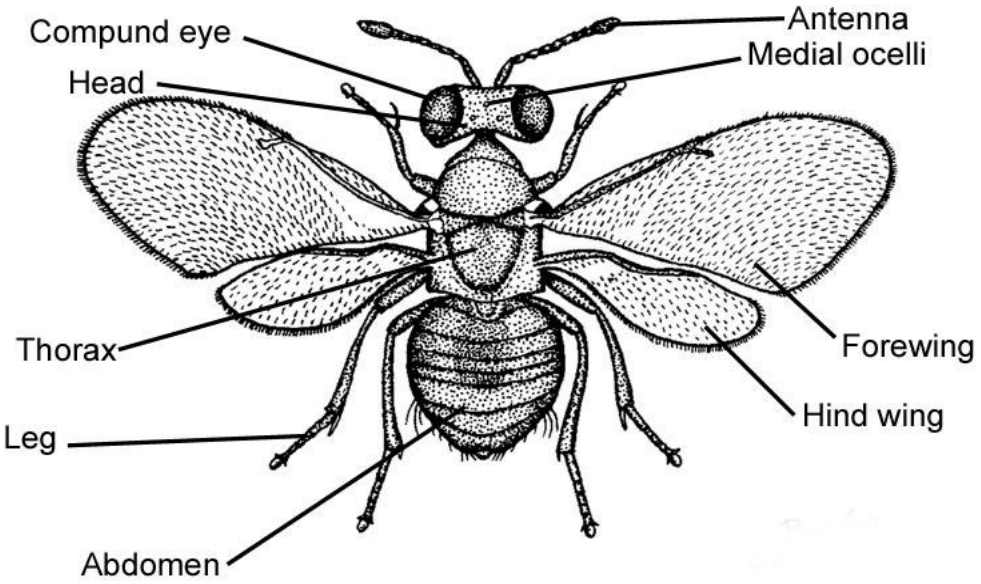


Figure 4.16.Structure of Insect

Insects are dioecious animals that reproduce only sexually. Their individual development can be direct and indirect with full and incomplete metamorphosis. In direct development from eggs appears individual, basically similar to the adult insect (at silverfish). In the indirect development with complete metamorphosis from egg larva, which turns into a pupa and it is into an adult (in Lepidoptera, Hymenoptera, Diptera). With the development of incomplete transformation from the egg comes out the larva, gradually turns into an adult (cockroaches, bugs, dragonflies). A typical representative of the class of insects is chafer. His body is covered with chitinous cover, performing the functions of the external skeleton. The head includes five segments and adjustably connected by a neck of the breast. On his head is biting type mouth parts, formed by the upper lip, a pair of jaws (upper and lower) and lower lip.

On the lower jaw and lip arranged organs of touch and taste (palps). On the sides of the head has a pair of compound eyes, and in front of them -Authority olfactory (antennal pair with extended plates at the ends). The breast is composed of three segments, each of which bears on the pair of legs. The middle and posterior segments are two pairs of wings: the first-rigid (elytra), the second - membranous. The abdomen consists of nine segments and is fixedly connected with the breast. On the edge of its dorsal side in each segment are spiracles - outlets trachea. Digestive system begins from the oral cavity which follows by the esophagus, rolling in the gizzard, where the food is ground chitin teeth, then goes into the midgut and subjected to digestion and absorption, and undigested residues are thrown out through the anus of the hindgut. The excretory system consists of Malpighian tubules. Apart from these, the excretory function is performed by special education – the fat body which accumulates in the cells of dissimilation products. The function of the respiratory system performs tracheal tubes, providing a direct supply of oxygen to body cells. The circulatory system in not closed due to the specific structure of the respiratory system is underdeveloped. The heart is located on the dorsal side of the chest, a kind of tube with several pairs of holes. As blood enters the heart through the side holes at the time of relaxation. The nervous system of the beetle resembles that in crustaceans. Its form peripharyngeal nerve ring and taking from it the beginning of the ventral nerve cord, which units are concentrated mainly in thoracic part.

Class insects is about 1 million species that have structurally wings, mouthparts and type of development are distributed on orders. Insects are of great importance in nature and human life. They have a great role as pollinators of flowering plants (bees, bumblebees, butterflies). Insects are active participants in the circulation of substances under way. Many insects (beetles, carrion, kozheedy, dung, etc.) who eat the corpses of birds, animals, contribute to cleaning up the environment. Insects themselves are food for other animals. So, many fish species feed on larvae mosquitoes. A number of birds and mammals (anteaters) feed on adult insects. However, some insects are pests of agriculture and forestry (locusts, Colorado potato beetle, gypsy moth, and others.). And it is interesting to note that in order to deal with them are often used by insects, parasites on other insect species (different kinds of riders, wasps, etc.). Among insects there are carriers of pathogens of human parasitic diseases (malaria mosquitoes – malaria parasite, mosquitoes – pathogens of

leishmaniasis, fever mosquito, tsetse fly, the causative agent of sleeping sickness; housefly – agents of dysentery, typhoid, and helminthes eggs, protozoa cysts). Number and diversity of species of insects are reduced as a result of various kinds of human activities. Only insect protection will keep the animal world in all its diversity.

4.8. Type Chordates

Chordata is the highest type of the animal kingdom which unites about 40 000 species that populate all the living environment. Their distinguishing feature is the presence of an internal axial skeleton – chords, stretching along the body. In some species, it persists throughout life (lancelet, cyclostomes, cartilaginous fish), others - only in its infancy, and the further development of bone is replaced by the spine (bony fish, amphibians, reptiles, birds and mammals). Over the chord is the central nervous system of a tube-ectodermal origin. Under the axial skeleton is an intestinal tube, the front office which is penetrated near the gill slits. This part performs the functions and throat and respiratory system. Gill slits are saved or whole life (lancelet, cyclostomes, fish) or exist only in its infancy (terrestrial vertebrates). On the ventral side, under the intestinal tube, it is the central organ of the circulatory system – heart or vessel it replaces. In chordates and echinoderms like secondary mouth is formed. Chordates have a number of features peculiar to, and certain types of invertebrates: it is present bilateral symmetry of the body, per-hop arrangement of individual organs, skeletal system (vertebrae), muscles (muscle segments), the peripheral nervous system (spinal nerves), part of the blood vessels, as well as the presence of a secondary cavity of body.

Type Chordata is divided into three subtypes: tunicates (Larvaechordates) without cranium and Vertebrates (Cranial). Representative'sof tunicates are sea squirts, salps – marine animals. Signs of chordates they appear only in the larval stage. We have just emerged from the egg larvae are the notochord and the neural tube. In the future, these organs atrophy. As a result, only the ganglion remains of the neural tube. The larva is covered by a shell and turns into an adult. Without cranium represented by one class of Amphioxus, which constitute a small group of primitive chordates found in warm seas.

A typical representative is lancelet – small (up to 8 cm) translucent animal (Figure 4.17). Across the dorsal side of its body he has fin stretches rolling in

the tail. Most part of the life animal spends buried in the sand and putting out the front end of the head. One of the main features of the structure Amphioxus have no skull and hence the jaw apparatus. His body is covered with smooth skin from a single layer of the epidermis and the derma. The muscles lie under in and form of individual segments between which lie connective tissue layers.

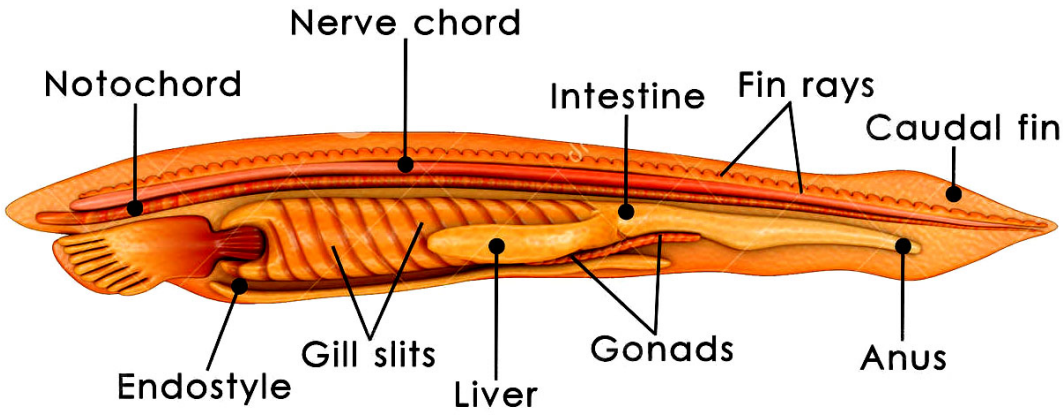


Figure 4.17. Structure of Lancelet, by Dreamstime.com

The axial skeleton is formed by the chord representing a tight elastic strand of large vacuolated cells of endodermal origin, enclosed in a sturdy shell. The nervous system has the form of Amphioxus tube lying on a chord. The head is forms a small extension of the brain which is rudiment. The sense organs are poorly developed. Only the front end of the body is the olfactory fossa, in the skin – tactile cells along the neural tube arranged light-sensitive education. Peripheral nerves extend respectively to each segment of muscle. It has a mouth surrounded by tentacles at the front end of the body. It is a sip behind him. The walls of the latter are penetrated a large number of gill slits in the partitions which are the blood vessels. After the last wall is carried out gas exchange between the animal's blood and washing the gills with water. Throat passes into the intestine, lined with ciliated epithelium. Due to the vibration of the cilia food particles contained in the water move through the intestine which is not differentiated. From its initial part hepatic departs outgrowth, and the final section ends with the anus. Thus, breathing, nutrition and Amphioxus occur passively. Authorities release Amphioxuspresented in segments next pair of branching tubular epithelial (nephridia), which are located on the sides of the pharynx. Nephridial tube has a hole opening into the secondary cavity. The opposite end of the opening in nephridia near gills cavity, where waste products

are out. Circulatory system in Amphioxus is closed and consists of two vessels (dorsal and ventral) which depart from smaller vessels. Blood flow is created pulsating abdominal vessels and bases gill arteries. Amphioxusare dioecious animals. The reproductive system is presented in male by testes, the female - ovaries. There are no excretory ducts. Mature gametes by the way of gap gonad walls stand out in near gills cavity. Sex cells are carried from the water current in the environment where there is external fertilization. The egg develops in the water, it comes out of it to float freely embryo.

In the evolution of Amphioxus were the original forms of higher chordates. This idea was firstly proved by Russian zoologist and evolutionist Kovalevsky (1840-1901), who found that these animals occupy an intermediate position between the tunicates and vertebrates.

Vertebrates are the most highly organized group of type of chord that is different from the other subtypes active way of tracking down and capture food. Vertebrates possess the most advanced sense organs needed for foraging, development of bodies movement, moving mouthparts (maxillary) apparatus and complex brain. All vertebrates complexity of the structure and characteristics of embryonic development can be divided into lower, or anamniotes (cyclostomes, fish, amphibians), and higher, or amniotes (reptiles, birds and mammals). Integument is represented in vertebrate by skin which consists of a multilayer epithelium and dermis and its derivatives (scales, feathers, hair).

The skeleton consists of the axial skeleton, skull, limbs and belts. Axial skeleton develops in the form of the chord, which is then displaced spine consists of segmental bone or cartilage located vertebrae. Skull appears in connection with the development of the brain. It has two parts - the skull to protect the brain, the organs of sight and smell, and the internal (visceral) skull, which serves as a support for the anterior part of the digestive tube, forming a jaw and gill arches. Limbs may be unpaired (dorsal and caudal fins) and steam. The skeleton of paired limbs release belt (shoulder, pelvic) and the free limb. Muscles of the body are divided into skeletal muscle and visceral (smooth muscle). In lower vertebrates, the skeletal muscles, as in Amphioxus, located in segments, the higher segmentation is broken, and the muscular system has a complex structure and location. The digestive system is characterized by intestinal differentiation in the front, middle and rear sections, the advent of tools for grinding food and digestive glands (liver, pancreas, etc.).

Respiratory phylogenetically related to the gut. They are presented in the form of gills or lungs and develop from the protrusion of the anterior intestinal tube. The excretory system is represented by the kidneys which can be of three types (headache, or pronephros, trunk and pelvic) and excretory channels (ureters). Pronephrosmetanephridia is similar to annelids. The mesonephros atrial funnel partially replaced by a capsule with a ball of blood vessels and filtration tubules. In this change kidney pelvis done entirely dissimilation and products do not enter the body cavity, and filtered from the blood in the organs of excretion. The circulatory system is represented by special muscular body – heart, divided into the chamber (atrium, ventricle), and the vessels, which moves blood to the heart (venous) and from (arteries). The circulatory system is always closed. The important role in regulation of metabolism and maintaining a constant internal environment of the body in vertebrates belongs to the endocrine glands (pituitary, adrenal, thyroid, etc.). The nervous system in vertebrates is divided into central (brain and spinal cord) and peripheral. The brain consists of five sections - frontwhich divided into two hemispheres, the intermediate, middle, cerebellum and medulla oblongata. From brain fade cranial nerves (in the lower 10 pairs of them, in higher - 12), and from the spinal cord segment by segment - spinal nerves. Senses represented organs of vision, hearing, smell, taste and touch. Reproductive organs consist of paired gonads. Vertebrates animals are dioecious with marked sexual dimorphism. Lower vertebrates have external insemination, in higher – internal. Subtype is divided into classes, the most important of which are fish, amphibians, reptiles, birds and mammals.

4.8.1. Class Pisces

Class Pisces is the most diverse and numerous class of these aquatic vertebrates that retain gills throughout life. They inhabit all waters of the world and tailored to the most diverse conditions of the aquatic environment. We know about 20 000 species of fish. A typical representative of the class of fishes is the river perch. His body is elongated, streamlined: the head is gradually transformed into the body, and the body - in a ponytail. The skin is covered with protective scales, increasing annual rings. It consists of many glands that produce mucus, due to which decreases friction during movement of the fish. Sliding is paired pectoral and pelvic and unpaired (dorsal, caudal and

anal) fins. Curves of the body, the mobility of the fins, gill covers and jaw muscles are provided which lie under the skin and attached to the skeleton. We perch has a special body - the swim bladder, performing hydrostatic function. It is filled with a gas that stabilizes the fish(Figure 4.18). This bubble can expand and contract freely, whereby the proportion of fish varies, and it moves in a vertical direction. Skeleton make up the spine, ribs and fins (front and rear dorsal, caudal, anal and paired pectoral and pelvic). Spine form numerous vertebrae, the upper limit of the arc which the spinal canal where the spinal cord is located. The last is divided into two parts - trunk and tail. The skull is divided into the dorsal portion which houses the brain, the organs of sight, smell and taste, and the abdominal portion forming the gill arch, the jaw with conical teeth to hold the grasped production. Digestive system begins from mouth opening, leading to the mouth, then subsequently go pharynx, esophagus, stomach, small intestine and back. Digestive enzymes liver and pancreas enter the small intestine. Authorities release presented mesonephros oblong shape, lying on either side of the spine. Urine output in the ureter bubble is opening behind the anus. Respiratory system consist of gill filaments, sitting on the gill arch. Water washes through gill slits gill filaments, gives the dissolved oxygen in the blood is enriched with carbon dioxide and extends outwardly from the operculum. Since breathing is carried out.

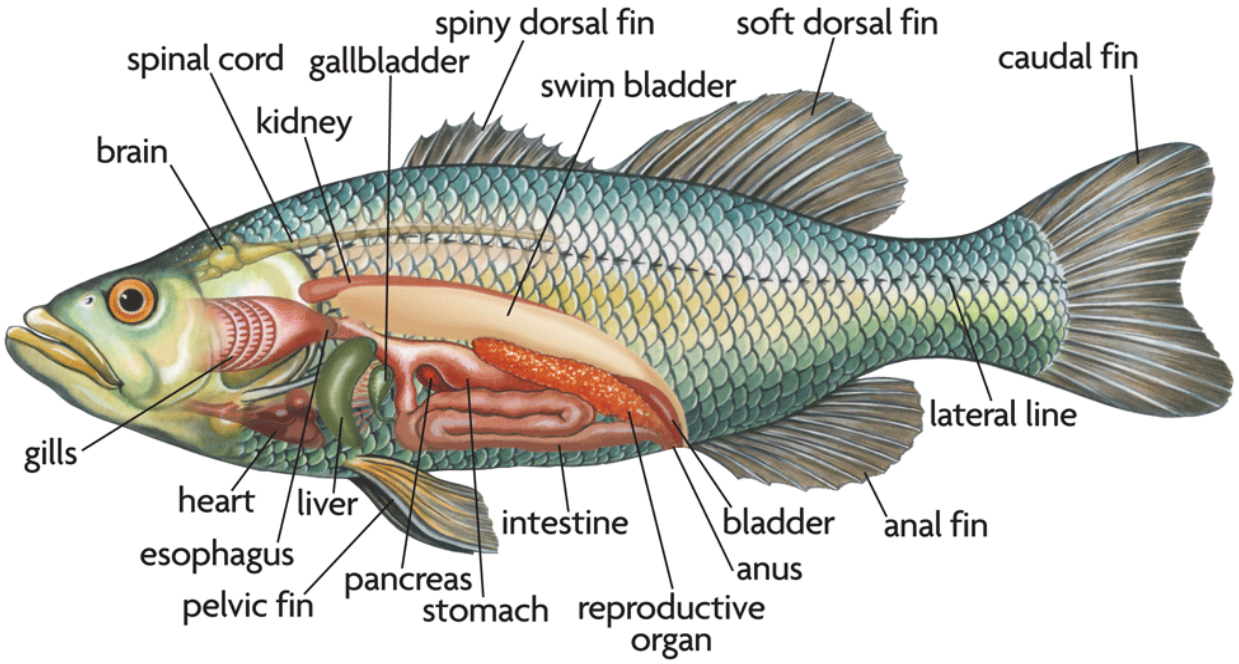


Figure 4.18. Structure of fish

The circulatory system in fish is closed. It is represented by one circulation. Two-chambered heart (one atrium and one ventricle) it receives only deoxygenated blood that is collected from the internal organs and muscles in the vessel flows into the atrium. Ventricular blood moves into the abdominal aorta and guided to the gills. Extend from the aorta into smaller vessels that carry venous blood, saturated carbon dioxide gas to the gills. The gills of the blood give carbon dioxide, saturated with oxygen. Arterial blood is collected in the dorsal aorta which breaks into smaller vessels that carry blood throughout the body. The walls of the capillary gas exchange occur. Venous blood is collected into a vein and it falls into the atrium. The central nervous system consists of the brain and spinal cord. The brain is small in size, it distinguishes the front, intermediate and midbrain, cerebellum and medulla oblongata. The forebrain is the center of smell, the midbrain - the perception of visual stimulation, medium - visual center, the cerebellum - coordination of movement and balance, the medulla oblongata - breathing, blood circulation and other functions. It departs from the brain by 10 cranial nerves. The spinal cord is located in the spinal canal of the spine. Inside it passes the narrow central channel which goes into the brain cavity. From the spinal cord in segments extend on the right and left spinal nerves. The organs of vision are the eyes of a spherical lens, hearing - inner ear (membranous labyrinth), located in the skull and has no external opening, sense of smell - olfactory bags, opening two nostrils on the dorsal side of the front of the head. A peculiar sense organ is the lateral line. Its channels extend laterally along the body and communicate with the environment in small openings. Lateral line allows the fish to focus on the direction of movement of the water, its chemical composition, pressure, and low-frequency sounds. Touch function executes the entire surface of the body. Fish reproduce sexually. The testes and ovaries are paired. Fertilization is external: the eggs and the seminal fluid with sperm released into the environment, where fertilization takes place. This process is called spawning. The fertilized eggs develops embryo which leaves the egg shell and turns into a larva. Last grows and have reached puberty, it becomes adult. Many fish (sturgeon, salmon, etc) gather in large flocks and from the seas rise into the upper reaches of the rivers to spawn. This is migratory fishes. Fish that live in brackish areas of the sea adjacent to the mouth of the rivers (the bream, catfish, pike and others.) are called semi. Depending on the characteristics of the skeleton structure of the fins, the method of breathing and other signs of fish are

divided into elasmobranch (sharks, rays), lopasteperyh (crossopterygian, lungfish), ray-finned (ganoid, typified by sturgeon) and bony. Fish has a great economic importance. Meat of fish is a valuable food product. In addition, it is used to produce vitamins, fat meal to livestock. However, in recent years, the world's fish stocks have decreased significantly. The main reasons for this is the excessive overfishing, water pollution, construction of hydraulic structures on rivers. Many species of fish have disappeared or are on the verge: destruction. For the purpose of enhancement of fish resources in the country are carried out activities aimed at the protection and reproduction of fish.

4.8.2. Class Amphibians

Amphibians is small in the number of vertebrate species group (around 2500), leading water and land lifestyle. Along with the features typical of aquatic ancestors they have a number of features which are typical of terrestrial vertebrates. This are: pulmonary respiration, circulation, two, three-chambered heart, differentiation of the foreleg on the shoulder, forearm and wrist, back - on the thigh, calf, foot. In addition, the cycle of development of amphibians aquatic larva turns into the adult form, living mainly on land. Modern amphibians include three companies: legless (caecilians, adapted to underground, burrowing life), caudate (newts, salamanders, ablistomy) and tailless (frogs, toads, tree frogs). Tailless is the most highly organized and a large number of species on the group. The ancestors of amphibians are considered ancient crossopterygian fish. From these, about 300 million years ago and the first land vertebrates - tailed amphibians.

A typical representative of tailless amphibian is frog(Figure4.19). Her body is short, broad, covered with smooth skin which is rich of mucosa glands. Flat head, the neck is not expressed and no tail. The hind limbs are elongated, with swimming membranes, front - smaller, they are four fingers instead of five.

Skeleton bone, braincase submitted, the spine and limb bones. Brain box is small. The spine is short, consists of a cervical vertebra, several trunks, one of several sacral and caudal, fused into one bone. Frog has no ribs. Belt forelimbs up the sternum and the pair of crows bone, clavicle and scapula. Free forelimb separated shoulder, forearm, wrist, and back - on the thigh, calf, foot. Muscles located in segments and provides movement. The digestive system is represent-

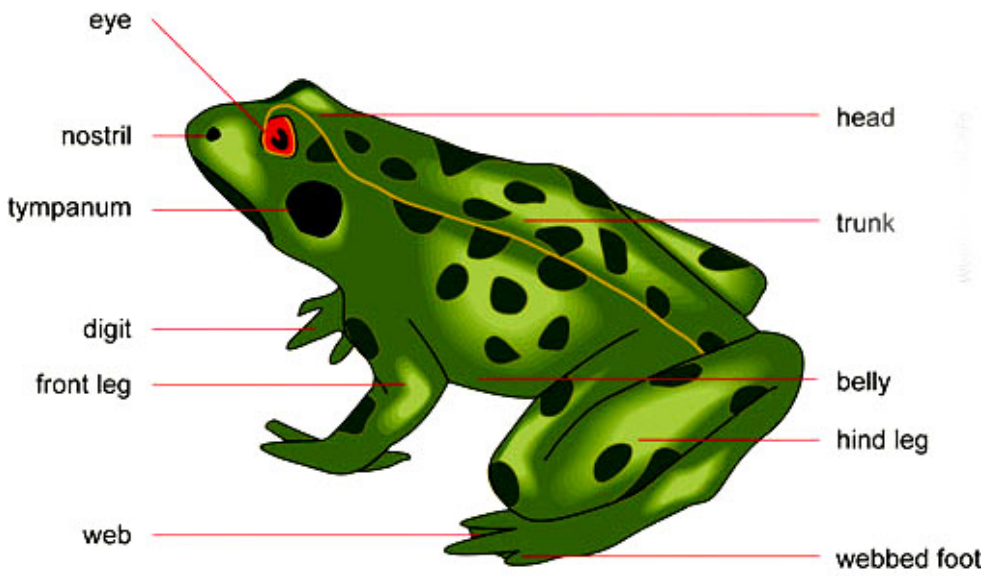


Figure 4.19.Morphology of a frog

ted by the mouth, esophagus, stomach and baggy short intestine(Figure4.20). In the front part of the intestine open ducts of the liver and pancreas, and in the rear, extended (the cloaca) - ureters and ducts gonads. Frog captures extraction using an adhesive tongue is attached to the front end of the mouth. The food is

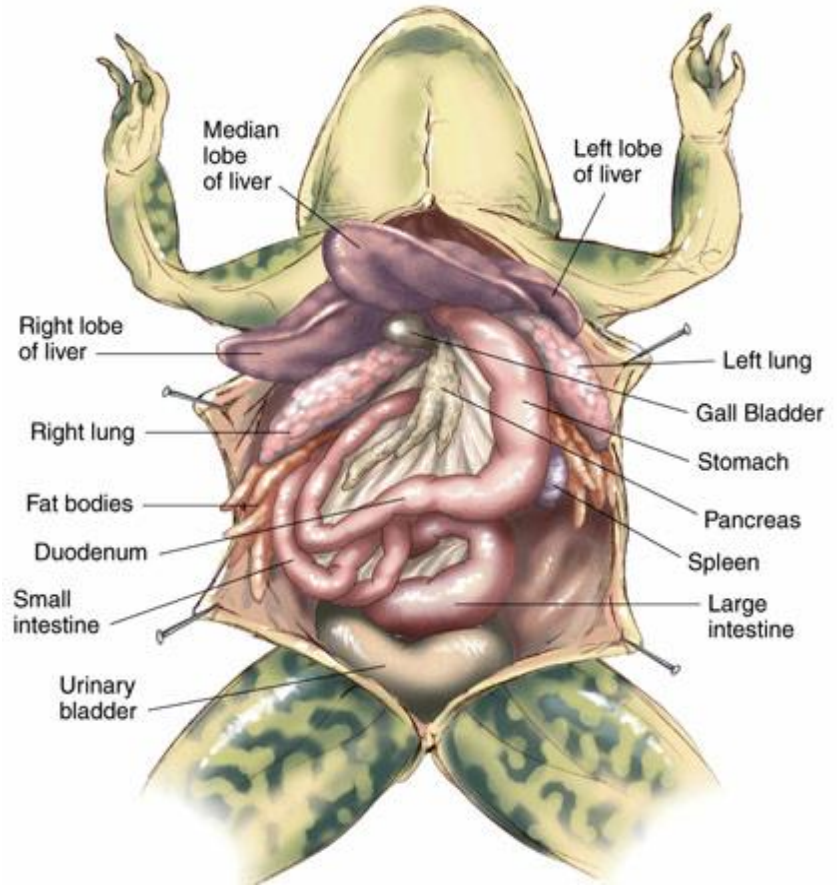


Figure 4.20. The internal structure of a frog

not chewed; teeth serve only to hold the prey. The swallowing involved eyeballs: poi reducing specific muscles they are drawn into the mouth and pushes the food. Excretory system consists of truncal kidneys, ureters and bladder. The urine from the kidney to the ureter enters atrium, and from then - to the bladder and filling as it is removed to the outside through the cloaca. Respiratory organs are the lungs. They have the form of cylindrical bags with thin walls. The inner surface is the cellular. However, the surface of the lung is low, so the skin is an important organ of respiration. The mucus covering the body and protects it from drying out and promotes gas exchange. With the advent of pulmonary respiration complicated structure and the circulatory system. The heart was the three-chambered (two atria, one ventricle), formed the second (lung) circulation. The right atrium is localized only deoxygenated blood in the left - arterial and ventricular - mixed. Arterial blood is supplied only to the brain, and mixed -webs and organs. Large circle of blood moves through the arteries and ventricular throughout the body and flows off through the veins into the right atrium. It is a small circle of the ventricle to the lungs and skin and is returned from the lungs into the left atrium. The central nervous system consists of the brain and spinal cord. The brain consists of 5 departments (as in all vertebrates). The forebrain is already possible to distinguish between the cerebral hemispheres, but it still remains the olfactory center. The midbrain well defined visual hillocks. The cerebellum is small due to the uncomplicated motor acts in amphibians. From the brain move away 10 pairs of cranial nerves. Spinal cord compared to fish has a complicated structure. In connection with the emergence of limb spinal nerves form the brachial and lumbosacral plexus. In connection with the release to land complicated the structure of the sense organs. The eye appeared lenscompact and convex cornea is adapted to vision at a fairly far distance. There are eyelids protect the eyes from the effects of dry air, and the nictitating membrane. The body consists of an inner and middle ear. The latter is the auditory ossicles (stapes) closed eardrum and adapted to capture sound waves. Smelling the arrangement of color nostrils, which serve not only for the sense of smell, but also breathable.

Organs of taste are the taste nipple on the tongue, palate, jaws. Fertilization of amphibians, like the fish is outside from fertilized eggs after 8-10 days larva called a tadpole, resembling fish fry. At first, it feeds the remnant of the yolk is not used embryo. He first has a tail, lateral line, gills, two-chambered heart, and

one circulation. But after a certain time are put forward, then the hind legs are formed by light, the second circulation disappears lateral line, tail, shorter intestines. After 1.5-2 months tadpole turns into a frog. Amphibians are useful animals. They feed on insects, their larvae and other invertebrates; do serve as food for many birds and mammals. Some species of amphibians are used for human consumption. Grass frog is laboratory animals in research.

4.8.3. Class Reptiles

It is the oldest of this class of terrestrial vertebrates that are not associated with an aqueous medium at any stage of individual development. Being cold-blooded animals, they have adapted to live in the tropical forests, deserts, arid steppes and are becoming increasingly rare as we move to the polar latitudes. Reptiles living in water (crocodiles, turtles), are secondary aquatic animals as their ancestors from the original ground lifestyle went to the water. Out of reptiles on the land accompanied by the formation of a number of them aromorphoses most important of these are considered to be durable shell around the egg yolk accumulation in it and forming an aqueous embryonic membranes (amnion), ensured the development of the embryo in the air; the cerebral cortex; improving the structure of the skeleton, circulatory, respiratory and excretory systems. Reptile body is divided into head, neck, trunk, tail and limbs. It is covered with dry, devoid of skin glands. Only some types of odorous gland preserved to attract and repel other animals. Skin formed of scales, plates or that prevent water loss and eliminate the possibility of skin respiration. The spine is divided into five sections: cervical, thoracic, lumbar, sacral and caudal. The neck is very mobile due to the occurrence of two vertebrae. To align the edges of the thoracic vertebrae which on the ventral side attached to the sternum form the thorax. Lumbar vertebrae also have ribs, the ends of which end freely. Skeleton belts and paired limbs correspond to their structure in amphibians: shoulder and thighs are horizontal ground surface, so that the body sags and drags along the ground. Skull bone bears elongated jaw, forming a long snout. The muscular system in reptiles is more pronounced than that of amphibians. In segments of muscle arrangement almost disappears. There are the intercostal muscles involved in breathing. Powerful chewing and neck muscles develop. Digestive system begins the mouth opening. Followed by the oral cavity, where a long, forked tongue, an employee body touches and taste and the jaw

provided with the same structure for the teeth. The latter is necessary to capture and hold food. In the mouth ducts of the salivary glands opens, the secret of which facilitates the ingestion of prey. Alimentary canal clearly segregated in the throat, esophagus, stomach, small and large intestine, on the border between which there is the germ of the cecum. The intestine ends by cloaca. In the duodenum open ducts of the liver and pancreas. Authorities release presented pelvic kidneys and ureters, flowing into the cloaca. It is opened and the urinary bladder. The respiratory system is complicated. There is a long trachea branches into two bronchi entering the lungs. The bronchi are represented by thin-walled honeycomb bags with numerous internal divides which provides with capillaries. The nervous system of reptiles is more perfect than that in amphibians. This is manifested in the progressive development of the brain. Hemisphere larger first bark appears. The forebrain is the center of higher nervous activity that determines the behavior of animals. The average brain controls perception of visual information, and is also involved in the formation of behavioral reactions. The size of the cerebellum increases in connection with the increasing complexity of coordination. Medulla oblongata forms a bend, typical of all higher vertebrates. However, in spite of the progressive changes in the structure of the brain, the basis of the behavior of reptiles makes unconditioned reflexes

The circulatory system in reptiles has two circulation – large and small (pulmonary), which are separated from each other fully, causing the blood is partially mixed. Heart, three-compartment is divided into two atria and one ventricle, which is partially divided muscular septum into right and left halves. Depart from the three vessels of the heart, one right aortic arch forms a bearing for the arterial blood to the carotid arteries to head, another - left arc along which the mixed blood and the third - the pulmonary artery where - venous blood circulates. Reptiles are all typical of the higher vertebrate endocrine glands (pituitary, adrenal, thyroid, etc.). High development reaches the senses. Eyes are adapted to consider the objects in the air due to the movement of the lens and change its curvature. They are protected by movable, opaque centuries, including the third eyelid - nictitating membrane, through which the eye surface is constantly moistened. The organ of hearing consists of an inner and middle ear, covered the eardrum, located behind the eyes in a small recess. Olfactory pair represented pouches nostrils opening holes in the head and into the oral cavity, resulting nosorotovoy formed channel.

Reptiles are dioecious animals with marked sexual dimorphism. Reproductive organs are paired. The gonads are in the body cavity. Males have paired copulatory organs. Fertilization is internal. Some reptiles (lizards, crocodiles, turtles) lay their eggs in the warm sand and the development of the fetus takes place under the influence of the ambient temperature, others ovoviviparous (the snake). They fertilized eggs pass all the stages of embryonic development of the female reproductive tract and embryo comes from the egg shells immediately after oviposition. The reptiles are descended from the ancient Paleozoic amphibians - stegocephalia whose torso was often covered with bony scutes. Appeared in reptiles the progressive features of the structure resulted in their heyday in the Mesozoic era. Among them, the largest group was the dinosaurs. The body length in some species reaching 30 m. Carnivorous dinosaurs moved on two legs, horny -on four. Some species of herbivorous dinosaurs moved on to life in the water. The second largest group among the fossil mammal-like reptiles, lizards up - moving prey animals that there has been a transition to warm-blodded and showing signs typical of mammals. It is assumed that from primitive mammal - like dinosaurs began the evolution of ancient mammals and the dinosaurs became isolated from the planning to the ancestors of birds. By the beginning of the Cenozoic era, most reptiles became extinct. Currently, class Reptiles numerous, includes about 6000 species, which are divided into three units: Scaled, turtles and crocodiles.

Scaled combined lizards, chameleons and snakes are the largest group of reptiles (approximately 4,000 species). Their body is always covered with horny scales(Figure 4.21).

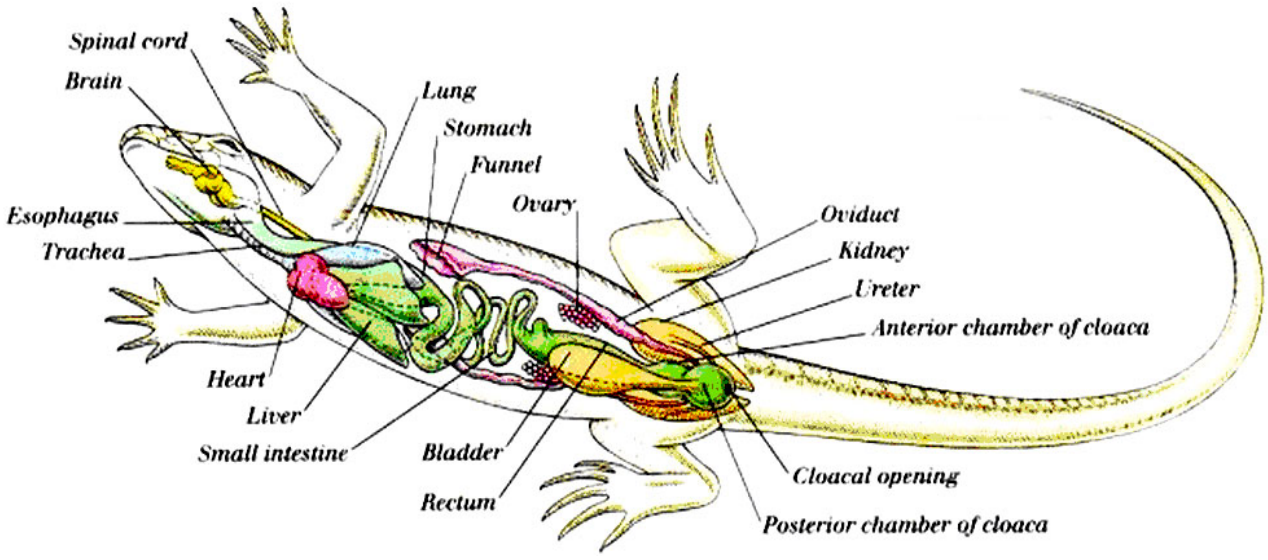


Figure 4.21. Internal anatomy of a female lizard

Lizards are characterized by well-developed five-fingered limbs, movable eyelids and eardrums. The body is long, from a few centimeters up to three meters or more (Komodo dragon). Many species are able to discard at danger tail, which is then reduced by a pronounced ability to regenerate. They live in the steppes, deserts and forests, mostly tropical. Typical representatives are agama lizard, lizards, poisonous lizards.

Chameleons – reptiles which body color can vary greatly depending on the lighting, temperature and other factors. The body reaches a length of up to 60 cm, most species capable fold spiral tail, grasping branches. They feed on insects, which lasts a long tongue. They live mainly in forests of Africa, on the island of Madagascar, in the south of Europe, West Asia and South Asia.

Snakes are elongate body from 8 cm to 10 m (boas), covered with scales smaller than the lizards(Figure4.22). They have reduced their waist and limbs, no chest, the ribs on the ventral side end freely, respiratory system represented by a single light. Among the snakes are non-poisonous (boas, pythons, snakes) and toxic (viper, cottonmouth, rattlesnakes, sea snakes, cobra, etc.). Poisonous snakes teeth are arranged on the upper jaw, one on each side, in their channels or ducts open grooves venom glands (modified salivary glands). The venom of snakes in large doses disrupts the nervous system, heart, alters the permeability of the walls of blood and lymph vessels. For the treatment of bitten apply specific therapeutic serum.

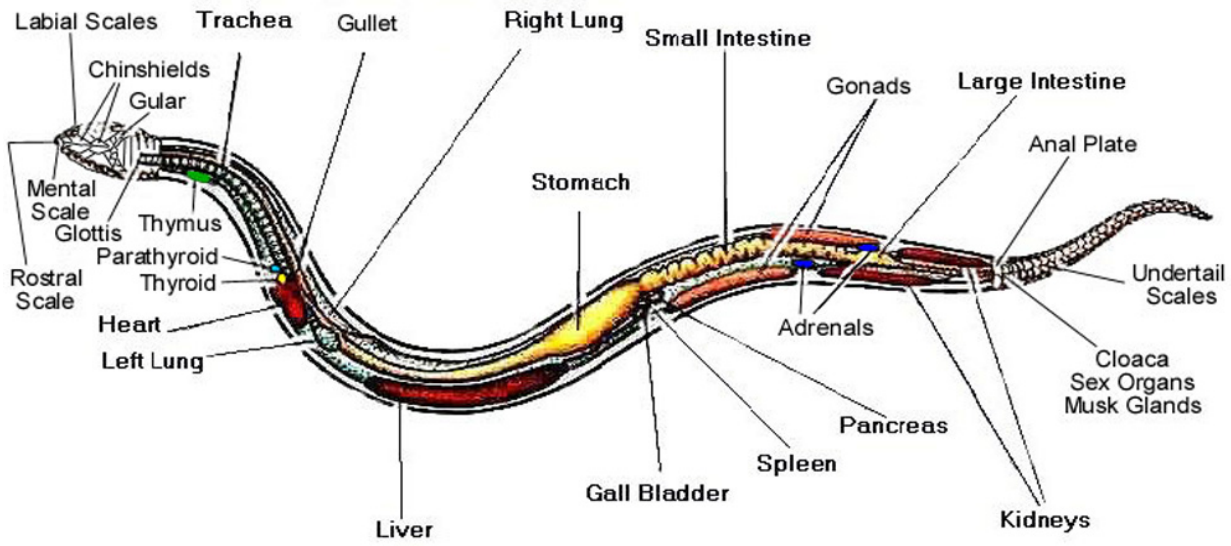


Figure 4.22. Internal anatomy of a snake

Turtles are reptiles the body of which consists of two boards, fused with the vertebrae and ribs. The rib cage is fixed. Breathing at the expense of relaxation and contraction of the shoulder and pelvic muscles. At sea turtle limbs transformed into flippers. Exceptionally hardy, long may go without food. They live mainly in the steppes and deserts, in fresh water and seas. Eggs lay in reproduction on land in the sand.

Crocodiles group are most highly reptiles that have fallen to the water of life (Figure: 4.23). The body length is up to 7 m (Nile crocodile). For crocodiles swimming membranes are characterized by the presence on the hind legs, tail flattened laterally, four-chambered heart. Lungs have a honeycomb structure, the teeth of the conical shape, is highly developed cerebellum. They feed mainly on fish. They live in rivers, lakes and swamps of the tropics. Representatives are Nile crocodile, gharial, alligator, caiman and other national economic importance of reptiles is not big. Small lizards, chameleons destroy insects.

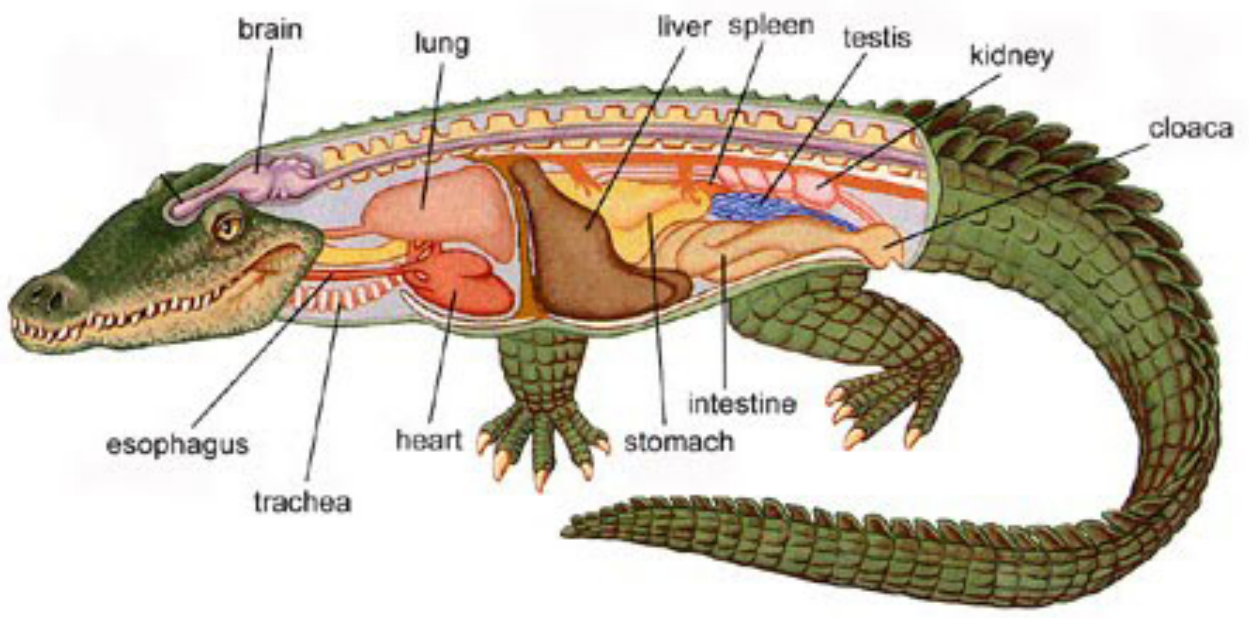


Figure 4.23. The internal structure of a crocodile

Snakes, steppe boas eat small rodents. Lizards, small snakes serve as food for many species of birds. The venom of snakes is widely used in medicine as a drug. In industry crocodile skin is used for manufacturing of shoes, handbags, various handicrafts, for that crocodiles are bred in special farms. Meat and eggs

of some species of turtles eat and horny scutes shell goes to the production of souvenirs. Rare species of reptiles are protected by law.

4.8.4. Class Birds

Birds on a structure similar to the reptiles and represent their progressive branch, which is adapted for flight. This is the highest two-legged vertebrates that have a constant high body temperature, forelimbs that evolved into wings. Spread wings and tail to form a much larger area than the area of the body. Body of bird is compact, streamlined, small head, long neck and mobile. The body ends with a tail. The skin of birds is thin, dry, almost devoid of glands. Only in some species there is a oil gland that produces fat-like secretion that enhances the water-repellent feathers. Due to the formation of the epidermis horny beak cover, claws and scales that cover the toes and tarsus (lower part of the tibia). Derivatives are skin and feathers, which are divided into contour and down. Among the contour feathers are distinguished: 1) steering (tail feathers), involved in the management of the flight and braking during landing; 2) primaries (wing feathers), forming the wing surface and support the bird in the air; 3) opaque, covering the body from the top (Figure 4.24).

Downy feathers are placed under the contour, help maintain a constant body temperature. All the birds are characterized of moult. Worn feathers fall out, and in their place new ones grow. The skeleton of a bird is light, because the bones are filled with air and a solid. The spine is divided into five divisions - cervical, thoracic, lumbar, sacral and caudal. Cervical vertebrae have extreme mobility. The thoracic vertebrae are fused together (the ribs) which are removably connected to the sternum and rib cage form. As a result of the merger of the lumbar, sacral and caudal vertebrae in part with each other and the pelvic bones formed synsacrum, which serves as a support for the hind limbs. On the sternum there is a projection - the keel, which serves for the attachment of muscles, resulting in movement of the wings. The skull distinguish brain box with eye sockets and jaws devoid of teeth. The bones of the skull are fuse together completely until the disappearance of the seams. Front limb - wing - consisting of the humerus, ulna and radius of the forearm and hand. Hand has only three fingers. Wing fully adapted for flight. Hindlimb

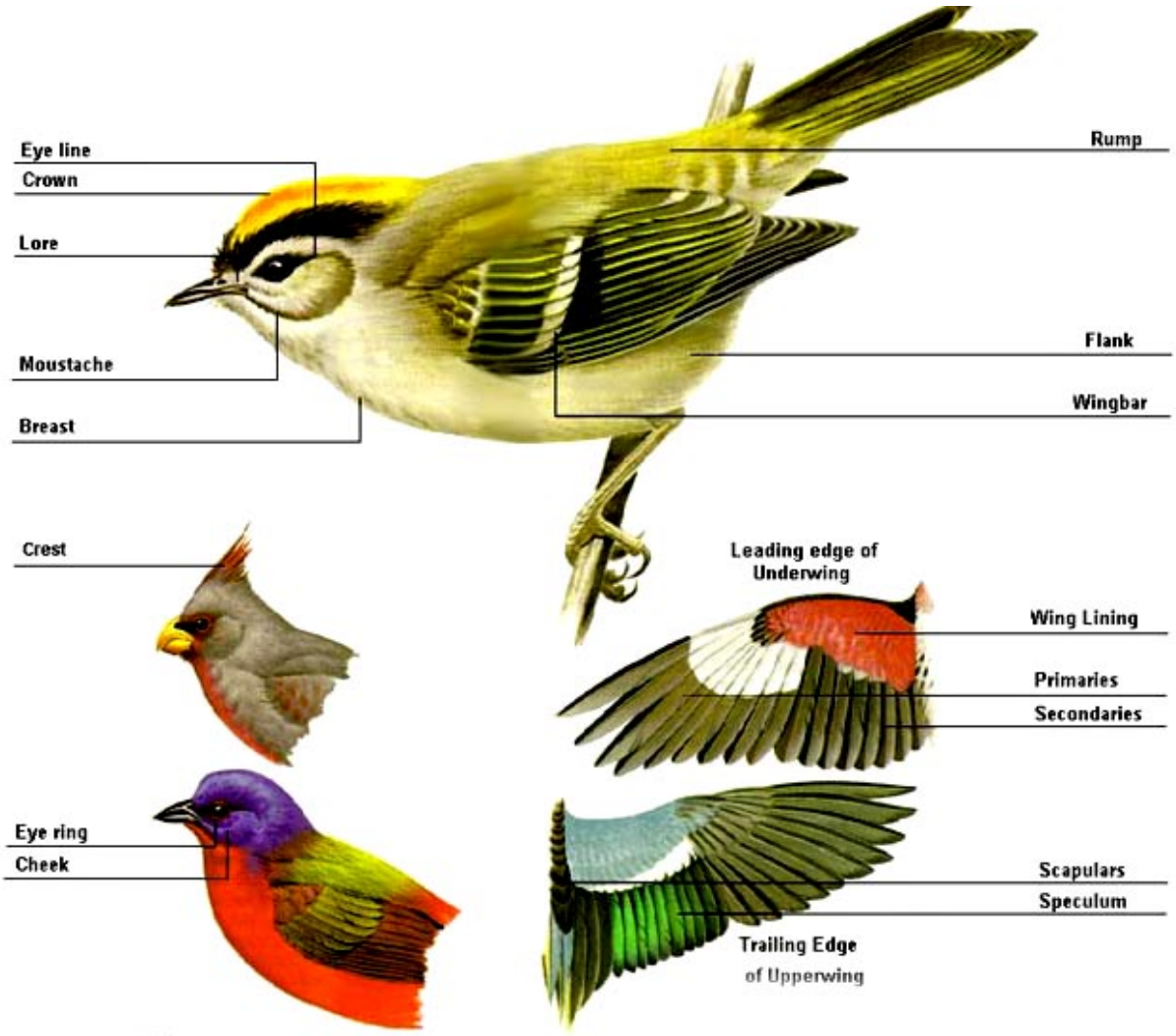


Figure: Parts of bird, by John P.Otnail.

formed thighs, legs fused from the tibia and bobbin, formed by fusion of the bones of the foot in a single bone (Figure 4.25). The lower edge of the bobbin attached four fingers. The muscular system is well developed. It is characterized by a muscle, raising and lowering the wing, range of which depends on the ability to fly. The abdominal muscles are weaker than infants. High development reaches the muscles of the neck and hind limbs, especially in birds that have lost the ability to fly. Digestive system is characterized by the absence of teeth. Authority gripping and holding food is a beak, horny dress which covers the jaw. The food through the mouth and throat enters the long esophagus, which forms a pocket-enlargement - goiter, where it is softened. The rear end of the esophagus opens into the stomach which divided into two parts - the glandular, releasing gastric fluid, and muscle, where the mechanical grinding food. The intestine consists of the duodenum, small intestine and colon

is very short back, ending the cloaca. In the duodenum open ducts of the liver and pancreas. The remains of undigested food do not accumulate in the hindgut, and removed as they become available, easier than birds weight. Excretory organs are the pelvic kidney with the ureter opening into the cloaca. The bladder is not, so that urine does not stay in the body and, together with the faeces ejected fromthe cloaca.

Respiratory system of birds is adapted for flight. The air through the nasal cavity and the pharynx into the trachea enters that in the chest cavity is divided into two bronchi. This place is a voice machine. Included in the bronchi and lungs repeatedly branching in them. Light birds have a complex structure and represent a system through pneumatic tubes that do not have blind endings. Some of them are expanding in the air sacs, which are located between the muscles, internal organs, come in long bones. During the flight portion of the air passes through the lungs twice - with sucking in on the stroke of its wings and pushing when lowering the wings due to compression bags. This phenomenon is called the phenomenon of double breathing in birds. Birds nervous system is like in all vertebrates and consists of the brain and spinal cord. The brain has a large size at the expense of further development of the forebrain hemispheres. Functionally it is the highest department. The average brain is well developed and together with the forebrain provides challenging behaviors. Typically strong development of the cerebellum, which is associated with complex coordination of flight movements. From the brain moves away 12 pairs of cranial nerves. The spinal cord forms a strong thickening in the field of waste spinal nerves that make up the brachial and lumbar plexus due to the strong development of the hind limbs extended sacral region of the spinal cord. The basis of the behavior of the birds makes unconditioned reflexes, to identify the various forms of behavior (mating dance, building nests, incubating and feeding of the chicks, migration, and so on). But birds observed ability to produce and conditioned reflexes. The circulatory system is characterized by a complete separation of arterial and venous blood flows. Heart quad is composed of two atria and two ventricles. The left side of the heart chambers is the arterial blood and in the cells of the right - venous. From ventricular depart only two vessels instead of three as in reptiles: right aortic arch (the main vessel of the systemic circulation) - from the left ventricle and the pulmonary artery (the main vessel of the pulmonary circulation) - from the right. From the senses well-developed sight and hearing. The eyes have a dual of accommodation

(marked change not only the shape of the lens, and the distance between it and the retina). They are equipped with three centuries (top, bottom and nictitating membrane). All birds have color vision. The organ of hearing consists of three parts - the inner and middle ear and external ear openings. The sense of smell in birds is relatively weakly developed, while the taste buds are able to distinguish between sweet, bitter, salty.

Birds are dioecious animals. The male reproductive system is paired (two testicles, two cotyledons) the female unpaired (left ovary and oviduct). Oviduct has one end - the cloaca, the other - into the body cavity.

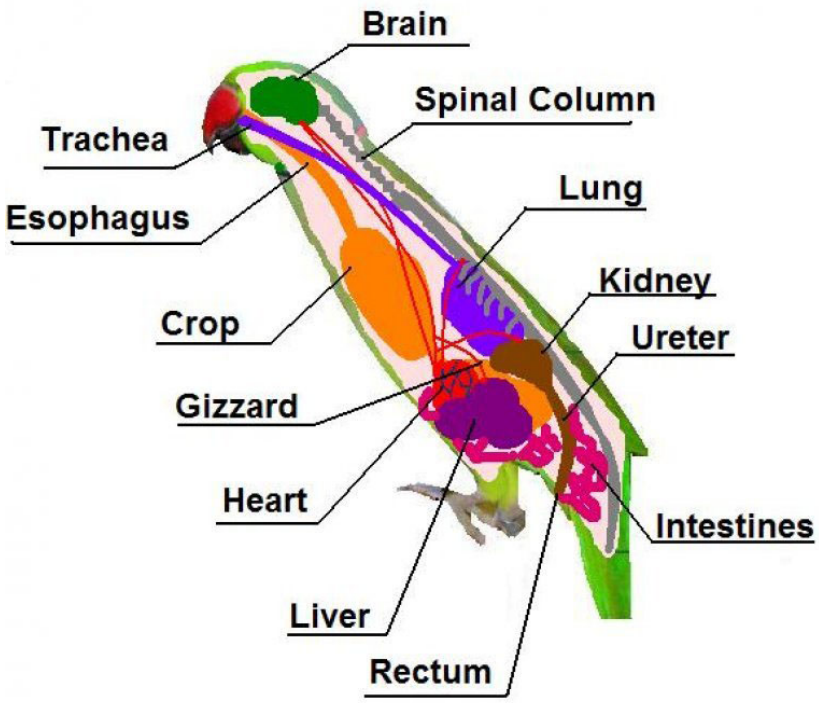


Figure 4.25. The internal structure of a bird

Bird egg is a complex entity. It consists of the eggs, yolk-called informs in the ovary, and systems of egg shells (liquid protein outer shell, shell) produced by the oviduct(Figure 4.26). Fertilization of birds is inside. They have direct type of development. According to the degree of maturity at the time of the chicks hatching and brood is divided into altricial. Precocial chicks (ostriches, geese, galliformes) are covered with down, and sighted after drying, can run around and look for food on their own, while nestling (doves, woodpeckers, sparrows) are born blind, naked, long in need of care parents. Birds evolved

from the ancient reptiles - pseudosuchian, which had the same structure of the hind limbs, as well as birds.

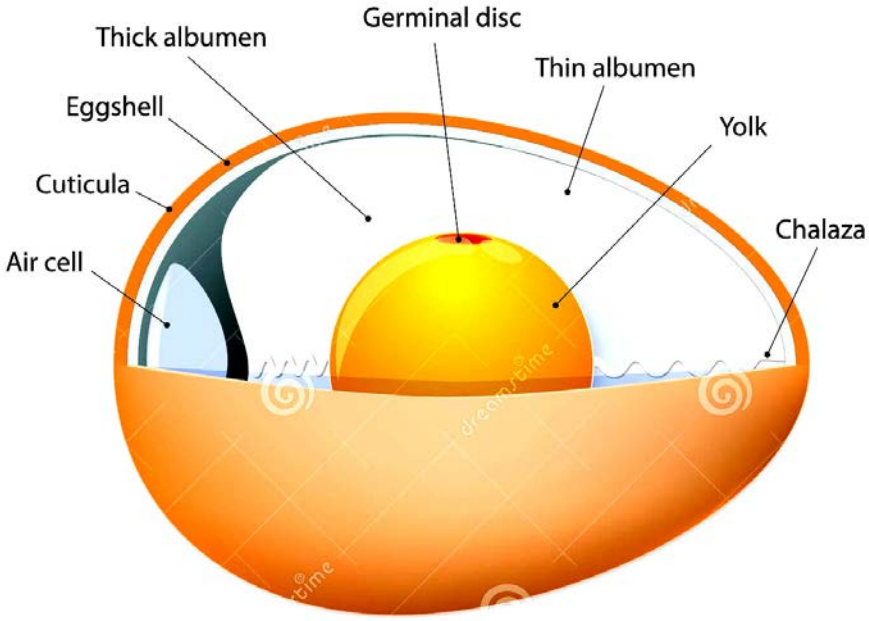


Figure 4.26. Structure of bird egg, by dreamtime.com.

The Class Birds includes about 9000 species are grouped into three superorder: ratites, or running (ostrich, kiwi); penguins (emperor penguins or floating, spectacled, Magellan, Galapagos, crested) and the keel, or flying (chicken, columbiformes, crows, owls, woodpeckers, sparrows).

The value of birds in nature and human life is determined primarily by their high biological activity. Birds consume large amounts of insects and their larvae consume small rodents, at the same time are themselves food for other animals. Birds contribute to the spread of fruits and seeds of many plants. Some bird species are peculiar nurses of our planet, as scavengers. Such birds as geese, chickens, produce meat, eggs, fat. Many bird species act as vectors of pathogens for human diseases (toxoplasmosis, parrot fever). However, birds do more good than harm. Currently, however, due to human activities, their number and the number of species are significantly reduced.

4.8.5. Class Mammals

Mammals are the highest class of vertebrates which bodies have reached the highest differentiation. They are characterized by the progressive development of the central nervous system, the presence of hair, warm-blooded,

nurturing babies in the mother's body and feeding them with milk. The body of mammals consists of a head, neck, trunk, limbs and tail and is covered with leather. The skin shows a multilayer epidermis and proper skin, transforming into the subcutaneous tissue, where fat deposits accumulate. Derivatives are the epidermis skin appendages - hair, nails, claws, hooves. The skin is rich in glands. Recent secrete sweat, which is water with dissolved salts. The sweat glands, releasing sweat involved in thermoregulation. Modification of the sweat glands is lactiferous glands, the number of different species which ranges from 1 to 14 pairs.

The skeleton of mammals divides into five departments. Between vertebrae are flat articulated surface cartilaginous disc between them. The cervical spine is always composed of 7 vertebrae. Thoracic vertebrae (12-15) coupled to the ribs and sternum form together with the chest. The vertebrae of the lumbar (2-9) have only rudimentary ribs. Sacral department typically consists of four fused vertebrae, and the number of caudal vertebrae is different.

Belt forelimb formed blade and collarbone, back - three fused pelvic bones forelimb consists of shoulder, forearm and bones, back brush - from the hip, tibia and foot bones skull is characterized by large braincase lower jaw is formed by a single bone, which is attached to the temporal skull area muscular system achieves an exceptional development and complexity, has hundreds of striated muscle (Figure 4.27). Big development in mammals reach the subcutaneous muscle in primates and humans, they form mimic muscles in mammals only characterized by the diaphragm (diaphragm) which separates the chest cavity from the abdominal. The diaphragm plays an important role in breathing. The digestive system begin from oral cavity, limited jaws bearing teeth are differentiated on the last chisel-shaped incisors, large canines and molars in the mouth and tongue is open ducts of the salivary glands. Tongue is not only agitates food saliva promotes its wettability, but also contains taste buds. Mouth enters the pharynx, followed by the stomach with numerous glands, duodenum, colon and rectum. Liver and pancreas secret entering the duodenum, helps to digest food. The digestive tract of mammals ends independent anus. The excretory system is represented by pelvic kidneys and urethras, flowing into the bladder, which does not open into the cloaca, and in the urethra. Mammalian respiratory system is characterized by complexity of the structure of both the lung with alveolar structure, and respiratory tract. Air from the throat enters the larynx, which is composed of cartilage produced by gill arches. The larynx

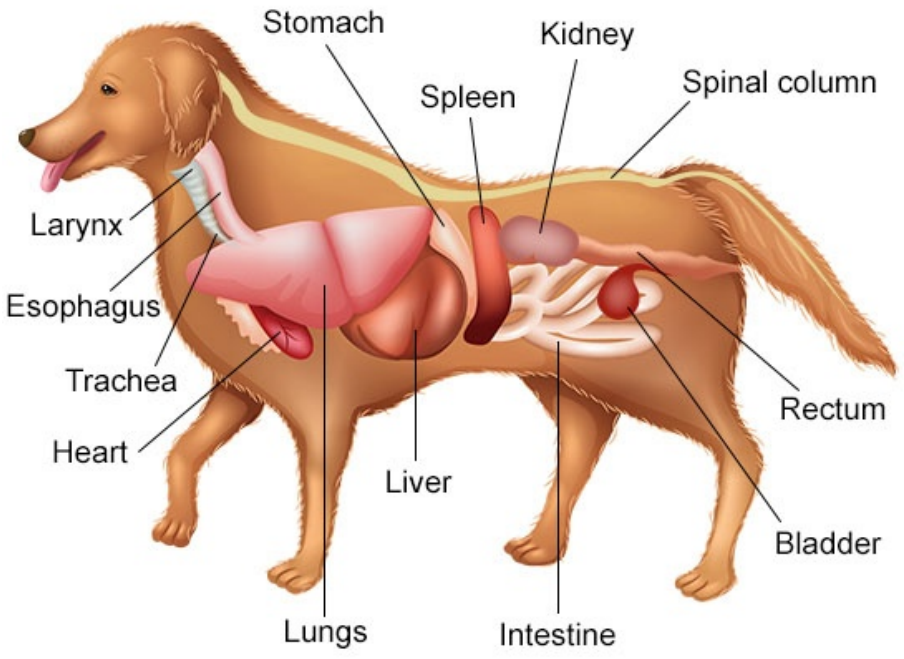


Figure 4.27/ The internal structure of a dog.

moves into the trachea. The last branch in the bronchi, down to the smallest - bronchioles, ending bubbles with cellular walls, called alveoli where gas exchange occurs. Perfection of the respiratory system provides the intensity, which is a prerequisite for high availability and constant body temperature. The inhalation and exhalation are performed by the diaphragm and intercostal muscles. The role of the skin in breathing is low. The nervous system of mammals, as well as other vertebrates, is represented by brain and spinal cord. The brain consists of five departments. Frontal brain is especially strongly developed by increasing the cerebral hemispheres. Mammalian forebrain compared with reptiles is a neoplasm. It is the center of higher nervous activity. Front cortex covered in most species numerous grooves which increase its surface. Middle mammalian brain is relatively small in size. It consists of four lobes - two visual and auditory two. There is also the progressive development of the cerebellum. It consists of two hemispheres and the central part (worm). Cerebellum provides complex forms of coordination. From brain 12 pairs of cranial nerves fade. The circulatory system of mammals consists of two circulations. Large circulation starts from the left ventricle of the heart left aortic arch, which extends in the dorsal aorta. It runs along the spine and is purely arterial blood to organs and tissues. It starts the pulmonary circulation

from the right ventricle of pulmonary artery, which is divided into right and left branches and carries venous blood to the lungs. Pulmonary arterial blood is on the pulmonary veins and enters the left atrium.

The spinal cord is located in the spinal canal. The tail of his department is reduced and the spinal cord usually ends in the lumbar region and never sets below the sacral region. The bodies of mammals are characterized by high development senses of smell, by which animals orient themselves in space, gather food, escape from enemies, and so on. The bodies of less developed than that of the birds, as the accommodation is achieved only when they change the shape of the lens.

The most highly developed vision in primates and large ungulates. Taste organs in the form of epithelial buds are on the tongue and soft palate. The bodies are in touch the skin in the form of long coarse hair which are situated on the chin, lips, eyebrows and cheeks. The complex structure is the organ of hearing, consisting of three divisions: the inner, middle and outer ear, the inner end of which tightened the eardrum. Most of representatives have a cartilaginous pinna for collecting sound waves.

Mammals are dioecious animals with internal fertilization. Gonads are paired. Testes of the most mammals are cutaneous pouch (scrotum) which communicates with the body cavity of the special channel. Ovaries are in the abdominal cavity. Genital tract presented in oviducts, uterus and vagina paired oviducts open into the uterus, where the fertilized egg develops. The presence of the uterus, which comes about fetal development, is one of the characteristics of mammals. In the early stages of embryonic development the embryo is immersed in the uterine lining. Embryonic shell formsaround it afterbirth (placenta) - rich in blood vessels of the spongy body, through which the gas exchange of the embryo, it is powered by the mother's body of nutrients substances, and the removal of waste products. Bud passed difficult way of development. In the early stages he laid the notochord, gill slits, which are then gradually reduced, and the embryo acquires the signs typical for the class. The female brings up baby milk, your body warms, protects against enemies taught to seek food.

Currently, the class includes about 4000 species, and is divided into three sub-classes (cloacal), marsupials and placental sub-classes.

Cloacalare ancient mammals, delaying as reptiles, eggs front end of the skull they have extended in the beak, wearing horn cover. The teeth in adults

are no individuals. The intestines and genitourinary organs open in a cloaca. Body temperature ranges from 24 to 34 ° C. Cubs feed milk. Mammary glands do not have nipples and opened numerous holes in the glandular (milky) field, from which the young lick milk. Representatives - echidna, living in Australia and New Guinea, and the platypus, is living in Australia and Tasmania.

Marsupials or lower animals are the most primitive of the modern live-bearing mammals. Body length varies in different species from 4 to 160 cm, with much well developed tail. Teeth of marsupials poorly differentiated and, in front of indigenous, do not change. Body temperature is not strictly constant, but higher than cloacal. Placenta in marsupials is absent or poorly developed, in connection with which the young are born after a short period of embryonic development of the underdeveloped, very small (the giant kangaroo, for example, the size of a walnut). On the ventral side of the body there is a case where there is a further development of the embryo. Being in a bag hanging on young breast nipples. In this case the edges of the mouth are fused around the nipple. Milk is injected into the calf's mouth by reducing the specific muscles glands. The development of a baby in a bag can take up to 250 days. Currently marsupials survived in Australia and parts of South America. Typical representatives are kangaroos, marsupial wolf, koala, marsupial squirrel, opossum, etc.

Placental or higher animals are the main group of modern mammals, which arose from primitive mammals regardless of cloacal and marsupials. They are characterized by a long period of intrauterine development of the fetus, the presence of placenta, significant brain development, differentiation of teeth.

The role of mammals in nature and human life is determined by their great economic importance as a commercial and domestic animals, and agricultural pests. Mammals are an important source of meat, fat, milk, wool, skins, as well as labor. Currently valuable species of wild animals bred in captivity (farming) for fur. In medicine used antlers of deer, endocrine organs as a raw material for medicines. Many mammals (mice, rats, rabbits, dogs, monkeys, etc.) are used as laboratory animals to study the functions of the body, the mechanisms of action of drugs, diseases simulation. Mammals can be a source of human infection with pathogens of parasitic diseases. For example, rodents of the steppes can spread plague pathogens, tularemia; dogs and jackals - rabies pathogens, leishmaniasis, echinococcosis; cat - of opisthorchosis, toxoplasmosis; cattle - bovine tapeworm; pigs - pork tapeworm, trichinella.

Chapter 5.Human health

The human body is a complex system which is characterized by different levels of organization of matter (molecular-genetic, cellular, tissue or organ). It consists of organs and organ systems, the interaction of which provides individual life. Knowledge of the structure and functions of the body allows to each person consciously abide by the rules of personal and public hygiene, to be healthy and physically fit. Features of the structure of the human body and of life science study such as anatomy, physiology and hygiene.

Human anatomy isthe science of the structure and shape of the human body, its tissues and organs, taking into account age, sex and individual characteristics. Finest structure of organs is a subject of study of the microscopic anatomy - histology (the study of tissues) and cytology (the study of the cell). Comparative anatomy describes the structure of the same organ systems in animals which belongs to different taxonomic groups, on the basis of what are known evolutionary mechanisms of the human body.

The anatomy of age study changes in the structure of the body, resulting in a lifetime, from birth to old age. Pathological anatomy describes the changes in the structure of organs and their systems, resulting from last diseases. Human physiology is the science of life processes (functions) and the mechanisms of their regulation in cells, tissues, organs, organ systems and organism as a whole. Physiology as a science includes cell physiology, physiology of certain groups of organisms, comparative and special.

Cell physiology studies the basic properties inherent in the majority of animals. At the cellular level all organisms have more similarities than differences and this similarity creates the foundation for an evolutionary approach to the study of human physiology. The physiology of the individual groups of organisms is studying functional properties of plants and animals. Physiology of animals is physiology of human and mammals. Comparative physiology examines the function of individual organs and systems in different groups of organisms, identifying the general principles of the functional organization.

Special physiology studies the functions of individual organs and systems of animals and humans - heart, liver, circulatory systems and so on.

Hygiene skills and knowledge are necessary for everyone to preserve physical and mental health, performance and the maximum duration of the active life. As biological science hygiene breaks down into a number of private

applied disciplines: health of the cardiovascular, respiratory, nervous, digestive and other systems; care of vision, hearing; food hygiene, home, school hygiene. Hygienic aspects of the environment are as follows. The environment has a permanent effect on the human body. Between the organism and the environment at each point in dynamic equilibrium is established. Environmental factors do not cause disease if their variations are within the constitution. The disease occurs if any unusual factor is the strength or quality impact as well as in case of unfavorable interaction factors. The great importance for the decision on the environmental challenges is the development of master plans for the placement of industrial enterprises and their complexes Man is not only exposed to environmental factors, but also he is able to influence it. These impacts are, on the one hand, can be harmful, and the other - help to maintain health, improve working conditions, food and life.

Anatomy, physiology and hygiene of the person form the basis of modern medicine. The development of these sciences contribute to the development of effective methods of treatment of disorders of the activities of the vital organs of the human body and the management of communicable diseases. Knowledge of anatomy, physiology and hygiene are also needed to create optimal working conditions in the production and development of physical exercise and sport system.

5.1. Overview of the human body

Structural unit of the human body like any living being is a cell. At the heart of the human body's vital functions are such important cell functions as metabolism, growth, development, movement, irritability, reproduction. The cells are similar in structure, have a common origin and the same function are combined into a fabric. In most tissues between cells is a special intercellular substance of various structures. According to the functions they perform tissue divided into four groups: epithelial, connective, muscle and nerve (Table. 5.1).

Epithelial tissue forms the outer body and lining covers many cavities of internal organs. In these cells in close contact with each other, so very little intercellular substance. This structure hinders the penetration of tissue into the body of microbes harmful substances. Most cells of epithelial tissue are located numerous layers, reliably protecting organs located beneath them. Epithelial cells exposed to harmful influences, in most cases, are killed. In this regard, they are capable of rapid reproduction. A good example is the superficial skin

cells: they gradually die off, exfoliated and replaced by new ones due to breeding a deep layer of cells.

Table 5.1. Types of human tissues

Type	Variety	Mainfunctions	Location
Epithelial	Single-layer	Protective	The mucous membrane of the internal organs
	Multi-layer	Protective	Skin epithelium
	Glandular	Secretory	Exocrine and endocrine glands
Coupling	Bone	Protective, support, hematopoietic	Skeleton
	Cartilage	Defending, reference	Skeleton, larynx, trachea, bronchi, and others.
	Adipose	Reference, protection	The skeleton, skin dermis, tendons, ligaments, fascia, internal organs
	Fibrous	Stock up	Viscera subcutaneous cellular tissue, internal organs
	Blood	Protection,respiratory, transport	Cavities of the heart, blood vessels
	Lymph	Protection, transport	Lymphaticvessels
Muscle	Striated	Initiation, reducing	Musculoskeletal body device and some internal organs (tongue, pharynx, the initial part of the esophagus, heart)
	Smooth	Initiation, Reducing	Muscles of the digestive tract, blood and lymph vessels and other internal organs
Nervous	–	Initiation, conducting	Brain and spinal cord, ganglia, peripheral nerves

Epithelial tissue forms glands which secrete various secrets: the salivary glands – saliva, sweat – sweat, etc.

Connective tissues are formed by loosely arranged cells, between which the intercellular substance of various structures. In the bone it has the form of plates, consisting of an amorphous material formed ossein protein, collagen and protein fibers(Figure5.1). Crystals disposed between the fibers of mineral salts (mainly calcium salts).

They give a special bone strength. Cartilage cells enclosed in a capsule and oval are uniform among dense extracellular matrix comprising collagen fibers. The fibrous connective tissue composed of loosely or closely spaced cells, and extracellular matrix that is formed from the protein elastin fibers. The cells of adipose tissue contains fat reserves. A special type of connective tissue is blood,

intercellular substance which serves as plasma and cellular components - red cells, white cells and platelets. Muscle tissue make up the bulk of the muscle

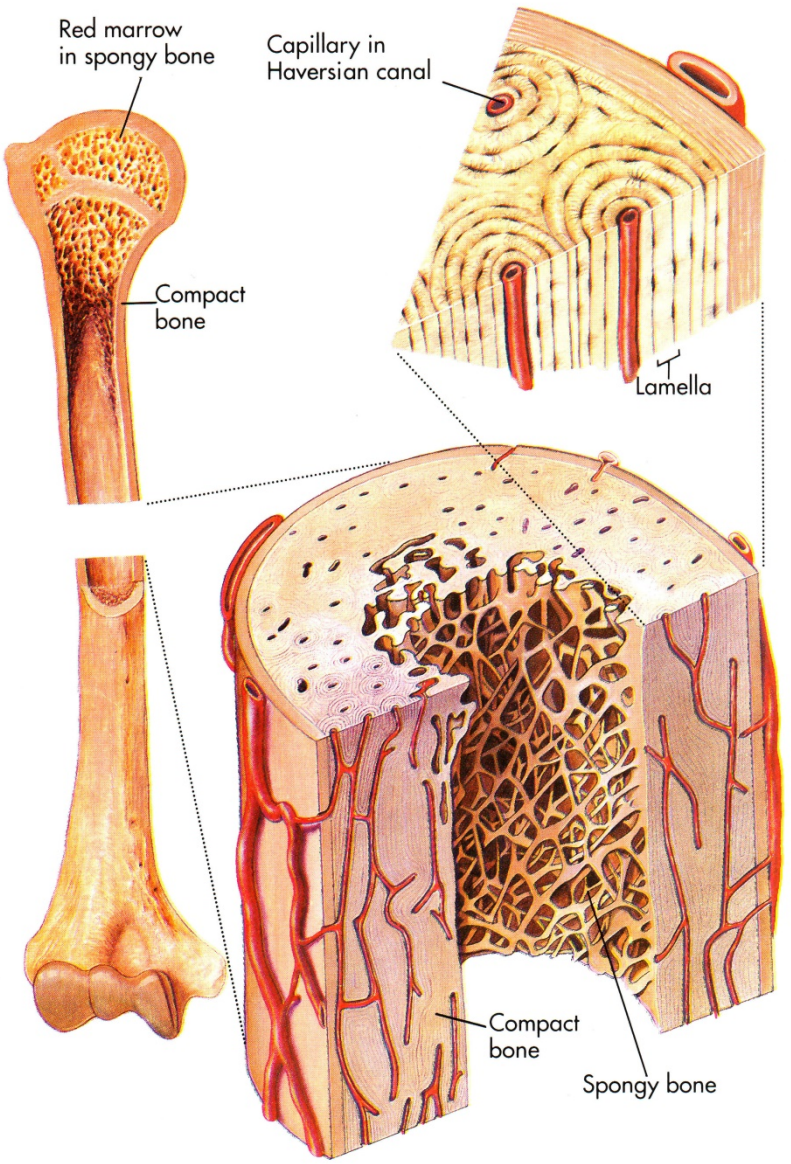


Figure 5.1.Organization of compact bone.

and ensure their contractile function. There are striated and smooth muscles. Striated muscles are skeletal muscles. They consist of a muscle fiber length from a few millimeters up to 10-12 cm. Each fiber cytoplasm contains by numerous myofibrils and oval nuclei. Have a cross-striation, due to alternation in myofibrils sections with different physical, chemical and optical properties. Functionally, they are voluntary muscles, t. E. Reduced by the will of man. Smooth muscles are the muscles of internal organs (blood vessels, bowel, bronchus, bladder, ureters, and so on). They are presented by fusiform cells in the cytoplasm which are rod-shaped nucleus and myofibrils consisting of

filaments of contractile proteins – actin and myosin. Smooth muscles contract freely, but the speed and force of contraction less than that of skeletal muscle. Smooth muscles can be a long time in a state of contraction.

The main properties of muscle tissue are excitability (the ability to perceive the action of stimuli and respond to them) and contractility (ability to do the job, or change the form by contractile proteins).

Nervous tissue is formed by special cells - neurons and intervening connective tissue cells (neuroglia), acting as a nutrient, supporting and protecting functions(Figure. 5.2).

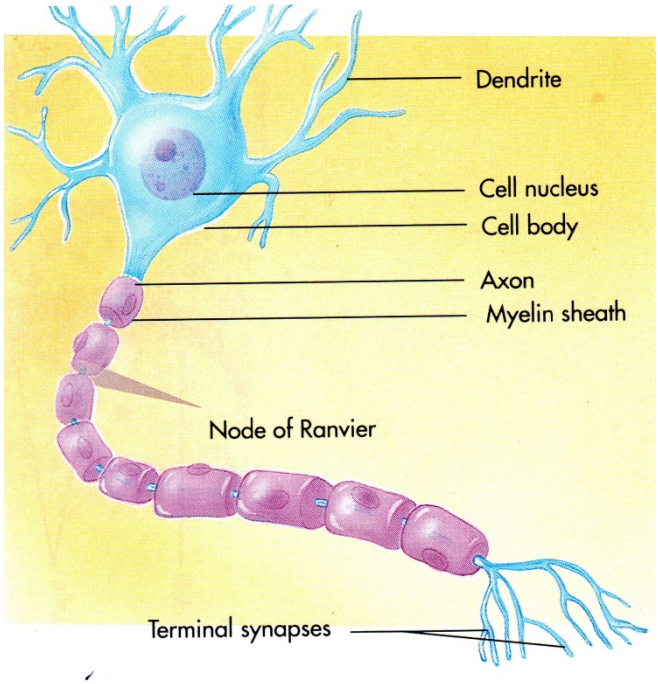


Figure 5.2. Idealized structure of a vertebrate neuron

A neuron consists of a body and the cytoplasmic processes. In the cytoplasm of the cell body is the nucleus with the nucleolus. They are of two types: dendrites (short, tree-like branching, providing the perception of irritation and transfer of excitation in the body of the neuron) and axons (long, low branching, conducting from the body of the neuron excitation). The bodies of the neurons are located primarily in the brain and spinal cord. In the central nervous system forms the gray matter. Neurons are long processes in the central nervous system white matter and form. Axons coated with special shells form nerve fibers. Some of them are using the peripheral endings - receptors - called perceived irritation and sensitive (afferent) tissues; the other with the help of endings convey excitement at working bodies and called motor (centrifugal)

fibers. Synapses are places where the transmission of nerve impulses from one neuron to another, or to the appropriate authority. Unequal fiber beyond the brain and spinal cord by means of connective tissue are collected in bundles - the nerves which gives numerous branches to all organs. Depending on the fibers form the nerves may be sensitive, motor or mixed. The basic properties of the nervous tissue - excitability (the ability to perceive stimuli) and conductivity (ability to conduct excitation).

All tissues are closely interrelated and form organs - separate parts of the body, with a definite structure and function. Each body is composed of several kinds of tissues, one of which is predominant. For example, the liver is mainly formed by epithelial tissue although it contains connective, muscle and nerve tissues.

The digestive system is formed by oral cavity with tongue and teeth, pharynx, esophagus, stomach, intestine and digestive glands (salivary, pancreas, etc..). In addition to the digestive in the human body are musculoskeletal, respiratory, circulatory, nervous, excretory, reproductive and endocrine systems. The integrity of the body is provided with two regulation mechanisms - nervous and humoral. Nervous regulation is carried out of the central and peripheral nervous system. Humoral regulation is provided by blood, tissue fluid and lymph, which contains a variety of biologically active substances - hormones and vitamins.

Nervous and humoral regulation mechanisms are interrelated and complement each other. The nervous system innervates all organ systems, including the endocrine. Nervous control functions are leading. At the same time, hormones affect the nervous system, resulting in the evolution of a single nerve formed humoral regulation mechanism of vital activity. This mechanism ensures the continuity of human adaptation to changing environmental conditions.

5.2. Nervous system

The nervous system is represented by a set of morphological and functional nerve cells (neurons), their processes, and other structures of the nervous tissue. It brings together the work of all organs and systems, ensuring the unity of the body as a whole, provide the human relationship in the process of constant interaction with the environment.

Nervous regulation of organs and systems of the body is more perfect than the humoral (through tissue fluids), as the nervous system through the

interaction of the cells is faster than through the blood and lymph, and nerve impulses on the spikes of neurons are sent only to specific cells. The nervous system is divided into central, peripheral and sensory organs, or peripheral analyzers. The main function of the central nervous system (CNS)is a higher nervous activity.

5.2.1. The central nervous system

CNS is the main part of the human nervous system which consists of spinal cord and brain.The main and specific function is the implementation of complex and highly differentiated reactions - reflexes.

Reflex is the body's response implemented by the nervous system in response to external or internal stimuli. The implementation is done by reflex nerve structures together constituting the reflex arc(Figure 5.3). The structure of the reflex arc consists of nerves that perceive irritation (receptors); sensitive (centripetal) nerve fiber carrying the excitation of the central nervous system; nerve center, which consists of a system of neurons, which receive and pass excitement; neurons transmitting excitation from the nerve center on the motor (centrifugal) neuron; motor neuron transmitting the excitation to the working body. To carry out any necessary reflex integrity of all parts of the reflex arc. Violation of at least one of them leads to the disappearance of reflex.

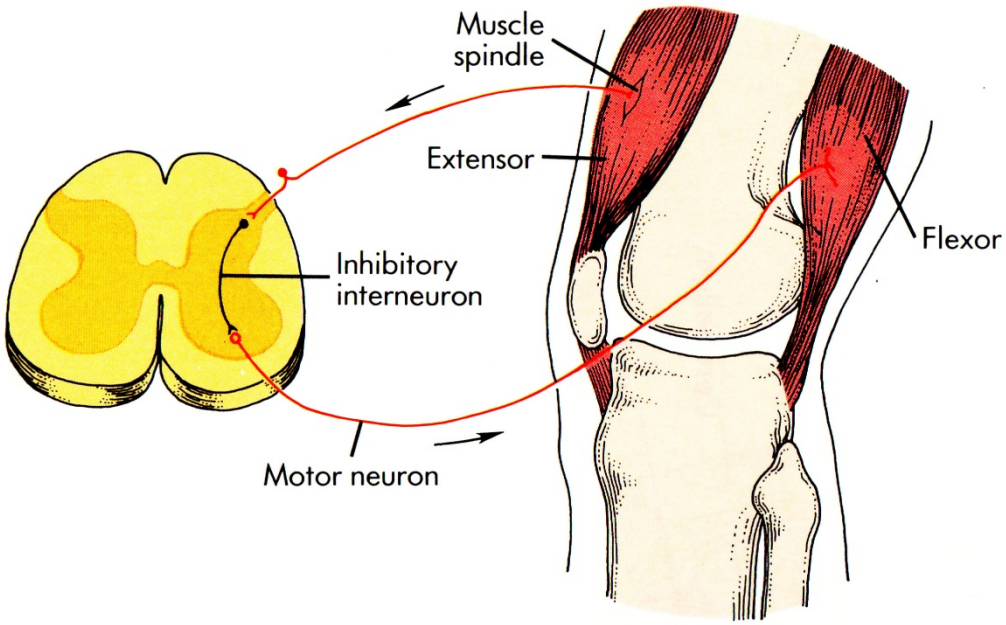


Figure 5.3.Reflex arc

Working bodies are present in the central nervous system and there are both direct and backward linkages that determine the processes of self-

regulation of body functions. In the implementation of reflex act involves not only the processes of excitation, causing or enhancing a response, but also braking processes of turning off those nerve centers which can interfere with the implementation of the reaction of the organism. Sechenov proved in his book "Reflexes of the Brain" (1863) that "all acts of conscious and unconscious life in a manner of origin are reflexes." On the basis of these ideas Pavlov (1849-1936) developed the theory of conditioned and unconditioned reflexes.

The activity of the central nervous system of a person reaches the highest perfection and complexity as compared with other mammals. The spinal cord is a phylogenetically ancient part of the central nervous system which located in the spinal canal. It has the form of a solid cylindrical shape with a neural tube cavity inside (the spinal canal). At the top of the spinal cord goes into the medulla oblongata, and the bottom ends at the level of the first lumbar vertebra. A cross section shows that the spinal cord is made up of gray and white matter. Gray matter located inside and has the form of a butterfly. From gray matter depart two rears and two front horn. The anterior horns are motor neurons which depart from the motor nerves. The posterior horns through the posterior roots enter the axons of sensory neurons. White matter lies outside of the gray matter. It forms six pillars: two front, two side and two rear. They are situatedin pathways by which excitation is transferred from all parts of the body to the brain (bottom path) from the brain and the periphery (downlink path). The spinal cord is divided into segments (cervical, thoracic, lumbar, sacral) whose number is equal to the number of vertebrae. Each segment comprises two pairs of nerves, called the roots of front and rear, 31 which form a pair of mixed spinal nerves. Each pair supplies the specific area of the skin and some muscle group. Between the II and II cervical thoracic and between X and XII thoracic vertebrae the spinal cord has two bulges - cervical and lumbar, which depart from the nerves to the upper and lower extremities. The main functions of the spinal cord are wiring and reflector. At the rear pillars of the white matter passes excitation transfer from the receptors of the skin, muscles, tendons and joints. On the side pillars passes excitement of the spinal cord to the cerebellum. The front pillars are ways that transmit impulses from the cerebral cortex to the motor neurons. The spinal cord reflex centers lie flexor, extensor, and other tendon reflexes, and vasomotor center, sweating centers, breathing, urination, defecation and sexual function.

The brain is an extended front portion of the spinal cord, is extremely complex in structure (Figure5.4). Even in the early stages of embryonic

development of the front of the spinal cord are formed five brain vesicles, which are then formed five centers of the brain: an elongated, rear, middle, intermediate and front.

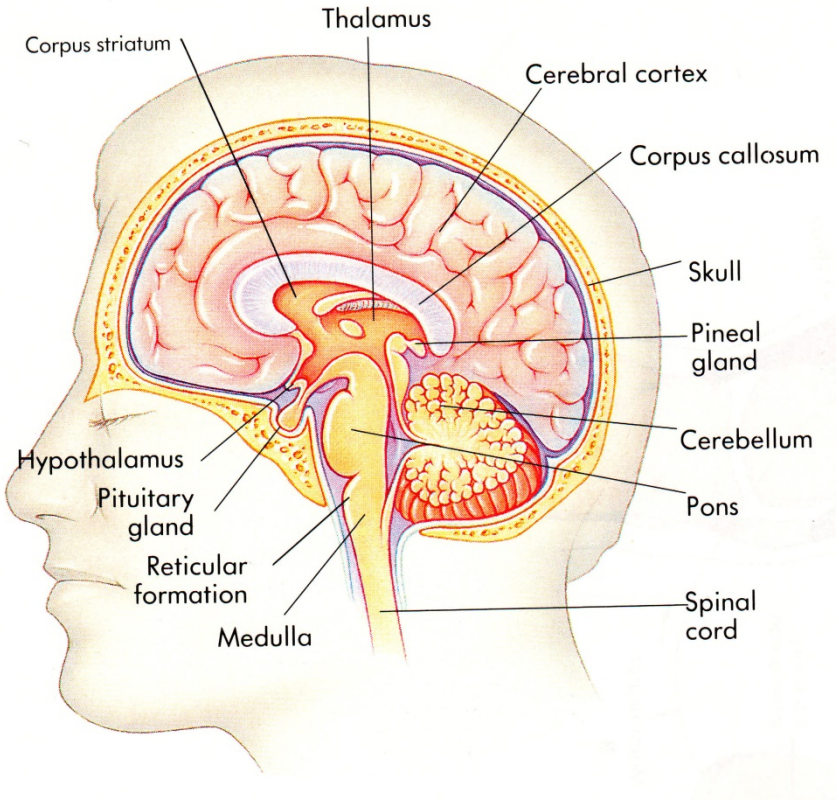


Figure 5.4.Section through the human brain

Each part has a different brain structure and functional significance (Table 5.2). Medulla oblongata is the lowest part of the brain located above the spinal cord. It consists of gray matter in the form of clusters of nerve cells, and white matter represented by bundles of nerve fibers. The walls of the medulla thick and made up of nerve fibers going to the higher centers of the brain. They limit the cavity, called the fourth cerebral ventricle. In the medulla oblongata are the nerve centers that regulate breathing, blood circulation and metabolism. The hindbrain comprises located between oblong and midbrain cerebellum and pons. The cerebellum has two hemispheres and the middle part - the worm. Outside covered hemisphere gray matter and white matter is inside. The cerebellum is anatomically and functionally closely related to the spinal cord and the medulla oblongata and the overlying brain. It is involved in the coordination of movement, regulation of muscle tone, in maintaining posture and balance of the body. Pons located beneath the cerebellum. It is formed by nerve cells and thick bundles of fibers connecting the medulla and midbrain.

Pons provides two-way communication between the headand spinal cord, is involved in the regulation of complex motor acts, muscle tone and balance of the body. The midbrain is located between the pons and the intermediate brain and consists of quadrigemina brain and legs. The thicker midbrain body passes the channel connecting the cavity III and IV cerebral ventricles. It centers located orienting reflexes, muscle tone, body posture, wakefulness and sleep, and go to up situated pathways of the brain and spinal cord and oblongata.

Table 5.2. Functions of various human brain regions

Regions of brain	Mainfunctions
Medullaoblongata	Excitation of the spinal cord in the higher-lying parts of the brain. Regulation of the activities of the respiratory, cardiovascular and digestive systems. Present the centers of salivation, chewing, swallowing, sneezing, coughing, vomiting
Hindbrain	Coordination, regulation of muscle contraction, muscle tone, body balance
Midbrain	Regulation orienting reflexes to visual and auditory stimuli, regulation of muscle tone and posture
Diencephalon	Perception of signals from the outside and internal environment, regulation of the internal organs. Visual hillocks are centres of switching impulses coming to them from the spinal cord, and from them are transferred to different areas of the cerebral hemispheres. In the hypothalamus are the higher centers of the autonomic nervous system is involved in the regulation of sleep and wakefulness. Over tubercle area is related to the sense of smell, behind tubercle - the regulation of vision and hearing forebrain (big brain)
Telencephalon (big hemispheres of brain)	Perception and analysis of internal and external environment signals. Participation in the formation of reflexes Ensuring higher mental functions
Frontallobe	Arbitrary regulation of muscle movement, coordination of mechanical speech, participation in critical thinking
Parietallobe	Regulation of bodily sensitivity, spatial orientation of the body; communication with the memory, related to speech and learning
Temporallobe	Perception and analysis of auditory stimulation, control of speech; participate in the evaluation of space and memory function
Occipitallobe	Perception and analysis of visual stimulation

Diencephalon includes visual hillocks under tubercle region (hypothalamus), and of foreign over tubercle area. It is located above the midbrain just below the cerebral cortex, and operating under its control. He is a collector of all kinds of sensitivity, because there are centers engaged in the regulation of the functions of internal organs, endocrine glands, body temperature, sleep, memory, instinctive behavior, mental reactions. The forebrain is represented by the cerebral hemispheres (right and left) of the brain, which are separated by deep longitudinal groove. The cerebral hemispheres are

composed of gray and white matter. Gray matter is outside, forming the cerebral cortex and basal ganglia. On the surface of each hemisphere are the following proportion: the frontal, parietal, temporal and occipital, which differ in cellular composition and structure. Bark provides interaction of the organism with the environment, regulates and coordinates its functions. Some of its share exercise control various body functions. White matter formed spikes of neurons of the brain which form conductive paths. In the cerebral hemispheres of the forebrain are the first and second lateral ventricles, cavities which, together with the other parts of the brain form a single interconnected cavities of the central nervous system where formed and circulates the cerebrospinal fluid.

Thus, the brain is the main regulator of all the vital functions of the human body and the material substratum of his higher nervous activity.

5.2.2. The peripheral nervous system

The peripheral nervous system is a part of the nervous system that includes the nerves ganglia (clusters of nerve cells outside the brain and spinal cord) and nerve endings (receptors). It consists of a cranial (extending from brain) and spinal nerves, and also arranged in the course of their nodes. From a physiological point of view, the peripheral nervous system is subdivided into the somatic (bodily) and autonomic. The somatic nervous system is represented by sensory and motor nerve fibres of spinal nerves. It supplies the skin, skeletal muscles, joints, tendons. The autonomic nervous system is comprised of clusters of nerve cells, on average, the medulla and spinal cord, and nerve nodes and nerve fibers lying outside the central nervous system at workers innervated organs. Transmission of nerve impulses in the synapses by means of neurotransmitters is any physiologically active substances (adrenaline, acetylcholine andothers). The autonomic nervous system regulates the activity of the circulatory system, respiration, digestion, excretion, reproduction and metabolism and growth of the organism (Table 5.3). On the basis of the anatomical and functional characteristics, it is divided into the sympathetic and parasympathetic part. The sympathetic nervous system is anatomically connected with the spinal cord, where the bodies of the first neurons are located. Their end processes in the nerve nodes has two chains on either side of the spine, where the second neurons, which innervate the working bodies of the processes of the body are. Sympathetic innervation causes an increase in metabolism, increased contraction of the heart muscle, vasoconstriction, pupil dilation, the body mobilizes the forces on active. The parasympathetic nervous

system is formed by clusters of nerve cells in the midbrain and medulla, the sacral region of the spinal cord, the nerves extending from them and nerve nodes located around or innervated organ or in its wall. It innervates the lacrimal and salivary glands, heart, bronchi, gastrointestinal tract, bladder, sexual organs, helps restore the energy expended of reserves, regulates the body's vital functions during sleep. Sympathetic and parasympathetic part of the vegetative nervous system innervates the same organs, but causes the opposite effect.

Table 5.3. The effect of the autonomic nervous system on the work of the organs of the body

Organ	Effect of sympathetic part	Effect of parasympathetic part
Heart	Makes therhythm quickens and increases the force of contraction	Makes the rhythm slows and reduces the force of contraction
Arteries	Narrow, bloodpressureincreases	Extends, reducespressure
Digestivetract	Motility and decreased secretion of the digestive system	Strengthens motility and secretion of liver and digestive organs
Bile	Relaxes the bile ducts and gall bladder, tightens the sphincter that contributes to the accumulation of bile	Reduces the bile ducts and relaxes the sphincter, which helps the exit of bile from the gall bladder
Thebladder	Relaxes the bladder and reduces sphincter	Reduces bladder and relaxes the sphincter
Muscle fibers of the iris	Extendseyepupil	Narrowspupildilates
Bronchi	Facilitatesbreathing,narrowsbronchi	Enhances the secretion of bronchial glands
Increases ofoxygen	Increase	Decreases
Amount of sugar in the blood	Increase	Decreases

Sense is a specialized education, consisting of sensory of nerve cells (receptors) and auxiliary nerve fibers, to perceive and analyze a variety of primary irritation of the external and internal environment and pass information about them in the central nervous system. Stimulation of receptors on nerve enters the cerebral cortex, where there is a corresponding zone and discrimination stimuli occur visual, audio, and other sensations. The collection of nerve structures, perceiving and analyzing irritation, Pavlov (1909) called the analyzer. The analyzer distinguishes peripheral, introducer and central parts. The peripheral part of the analyzer is perceiving irritation receptor, conductor is the sensory nerves that convey the excitement of the receptor in the central

nervous system, the central part is defined area of the cerebral cortex, where the driving test. All parts of the analyzer function as a single unit. Any damage of them leads to the loss analyzer function. It senses analyzers are sight, hearing, balance, touch, taste and smell. They provide a person the information that allows it to navigate in a constantly changing environment. The body of the eye is represented by having a spherical shape. It located in the orbit of the skull (Figure. 5.5). From the walls of the orbit to the outer surface of the eyeball approaches muscles through which it moves. Above and below the eyeball is protected for centuries, on the edge of which there are eyelashes. The eyelids and eyelashes protect the eyes from dust, eyebrows drawn off to the side that ran down his forehead. Lachrymal gland located at the outer corner of the eye, secretes a fluid that moistens the surface of the eyeball, eye warm, flushes debris. The walls of the eyeball formed by three membranes: the outer - tunica, secondary - inner-vascular and retina.

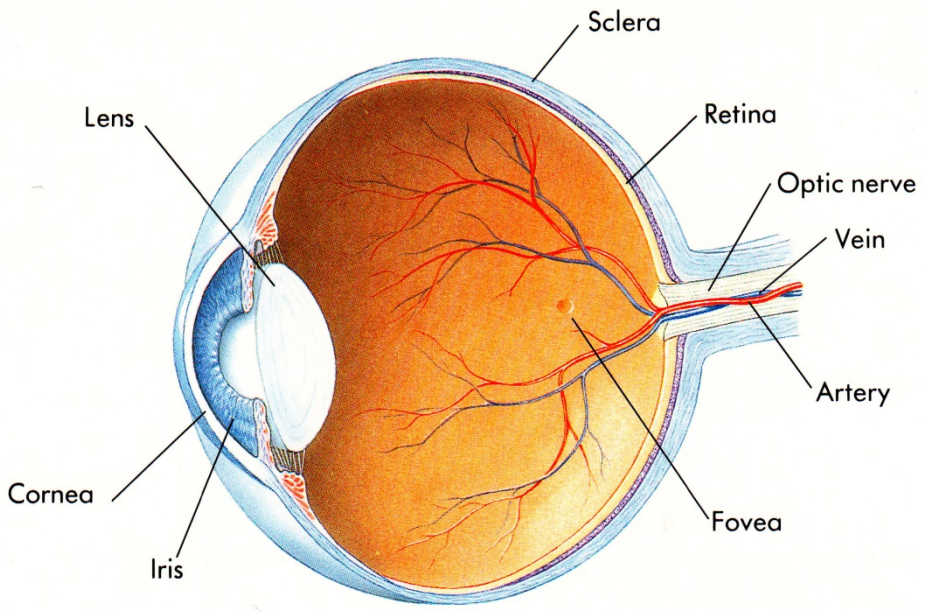


Figure 5.5. Human eye structure

Sclera is dense, opaque, gives shape to the eyeball. In front of the eye, it goes into the transparent convex cornea. The choroid is riddled with a dense network of capillaries, its inner surface is covered with cells containing the pigment. In front of the eye in the choroid becomes the iris having a different color depending on the amount of pigment contained therein. In the center of the iris has a small hole(the pupil) which reflexively expanding or narrowing passes into the eye the light rays. The retina contains light sensitive receptors - rods and cones, which are the peripheral visual analyzer department. Rods are responsible for -apprehension light, night vision, cones - for color perception,

daytime vision. Place the largest cluster of cones is called the macula, or place the best vision. Nerve fibers that make up the optic nerve (conduction of the analyzer) a departure from the light-sensitive receptors. Place it leaves the eye is called the blind spot, as there are no receptors. As the optic nerve excitation is transmitted to the visual centers, located in the occipital lobe of the cerebral cortex (the central part of the analyzer), where there is a distinction irritationallows you to receive a clear image on the retina of objects at different distances from the eye. The ability of the eye to the vision of the different distance of objects is called accommodation. If any of the accommodation can develop nearsightedness or farsightedness. With strong refraction of light rays are focused in front of the retina due to the increased curvature of the lens or the elongation of the eyeball, causing nearsightedness. Hyperopia is caused by weak refraction of light rays and focus them behind the retina. It arises from the shortening of the eyeball or the flattening of the lens. Violations of both with myopia and hyperopia with corrected optical lens selection. To maintain normal vision developed a set of hygiene rules. The eye should be protected from mechanical damage, read in a well-lit room, holding the book at a certain distance (up to 33-35 cm from the eye). The light should fall on the left. For the prevention of myopia is not recommended to bring readable text close to his eyes, as the lens may not be long in the convex position. During working in a bright environment is necessary to use glass lighting as bright light destroys lightperceptioncells. You can not read in a moving vehicle, as this is rapidly changing the focal length, which leads to a change in curvature of the lens, reducing its elasticity. With a lack of vitamin A disturbed night vision and developing so-called "night blindness". Factors that disturb the vision, are also nicotine, alcohol, drugs and other toxic substances. They cause tearing, redness of the eyelids, loss of eyelashes, in severe poisoning (methanol) observed damage to the optic nerve and loss of vision.

The organ of hearing is represented by the outer, middle and inner ear (Figure. 5.6).

The outer ear is made up of cartilage formation, the coated skin (pinna) and the external auditory canal, leading from the sink to the middle ear. The auricle helps a person to pick up the sound waves and direct them into the ear canal. This is facilitated by the muscles that move the pinna. The external auditory meatus is of the form 30 mm long tube lined with skin. At the junction of the ear canal and the middle ear is stretched thin connective tissue membrane,

called the eardrum. The latter is resilient, vibrating under the influence of sound waves, without distorting these fluctuations.

The middle ear is a small camera, which received name of tympanum. Middle ear cavity separated from the outer ear by the eardrum. The cavity contains three serially connected bones: the malleus, incus and stapes, which are so named because of their shape. The auditory ossicles transmit sound vibrations through the cavity of the middle ear. Hammer comes into contact with the eardrum, the anvil - with a hammer and with a stirrup. Stapes is con-

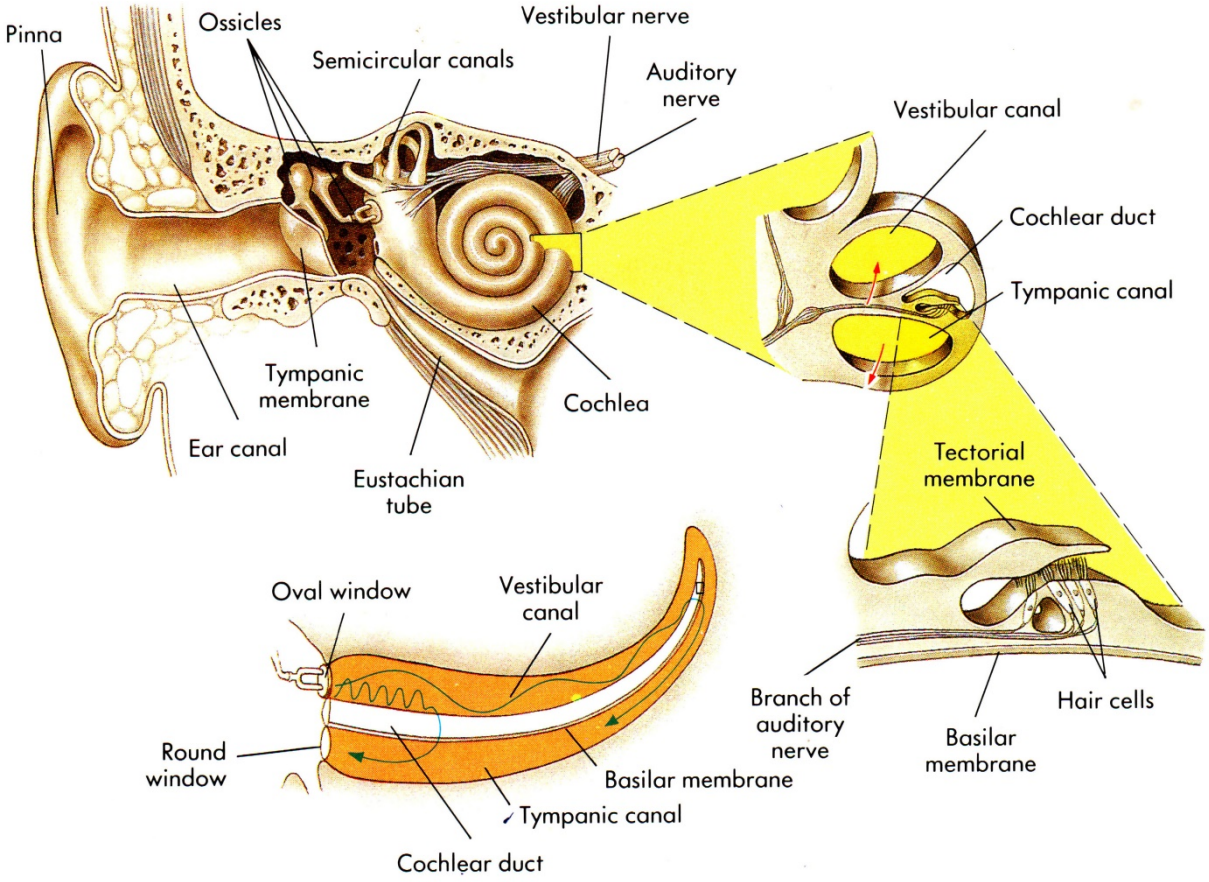


Figure 5.6. Human ear structure

nected to the membrane covering the hole, called the oval window, and leading to the inner ear. The middle ear hearing aid is connected to the nasopharynx (eustachian) tube, which serves to equalize the pressure on either side of the eardrum. According to the Eustachian tube to the middle ear can penetrate bacteria and cause inflammation, leading to fusion of the auditory ossicles and deafness. The inner ear is represented by bone and membranous labyrinth, located deep in the temporal bone. It distinguish between the auditory and balance of the body. The auditory portion (snail) consisting of helically twisted bone tube cavity which is divided into three channels bony prominences, the

membranous septum and basilar membrane. The channels are filled with fluid. The main diaphragm is formed by fibrous connective tissue. It is the receptor apparatus of the auditory analyzer (organ of Corti), which contains a special auditory nerve receptors (hair cells).

Sound stimuli, caught by the ear, the eardrum cause vibrations that are transmitted through the ossicles to the cochlea. Sound waves set in motion the fluid in the cochlea channels and perceived by receptor apparatus acoustic analyzer. Excitation with receptors on the auditory nerve is transmitted to the auditory center. Thus, the peripheral part of the auditory analyzer is ear wires - the auditory nerve and central - auditory zone, located on the outer surface of the temporal lobe of the cerebral cortex. With the help of the organ of hearing person perceives and distinguishes all the variety of sounds. Due to hearing people communicate with each other, studying speech. The organ of balance is located in the inner ear consists of a vestibule and three semicircular canals filled with fluid and placed in three mutually perpendicular planes. On the eve of the bag there are two - round and oval with special lime stones - otoliths, which are moved and their pressure irritate receptors (hair cells) when changing body position. Fluid in the cavities of the three semicircular canals, changing the position of the body and irritates the hair cells, which are transmitted to the excitement of the nerve to the relevant parts of the brain. The peripheral part of the balance of the analyzer are hair cells, conductors - and central vestibular nerve - the temporal lobe of the cerebral cortex. balance body monitors the position of the body in space, its movement and speed. Since it is also associated with the medulla and cerebellum, during stimulation analyzer reflex muscle tone changes. Normal functioning of the hearing and balance can be achieved keeping it clean ear canal, protected them from the impact of sharp and prolonged sounds, except for the effects of nicotine, alcohol, drugs and other toxic substances. Long exposure to harmful factors leads to hearing loss, disruption of control of balance. Bodies of touch combine several kinds of sensitivity, as in the skin are different receptors (peripheral part of the analyzer) that perceive temperature irritation, touch and pressure, pain stimuli. Stimulation of receptors on sensory nerves (conduction of the analyzer) is transmitted to the central part of the analyzer, which is in the parietal lobe of the cortex. Body muscular sense is represented by receptors located in muscles, tendons, ligaments and articular surfaces (peripheral part of the analyzer), sensitive nerves (conductor part), transmitting excitation in the anterior central gyrus of the frontal lobe of the cerebral cortex (the central part of the analyzer).

The body controls muscle sense of body position and its parts in space (even with closed eyes). The body is formed of taste receptors located on the tongue papillae, the mucous membrane of the mouth, palate, pharynx (the peripheral part of the analyzer). Receptors are able to perceive the taste of sour, bitter, sweet, salty. Excitation with receptors transmitted through sensory nerves (conductor part) in a flavored zone located in the temporal lobe of the cortex (the central part of the analyzer). In human there are hereditary differences in the sense of taste. The olfactory organ is formed by receptors located in the epithelium of the upper part of the nasal cavity (peripheral part of the analyzer). On spikes olfactory cells that make up the olfactory nerve (conductor part), excitation is transmitted to the olfactory region of the temporal lobe of the cortex (the central part of the analyzer). Irritants olfactory cells are the odorous substances in the air. During the reception, the olfactory sensations complement the taste of food. All the wealth of sensations, which perceives a person in contact with the environment, provides a function of not one but many senses simultaneously.

5.2.3. Higher nervous activity

Higher nervous activity is activity of the higher parts of the central nervous system which provides the most perfect adaptation of animals and human to the environment. The structural basis of higher nervous activity in human is the cerebral cortex with the subcortical structures of the front and intermediate marrow term "higher nervous activity" was introduced into science by Pavlov, who creatively developed and expanded the theoretical position of the reflex principle of brain activity and created the doctrine of the physiology of animals and human higher nervous activity higher nervous activity ensures individual behavioral human and mammalian adaptation to changing environmental conditions, is reflexive in nature, carried out by unconditional and conditional reflexes. Unconditional reflex- is inborn, stereotyped reaction of the organism is genetically fixed and implemented with the help of the nervous system. They were formed during the evolution of species. Examples of unconditioned reflexes are blinking, sucking in infants saliva in contact with food in his mouth, his hands flick with a finger prick.When unconditioned reflex excitation of the receptor is transferred by the reflex arc in the central nervous system (spinal cord, brainstem, etc.) and back to the working body. The set of unconditioned reflexes, providing sophisticated forms of animal behavior, is called instinct. For example, birds flights, caring for offspring, the bees building

honeycombs, beaver dams, and others. Only one of unconditioned reflexes the body is not enough to adapt to changing environmental conditions. This requires the development of conditioned reflexes. Conditioned reflexes is the individual acquired, formed on the basis of the formation of a temporary system adaptive reaction of the body connection between the conditioned stimulus and the unconditioned reflex act. The term "conditioned reflexes" was first proposed by Pavlov in 1903 in the study of brain function. The conditioned reflex is formed on the basis of unconditional. For the formation of a conditioned reflex, you must have two stimuli - unconditional and indifference (light or sound), and the first to act indifferent stimulus, then an absolute. Between indifferent and unconditioned stimuli requires a certain amount of time. The strength of both irritants should be optimal, the conditioned stimulus should be less absolute in their activity. For the elaboration of a conditioned reflex is necessary many times combination of effects of both stimuli. Pavlov called the conditioned reflex time communication, since it occurs only under conditions which are formed. The biological role it is to expand the range of adaptive capabilities of the organism to a variety of conditions. Conditioned reflexes are the basis of training, the development of speech and thinking of the child, the skills of labor, social and human creativity.

The formation of conditioned reflexes is possible with the help of the special properties of the brain a memory. Memory is the process of saving generated in the course of training of temporary connections. There are two types of memory - short and long term. Short-time memory stores information from fractions of seconds to tens of minutes, and then destroyed. Long-term memory allows you to store information for a long time during a person's life. In a natural setting in human produces a lot of conditioned reflexes. If the environmental conditions change, or that the conditioned stimulus is not reinforced by the unconditional, the conditioned reflex fades

Braking is an active nervous process aimed at reducing or suppressing the excitation process. Pavlov identified three types of braking: external (absolute), internal (suspended) and protective. External inhibition of the conditioned reflex inhibition manifests itself as a result of new strong enough outside stimulus. For example, a person with severe dental pain "ceases" to hurt bruised hand. External inhibition develops not only in the cerebral cortex, but also in lower parts of the nervous system. Therefore it is also called and absolute inhibition.

Internal inhibition is a form of inhibition of conditioned reflex activity that occurs when the conditioned stimulus no reinforcement unconditional. It develops in the cortex gradually, whereby internal inhibition also called conventional. Internal inhibition is acquired property, it is produced in the process of individual development, by controlling the behavior of the environmental conditions, respectively. Extinction of a conditioned reflex is a type of internal inhibition which occurs in the case of no reinforcement conditioned stimulus unconditioned. The opening of internal inhibition allowed to share all the positive conditioned signals that cause a physiological response, and negative which cause a conditional internal inhibition. Thanks to the internal braking carried subtle adaptation of the organism to the environment, at the same time inhibited biologically inappropriate response. Protective inhibition prevents the nerve centers from the effects of excessively strong stimuli and fatigue.

Considered reflex activity patterns are common to the higher animals and human, as they reflexively respond to specific signals from the environment (sound, light, temperature, etc.). For animals, it is the only signaling system, but for a man - only the first. The higher nervous activity of the person is fundamentally different from the higher nervous activity of animals due to work and articulate speech. The word for man acquired the value of the signal and was specifically human second signaling system. It was the same conditioned stimulus, as well as all other components of the first signal system.

Consciousness is the highest inherent in a human form of reflection of objective activity. It is the unity of mental processes, actively involved in understanding the man of the objective world and his life. Consciousness arises in the course of labor, social and productive activities of people and associated with speech. Thinking is an active process of reflection of the objective world in concepts and judgments, the highest product of matter organized in a particular way - the brain. The physiological mechanisms of thought explore the physiology of higher nervous activity. Being in close connection with the brain, thinking can not be fully explained by the activity of the body only. It is associated not only with the biological evolution of man, but also with its social development. In various religious teachings conscious human activity due to the presence of the soul, this is treated as a disembodied immortal immaterial force, existing independently of the body in the «other world."

The scientific explanation of human consciousness on the basis of modern science data was done by Pavlov, as well as the largest Soviet physiologists

Orbeli (1882-1958), Anokhin (1898-1974) and others in the works on the higher nervous human activities that have shown the failure of idealistic notions. Physical health and mental labor activity of the organism depends on the condition of the central nervous system which leads to fatigue breakdown of vital body functions - perception, memory, and performance. To avoid fatigue, useful during breaks to carry out industrial gymnastics, which are included in the performance of different groups of muscles. This leads to the stimulation of new areas of the cerebral cortex, inhibition previously worked areas, their rest and recovery performance. Mental labor also causes fatigue of the central nervous system. The most complete rest of the central nervous system gives a dream. Sleep is periodically occurring physiological state of the body, characterized by significant immobility, almost no reaction to external stimuli, and at the same time a special organization of activity of brain neurons. Sleep based on the rise and development of the braking, which by its nature can be unconditional and conditional. During sleep, in the higher parts of the brain is processing the received information for the period of wakefulness, changing function of the body, there is a drop of skeletal muscle tone, slow breathing and heart rate, lowering blood pressure. Dream creates optimal conditions for the activity of the brain and prevents overvoltage. The duration of sleep for a newborn is about 22 hours, for students - 9-12 and for adults - 7-8 hours. Smoking has a detrimental effect on the nervous system because the nicotine being absorbed in small doses, a stimulant effect on the nervous system, and more - causes her paralysis. Long-term intake of small doses of nicotine by smoking causes chronic poisoning.

Alcohol is highly toxic to all cells, the cells are sensitive to it nervous tissue, especially the cerebral cortex. Accumulating them, it causes severe violations of their functions. This is accompanied by memory loss, impaired motor coordination, speech, thinking and sleep. Man gets cheeky, rude, loses self-control. Chronic alcohol consumption leads to degradation of the individual. Drug use has the most devastating effect on the nervous system, in connection with which addicts quickly manifest violation of nervous and mental activity. In some cases, use of the drug leads to the premature death of a person.

5.3. The endocrine glands

Internal secretion glands are specialized bodies of vertebrate animals and human which have no excretory ducts and emit produced substances (hormones) directly into the blood or lymph. They are characterized by an

abundant blood supply, providing a rapid supply of hormones in the blood and delivering them to the organs and tissues.

Hormones are biologically active substances secreted by the endocrine glands. They have a purposeful action on other organs and tissues. The process of allocation of hormones in the tissue fluids is called internal secretion. The chemical structures of hormones are divided into three groups: amino acid derivatives (thyroxine, triiodothyronine, adrenaline, noradrenaline); polypeptides and proteins (insulin, growth hormone, vasopressin, melanotropin et al.) and fat-like substances, or steroids (corticosteroids, androgens, estrogens).

All hormones are physiologically active even in minimal quantities, have a selective effect on certain organs and tissues. For example, for adrenocorticotropic hormone anterior pituitary target tissue is an adrenal cortical substance. Hormones are very unstable and quickly disintegrate. They provide the regulation of the body's vital processes.

Coordination of physiological and biochemical processes in the body through hormones through the liquid medium (blood, lymph) called humoral regulation. Since all of the endocrine glands are innervated by nerves and their activity is controlled by the central nervous system humoral regulation is subject to the nervous regulationwith the help of which it is a single system of neurohumoral regulation. The latter ensures the normal functioning of the body in a changing environment.

The structure of the endocrine glands is considered the pituitary, thyroid and parathyroid glands, adrenal glands. For mixed glands secretion includes pancreas, testes, ovaries, thymus and the placenta, which combine with the hormone not endocrine functions (Table. 5.4).

The pituitary gland, or the lower brain appendage, is located on the base of the skull. There are three shares: front, middle and rear (Figure. 5.7). Anterior lobe produces several hormones the most important of which are growth hormone, thyroid-stimulating hormone and adrenocorticotropic. Hormone of growth stimulates the growth of the organism. If childhood amount of this hormone is insufficient, there is sharp growth retardation, and the man for life remains a dwarf. Excess of GH in children, on the contrary, leads to gigantism, and mature an increase in bone size face, hands, feet, language (disease, acromegaly).

Table 5.4. The physiological effects of hormones

Glands	Hormones	Physiological action
Pituitary gland: anterior lobe	Hormone of growth	Regulates bone growth and the overall growth of the body; acts on the protein, fat and carbohydrate exchanges
	Tireotropin	Stimulates growth of the thyroid gland and the formation of thyroxine
	Adrenocorticotropic hormone	Stimulates growth of the adrenal cortex and the formation of itshormones
Pituitary gland: average share	Melanotropin	Regulates the production of melanin pigment in the skin cells
Pituitary gland: posterior lobe	Vasopressin	Is synthesized by the hypothalamus, released neurohypophysis; supports water reabsorption in the renal tubules, also causes vasoconstriction and increase in blood pressure
	Oxytocin	Is synthesized by the hypothalamus, released neurohypophysis; stimulates the contraction of smooth muscles of the uterus, to a lesser extent intestinal, gall bladder
Thyroidgland	Thyroxine, triiodothyronine	It has diverse effects on the body, its growth, differentiation and tissue metabolism.
Adrenal glands	Adrenalin Aldosterone, corticosterone Hydrocortisone	Increases the effects of the sympathetic nerves; stimulates the breakdown of glycogen liver and muscle. Regulates sodium and potassium exchange Stimulates the conversion of protein to carbohydrates
Pancreasinsulin (endocrinepart)	Insulin	Increases glucose use by cells; reduces the concentration of sugar in the blood
	Glucagon	Increases glycogen stimulates the conversion of liver glycogen to glucose

Thyroid-stimulating hormone stimulates the thyroid gland and adrenocorticotropic affects the adrenal cortex, increasing the synthesis of corticosteroids. Average pituitary allocates only one hormone - melanotropin which stimulates the synthesis of the pigment melanin in the skin cells, intensity of its formation is regulated by hormones of the hypothalamus, as well as light-posterior lobe of the pituitary stores two hormones - vasopressin and oxytocin.

Vasopressin supports the reabsorption of water in the renal tubules at a certain level and it is one of the factors that determine the permanence of water-solutable metabolism in the body. Oxytocin causes contraction of smooth muscles of the uterus, intestines, gall bladder and the thyroid gland is located in front of the thyroid cartilage, in front of the larynx produces iodine-containing hormones thyroxine and triiodothyronine, involved in the regulation of processes of growth, development, tissue differentiation, basal metabolism, increase in the concentration of thyroxine in the body is accompanied by an

increase in breast size, bug-eyed, increased heart rate, irritability, sudden losing weight in spite of the abundant food intake (disease Graves' disease). The lack of thyroxin in children leads to stunted growth, puberty, mental development (cretinism disease). In adults, the lack of thyroxin leads to a decrease in basal metabolism, edema, decrease in body temperature, slowing of speech, of thought, general apathy (myxedema disease).

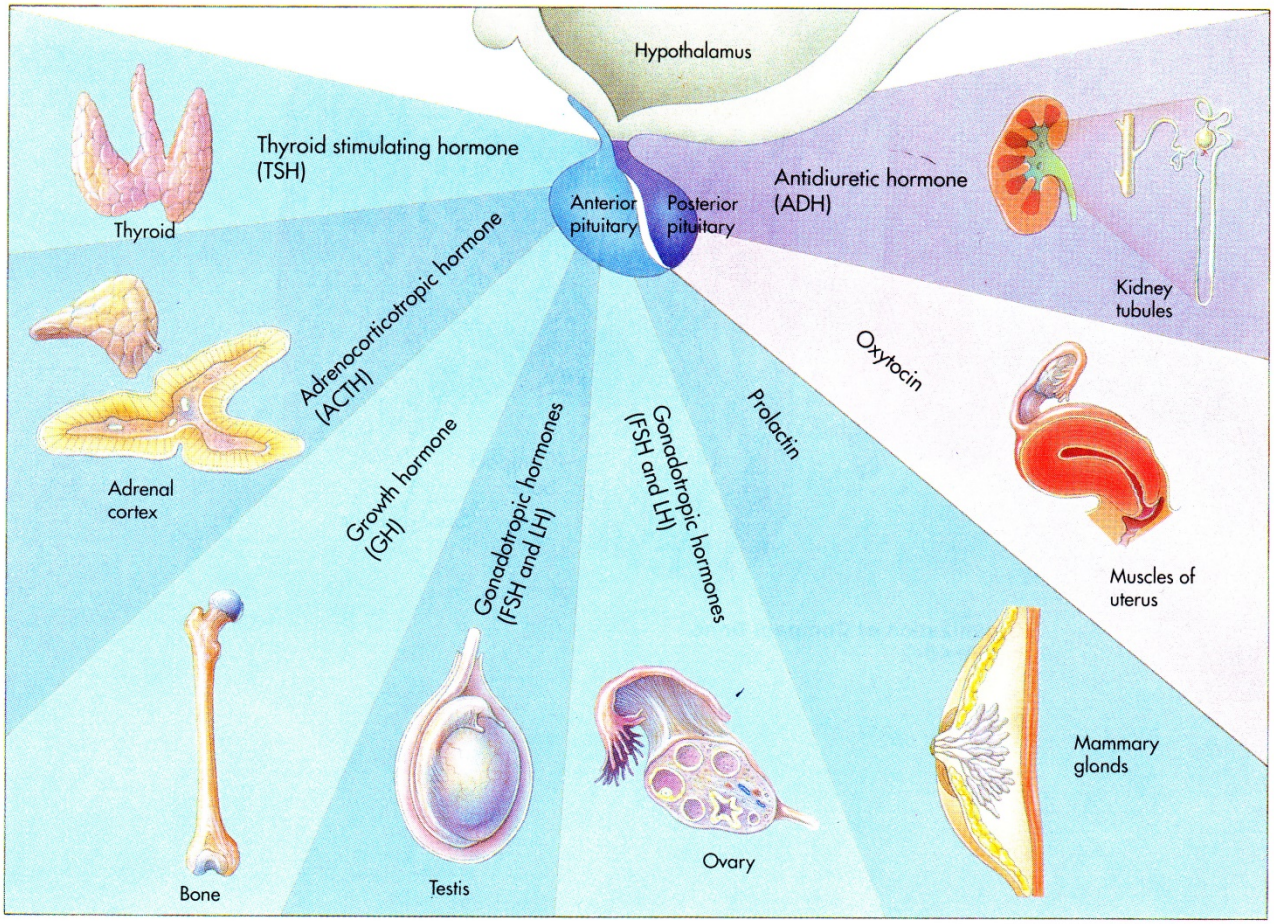


Figure 5.7. Role of the pituitary

Adrenal gland is paired glands adjacent to the kidneys.Upper ends consist of medulla and cortex. The medulla secretes hormones epinephrine and norepinephrine, that affect the heart, small arteries, blood pressure, basal metabolism, muscles of the bronchi and the gastrointestinal tract. Adrenal cortex identifies three groups of hormones: mineralocorticoids (aldosterone, corticosterone), regulating mineral metabolism; glucocorticoids (hydrocortisone, cortisone), regulatory protein, fat and carbohydrate metabolism; sex hormones (androgens, estrogens), regulating the activity of reproductive organs. Violation of the secretion of corticosteroids leads to a

change of the heart, emaciation, fatigue, change in skin color ("bronze disease").

The pancreas is one of mixed glands. Endocrine function is performed by its specific cell clusters (islets of Langerhans), producing the hormones insulin and glucagon which enter the bloodstream and influence carbohydrate metabolism. Increasing the amount of insulin increases glucose uptake tissue cells, deposition of glycogen in liver and muscle, reduce blood glucose concentration. It is needed for glycogen breakdown to glucose. The defeat of the endocrine part of the pancreas causes an increase in the amount of blood sugar, it begins to stand out in the urine (diabetes). Chronic administration of exogenous insulin treated diabetes, thus maintained close to normal blood sugar levels for many years. The role of hormonal regulation of the body's hormones cause physiological reactions).

They can stimulate or inhibit the function of an organ, to influence processes of metabolism, growth and differentiation of tissues and organs, mental, physical and sexual development. Hormones provide human adaptation to changing conditions of internal and external environment. The lack or excess of at least one hormone causes serious disorders in the body. For example, increasing the number of blood parathyroid hormone causes a decrease in bone strength.

The pituitary gland is considered as the central endocrine gland, since controls the activity of other endocrine glands by secretion of hormones triple. For example, increased formation of thyroid-stimulating hormone stimulates the secretion of the pituitary-minute Roxin thyroid. Similarly, adrenocorticotropic hormone regulates the production of hormones by the adrenal cortexand so on. In some cases, some hormones can have on a cell or organ of the aggregate or the opposite effect. For example, the breakdown of glycogen is stimulated by glucagon, but has a similar effect and adrenaline. Insulin makes lower level ofsugar in blood and adrenaline increases. It should be noted that the final result of a biological reaction or biological process does not depend on one, but many hormonal influences. Endocrine regulation of body waste is a complex and strictly balanced.

5.4. The musculoskeletal system

Musculoskeletal system unites skeleton and striated (skeletal) muscles and is one of the most important systems of the human body. It performs supporting and protective functions and plays a crucial role in the movement.

The skeleton is composed of bones and their connecting formations. In human, there are over 200 bones that make up 18% of body mass for men and 16% - in women. Tissues which form the boneisa variety of connective tissue. She is represented by mineralized bone cells and intercellular substance. Bone cells are of three types: osteocytes, osteoblasts and osteoclasts. Osteocytes walled intercellular substance contact each other and provide islets metabolism in tissues. Osteoblasts are bone formation zones. Osteoclasts are involved in bone resorption. The combined effect of all types of cells allows bone remodeling during the growth and change of functional load. Intercellular substance is collagen fibers and ground substance. The mineral component of bone apatite crystals formed, sulfate, and calcium carbonate.

The bones are long with a cavity inside (pipe), flat (wide) and short. In the long bones distinguish the middle part - diaphysis and two end - epiphysis. Diaphysis formed a compact substance, and epiphysis - spongy. Inside the diaphysis cavity in the bone marrow is yellow, and in the cells of the spongy material in the flat bones - red bone marrow. Outside, on the part of the medullary cavity of the bone is covered by periosteum. It is a thin connective tissue sheath, rich in nerves and blood vessels that penetrate into the bone through a special hole. Through the periosteum implemented nutrition and innervation of the bone. By the periosteum attached tendon ligaments, muscles. The human skeleton distinguish three divisions - the skeleton of the trunk, limbs, skeleton and the skeleton of the head.

The skeleton of the trunk or axial skeleton is divided on the spine and rib cage. The spine is formed by 33-34 vertebrae, arranged one above the other, between the bodies which are layers of cartilage, giving it flexibility and resilience. The spine consists of 7 cervical, 12 thoracic, 5 lumbar, 5 sacral and 4 coccygeal vertebrae. Sacral vertebrae fused to form the sacrum. Each vertebra comprises a body and an arc, which extends from the multiple shoots. Between the vertebral bodies and arcs are vertebrates holes constituting spinal canal where the spinal cord is located. The spine forms four bend. In the cervical and lumbar spine to face bulge forward, and in the thoracic and sacral - ago. Bends are important physiological significance because they increase the size of the thoracic and pelvic cavities, easier to maintain balance the body, soften the shocks while walking, jumping, running.

The rib cage is formed by the sternum, 12 pairs of ribs and 12 thoracic vertebrae. Seven pairs of the upper edges of the front are connected to the sternum, the eighth - tenth pairs - with each other cartilages and two lower pairs

of ribs are available, fixing soft tissue. The shape and size of the chest depending on sex, degree of muscle development as well as on the occupation and lifestyle of the person. The chest is the seat of the lungs, trachea, esophagus, heart, blood vessels. It participates in rhythmic respiratory movements due to rising and lowering by cutting edges, muscles involved in breathing. The skeleton of the limbs (upper and lower) can be divided into free limb skeleton (arms, legs) and belt skeleton (shoulder, pelvic) which strengthens the limb to the trunk. The skeleton of the shoulder girdle consists of two paired bones -scapula and collarbone. Skeleton of hands form a homeruns, forearm bones (radius and ulna) and hand bones (small wrist, the long pastern, and phalanges). The skeleton of the pelvic girdle consists of two massive pelvic bones back firmly coalesced with the sacrum, and the front almost rigidly interconnected in loomjoint. They have a round cavity which includes the head of the femur. Lower extremity skeleton form a femur, tibia (large and small tibia) and foot bones (tarsal short, long metatarsus and phalanges). The skeleton of the head or skull consists of cerebral and facial departments. Brain Unit (the skull) protects the brain from damage. It is formed by fixedly connected to each other flat bones: front - unpaired frontal top - paired parietal, on the sides - temporal and back - unpaired occipital bone with a hole through which connect the brain and spinal cord. The structure of the facial region of the skull includes lower and upper jaw, cheek, nose and other bones, which, besides the lower jaw is fixedly connected to each other. In the skeleton there are three types of bone connections: fixed, mobile and semi mobile. The human skeleton has basically the reference value to form the structural framework of the body and determining its size and shape. Some parts of the skeleton (skull, chest, pelvis) are the receptacle and the protection of vital organs -the brain, lungs, heart, etc. The skeleton is also a passive body movement, since it attached to the muscles. Furthermore, skeletal bone calcium depots are compounds of phosphorus and other elements and are involved in mineral metabolism. Inside many bones contain red bone marrow, where blood cells are formed.

Skeletal muscles, their structure and function of muscles, or muscles are organs of the human body and animals which consists of striated muscle tissue that can shrink under the influence of nerve impulses. Each muscle connective enclosed in a shell having a smooth surface. By reducing it moves relative to the adjacent muscle with minimal friction. The fibers at the ends of the skeletal muscles are moving in the tendon. The tendon ends are attached the muscles most likely to various bones, only the facial muscles are attached at one end to

the skin. Usually when driving reduced not one but a whole group of muscles. The muscles that perform similar functions are called synergists, and the opposite - antagonists. Almost every muscle has its antagonist (flexors - extensors, rotators - raising, compressing - decompress, etc.). The shape distinguishescan be long, short, wide and round muscles. The total number of the human body reaches 600. The share accounted muscle 28-32% of body weight at 35-45% of women and men. According to performed functions in the body are isolated muscles of the head, neck, chest, abdomen, back, limbs zones. To include the muscles of the head occipital-frontal, temporal, facial expression, chewing, and others, to the muscles of the neck - sterno-hyoid, sternoclavicular-mastoid and others which provide movement of the head. The muscles of the chest (external and internal intercostal), the diaphragm participate in the act of breathing, movement of hands (pectorals major). Abdominal muscles involved in the formation of the walls of the abdominal cavity. With their reduction also comes forward lean of the trunk and sides. The muscles of the back to form several layers and are involved in the movement of the spine, maintaining the vertical position of the body. The muscles of the upper extremity are divided into the shoulder girdle muscles (deltoid muscle, etc.)and the free limb. Biceps flexes the shoulder and upper arm in the shoulder and elbow joints and triceps unbend them in the same joints. On the front surface of the forearm flexors are the hand and fingers on the back - extensors. The muscles of the lower limbs form the pelvic girdle and the free limb muscles. By the pelvic muscles include the iliopsoas and three gluteal providing flexion and extension of the hip joint, as well as the preservation of the body in an upright position to the muscles, resulting in movement of the thigh and shin are the quadriceps and biceps. Foot and toes sets in motion a series of muscles of which the largest is calf. It is also involved in maintaining the body in an upright position. Working muscle is associated with muscle ability to contract and is determined by the product of the weight lifted load on the lift height. When relaxing the muscle work produces. To work the muscles need energy, the source of which is ATP formed during glycolysis. Work muscles depend on the intensity of their blood supply. Blood flow to the muscles supplied glucose and entrained products of its incomplete digestion. Continuous operation of muscles leads to muscle fatigue. Fatigue caused by the accumulation of lactic acid in them, carbon dioxide and other waste products. Fatigue - this is a normal physiological response of muscle tissue, it disappears after rest. For the first time exhaustion mechanisms have been studied by Sechenov in 1903. It found

that the rate of fatigue affect the rhythm of work and the amount of load. At an average pace of work and marked the highest load efficiency and slow the development of fatigue. Sechenov showed that restoration of working capacity of tired right hand is faster if the rest period to work with his left hand. This phenomenon he called active rest. Uninteresting work causes fatigue faster than interesting. Muscles are an active part of the locomotors system. By supporting muscle function provides protection of internal organs, which is carried out muscles surrounding a body cavity. Voltage, maintain muscle, even at rest, call them tone. With enhanced muscle support and the role of the skeleton are made motor acts. Changing the degree of muscle tension reflex occurs under the influence of impulses of the nervous system. Therefore, the muscles are and the executive body, since they are the receptors of the motor vehicle. When any change in the state of muscle receptors and signal chafe about these changes in the central parts of the nervous system.

The value of physical exercise for the formation of the skeleton and muscles is big. Regular exercise contributes to the formation of a human right body, the harmonious development of muscles. The degree of muscle development, their capacity and the amount depends on the variety of the exercises and training frequency. The work, regular workouts help strengthen blood circulation and muscles, increase muscle and nerve fibers, to increase bone mass and skeletal muscle. Sedentary lifestyle (hypo kinesis), on the contrary, is not conducive to the development of the musculoskeletal system. When a person becomes inactive hyperkinesia, muscle contractility decreases. The weakness of the muscles of the back, extremities causes a change in posture; there is a slouch, disturbed coordination of movements. People who are not engaged in physical activity, have more frequent cardiovascular, pulmonary and other diseases. It is now widely used and promoted physical education for education and proper development of the younger generation. Harmful influences on the formation of the musculoskeletal system have nicotine, alcohol, drugs. Disrupt the nervous, cardiovascular and respiratory systems, they impair blood flow to the muscles, reducing them to the intensity of metabolic processes, resulting in change muscle strength, increase consumer and industrial injuries.

5.5. Circulation system

Circulation of blood through the vessels movement, ensuring the exchange of substances between the organism and the environment is called circulation. It

is carried out by means of special organs, combined into a single functional system (Figure 5.8).

Circulatory system includes the heart and blood vessels (arteries, capillaries, veins) penetrating all the organs of the human body. The heart is the main organ of the circulatory system (Figure 5.9). It is a muscular organ which consists of four chambers: two atria (right and left), separated by atrial septum, and two ventricles (right and left), separated by the interventricular septum. The right atrium communicates with the right ventricle through the tricuspid, and the left atrium to the left ventricle - through the butterfly valve.

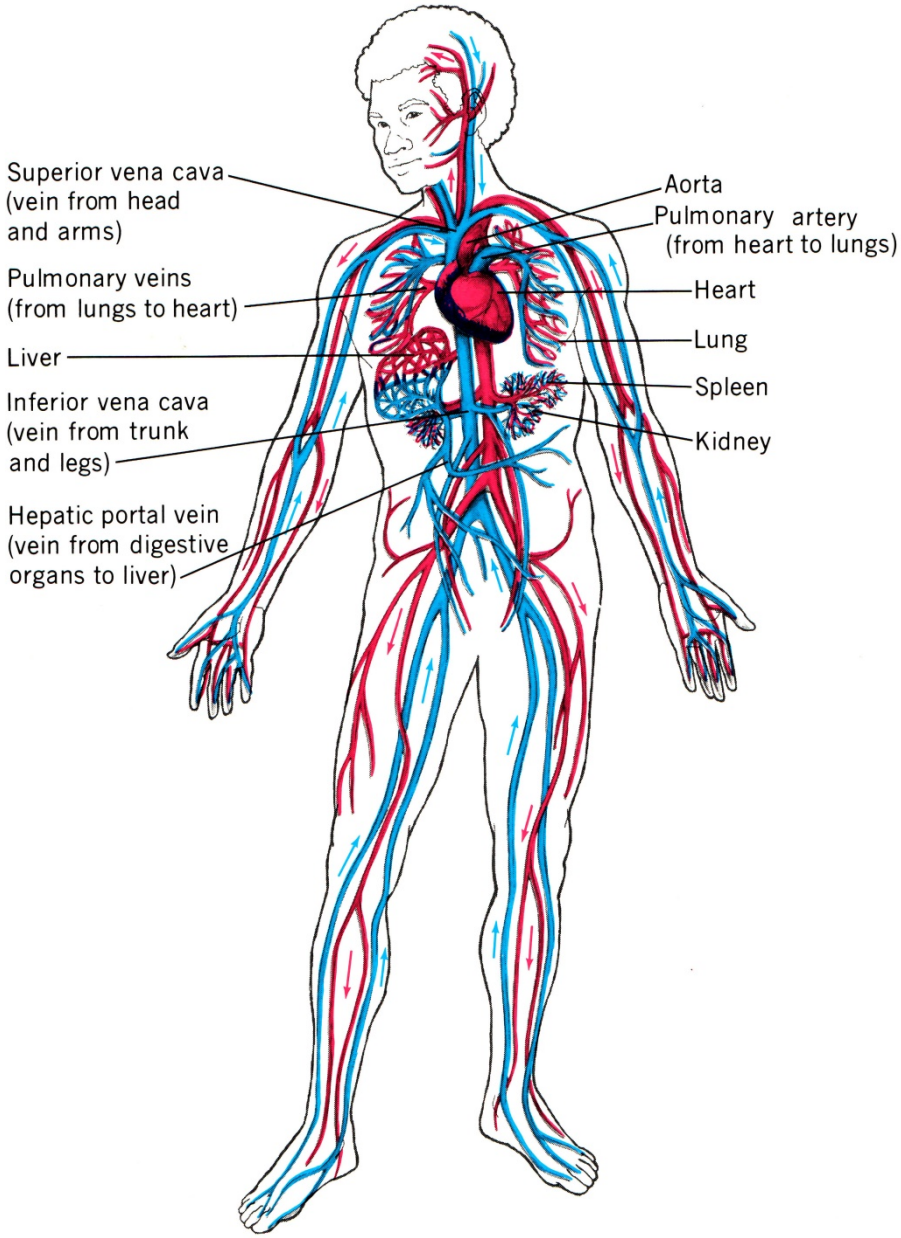


Figure 5.8. The human circulatory system

Adult human heart weight average about 250 g in women, and about 330 g in men. Heart length is 10-15 cm, the transverse dimension is 8-11 cm and anteroposterior - 6-8.5 cm heart volume in men the average is 700-900 cm^3, and for women - 500-600 cm^3. The outer walls of the heart are formed by the heart muscle, which is structurally similar to the striated muscle. However, the heartmuscle is characterized by the ability to automatically contract rhythmically through impulses that arise in the heart, regardless of external influences (automaticity of the heart). Function of heart is rhythmical discharge in an artery blood that comes to him through the veins. Heart beats about 70-75 times a minute in the body rest (1 time for 0.8 seconds). More than half of the time it is resting - relaxes. Continuous cardiac activity consists of cycles, each of which consists of a reduction (systole) and relaxation (diastole). There are three phases of cardiac activity: reduction of atrial, ventricular, and pause (relaxation
of the atria and ventricles). Systole atrial takes 0.1 seconds, ventricular - 0.3, overall pause - 0.4 seconds. This explains the ability of heart muscle to work without tiring, throughout life. The high performance of the heart muscle due to increased blood supply to the heart.Approximately 10% of blood ejected by the left ventricle into the aorta flows into the artery branching off from it, which feed the heart. Arteries - blood vessels that carry oxygen-rich blood from the heart to the organs and tissues (a pulmonary artery carries venous blood). The wall of the artery consists of three layers: an outer connective tissue sheath; medium consisting of elastic fibers and smooth muscle; inner formed endothelium and connective tissue. In humans, the diameter of the arteries varies from 0.4 to 2.5 cm. The total volume of blood in the arterial system is on average 950 ml. Arteries gradually treelike branching into smaller vessels - arterioles, which pass into the capillaries.

Capillaries are the smallest blood vessels (average diameter of about 7 microns) penetrate the tissues and organs of animals and human having a closed circulatory system. They connect the small arteries with small veins. Through capillary walls consisting of endothelial cells, appears exchange of gases and other substances between the blood and various tissues.

Vein is the blood vessels that carry saturated with carbon dioxide, metabolic products, hormones and other substances from the blood to the tissues and organs of the heart (except pulmonary veins, which carry arterial blood). The wall of the vein is much thinner and more elastic than artery wall. Some veins have valves that prevent blood from flowing backward. In human

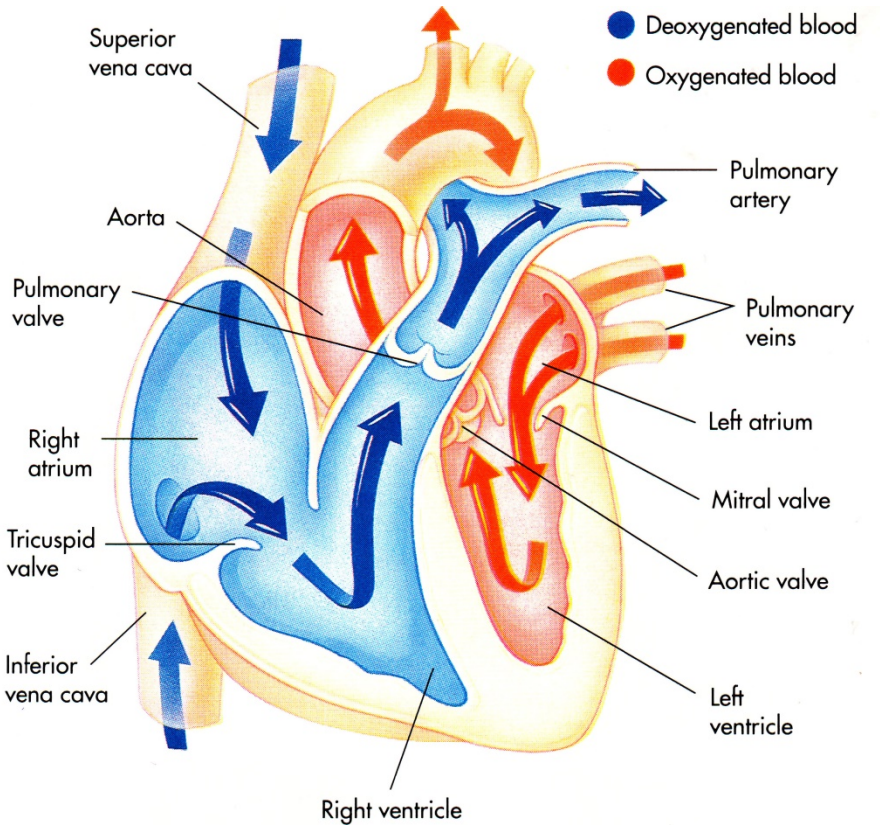


Figure 5.9. Path of blood through the heart

the amount of blood in the venous system averaged 3200 ml. The heart isinnervated by the autonomic nervous system. Sympathetic nerves speeds up the rhythm and increase the force of contraction, the parasympathetic - slow rhythm and weaken the strength of the heart contractions. Humoral regulation is carried out with the available in large vessels special chemoreceptors, which are excited under the influence of changes in the composition of blood. Increasing the concentration of carbon dioxide in the blood irritates the receptors and reflex strengthens the heart. Epinephrine also enhances the activity of the heart, acetylcholine, on the contrary, slows down (Table 5.5).

Table 5.5.Neurohumoral regulation of the cardiovascular system.

Factor	Heart	Vessels	Blood pressure level
The sympathetic nervous system	Speeds up the rhythm and strengthens	Narrows	Increases
Parasympatheticnervo ussystem	Rhythm slows and weakens the contraction	Extends	Lowers
Adrenaline	Speeds up the rhythm and strengthens	Contraction narrows (except vessels of the heart)	Increases
Acetylcholine	Slows the rhythm and	Extends	Lowers

	weakenscontraction		
Thyroxine	Speedsuptherhythm	Narrows	Increases
Calciumions	Speeds up the rhythm and impaired contraction	Narrows	Lower
Potassiumions	Slow down the rhythm and impaired contraction	Extend	Lower

5.5.1.The movement of blood through the vessels

Movement of blood through the vessels was first described in 1628 by the English physician William Harvey. In human and mammals blood moves through a closed circulatory system consisting of large and small circulation. Large circulation starts from the left ventricle and the right atrium ends. From the left ventricle the blood goes to the largest arterial vessel - the aorta. From the aorta depart numerous arteries, which entered the body, divided into smaller flasks and finally transferred into the capillaries. From the capillaries the blood is collected in small veins that merge to form larger caliber vessels. Two of the large vein - upper and lower hollow.Hollow carry blood into the right atrium. Through the capillaries of the systemic circulation of the body cells receive oxygen and nutrients and carry away carbon dioxide and other waste products.

All arteries that circle flowing arterial blood, in veins - venous. Small circulation from the right ventricle begins and ends with the left atrium. From the right ventricle of the heart receives deoxygenated blood in the pulmonary artery, which soon divides into two branches carrying blood to the right and left lung. In lung arteries branch into capillaries where gas exchange takes place: blood gives carbon dioxide and picks up oxygen. Oxygenated arterial blood flows through the pulmonary veins to the left atrium. In the arteries of the pulmonary circulation venous blood flows, and in his veins - arterial.Flow of blood through the vessels is possible due to the difference in pressure at the start and end of each circulation, the heart work is created. The left ventricular and aortic blood pressure is higher than the hollow veins and in the right atrium. The pressure difference in these plots provides blood flow in the systemic circulation. High pressure in the right ventricle and the pulmonary artery and the pulmonary veins in lower left atrium and allow movement of the blood in the pulmonary circulation. The main reason for the movement of blood through the veins is the pressure difference at the beginning and end of the venous system, so the movement of blood through the veins is in the direction towards the heart. This is facilitated by a suction effect of the chest ("respiratory pump")

and a reduction in skeletal muscle ("muscle pump"). During the inspiratory pressure in the chest is reduced. The pressure difference at the start and at the end of the venous system increases, and the blood is directed through the veins to the heart. Skeletal muscle, cutting, compressing the veins which also contributes to the movement of blood to the heart. The movement of blood in the capillaries is carried out by changing the connecting lumen of small arteries: their expansion increases blood flow in the capillaries, and the restriction - reduces.

Pulse is periodic jerky extension of the walls of arteries, synchronous with the heartbeat. Pulse an average of 70-80 beats per minute. Pulse can determine the number of heart beats per minute. Blood pressure is a pressure to the walls of blood vessels and heart chambers, resulting from contraction of the heart in pumping blood vasculature and vascular resistance. The most important medical and physiological indicator of the circulatory system is the pressure in the aorta and large arteries - blood pressure. Distinguish maximum or systolic blood pressure - the pressure levels in the arteries of the heart during systole in human is about 120 mm Hg, and the minimum or diastolic is the pressure in the arteries of the heart during diastole is about 80 mm Hg.

In the blood pressure value depends on: 1) the work of the heart and the strength of cardiac contraction; 2) the value of the lumen of blood vessels and their walls tone; 3) the amount of blood circulating in vessels; 4) the viscosity of the blood. Blood pressure level is controlled by neural and humoral factors. The speed of blood flow in vessels is 0.5 m / sec and in the aorta just 0.5 mm / sec in the capillaries.

Slowing of blood flow in the capillaries due to their huge number and a large total clearance (800 times the lumen of the aorta). The veins, with their consolidation as we approach the heart, the total clearance are reduced bloodstream and speed of blood flow increases. Normal activity of the human body is possible only in the presence of a well-developed heart-vascular system. The rate of flow will determine the degree of blood supply to organs and tissues, and the rate of removal of waste products. When the need for physical bodies in oxygen increases at the same time strengthening and quickening heart rate. Such work can only provide a strong heart muscle. To be resilient to a variety of work, it is important to train the heart, increase the power of his muscles. Physical labor, physical education develop heart muscle.

For blood oxygen enrichment exercise to perform is better in the open air.On the function of the cardiovascular system have harmful effects of

alcohol, nicotine, drugs. People who consume alcohol, smoking, more often than others, there are spasms of the heart vessels, more likely to develop atherosclerosis - a disease associated with changes in blood vessel walls. The internal environment of the body work of the circulatory system provides continuous transportation to the tissues and organs of nutrients and removal of the end-products of metabolism. This ensures preservation of the internal environment, resulting in the body are maintained at a relatively constant body temperature, blood pressure value, respiration rate, the content of sodium, potassium, calcium, chlorine, hydrogen, proteins, sugars, osmotic pressure of the blood and tissue fluid and so on. The parameters of the internal environment preservation an important role is played by the nervous and endocrine mechanisms. The internal environments of the body make up tissue fluid, lymph and blood. Tissue fluid fills the space between the blood capillaries and tissue cells. It is characterized by the specific composition of individual organs, almost devoid of protein. Its volume in humans is to 26.5% of body weight. Tissue fluid passage provides amino, glucose, hormones, fats, oxygen and other biologically active substances from the blood into the cells of the tissues and removing carbon dioxide and other waste products. Run-off from the organs into the lymph vessels, lymph fluid turns into lymph.

Lymph is fluid that circulates through the lymphatic system of human and mammals; composition close salts plasma has a low protein content. Circulating through the lymph vessels, lymph promotes the return of proteins from the intercellular spaces into the blood, and the redistribution of water to maintain normal metabolism in tissues. The lymph vessels of the intestines sucked fat. Lymph moves slowly through the lymphatic vessels which are located along the lymph nodes where lymph is enriched lymphocytes. The lymph nodes of the pro-coming destruction by phagocytosis of microbes, foreign substances, and the formation of antibodies.

Blood is a key component of the body's internal environment. In the adult its amount is 5.6 liters (7-8% body weight). Blood is circulated through the vessels, but part of it (40%) is in a depot blood (spleen, liver, lungs, skin and others.). The output of blood from the depot occurs during muscular work, blood loss, decrease in atmospheric pressure. Due to the movement of the blood is supported by continuous circulation of fluids internal environment.

These liquid blood connective tissues, since its cells (erythrocytes, leukocytes, platelets) are separated by intercellular substance liquid (plasma). Blood consists of 55-60% plasma and 40-45% - of the formed elements. Blood

plasma - translucent aqueous organic (proteins, fats, carbohydrates, amino acids, vitamins, hormones, etc.) or inorganic (mineral salts) of the compounds. Dissolved plasma proteins (albumins, globulins, fibrinogen) mineral salts and other substances produce certain osmotic pressure through which water exits through the cell membrane into the blood and performs water exchange between blood and tissues. The concentration of various salts in the plasma is relatively constant and corresponds to the content of their cells and tissues which is important to maintain a constant internal environment. The kidney is freed of blood plasma from the excess of mineral salts, water, and metabolic products. Blood plasma proteins give the desired viscosity, having a value in the maintenance of blood pressure at a constant level.

Erythrocytes, or red blood cells - a small (7-8 mm diameter) anuclear cells biconcave disk shaped(Figure. 5.10). The absence of the nucleus allows the erythrocytes contain large amounts of hemoglobin, and the shape increases its surface. In 1 mm3 of blood, there are 4-5 million of erythrocytes. The number of red blood cells in the blood is constant. It increases with the rise in height, large water losses. Erythrocytes are formed in the bone marrow, and are destroyed in the spleen and liver. The duration of the life of human erythrocytes is about 120 days.

Hemoglobin is red iron-containing pigment consisting of (hem) and globin protein. The pulmonary capillary hemoglobin combines with oxygen to form oxyhemoglobin by ferrous heme. The capillaries oxyhemoglobin tissue decomposes to release oxygen which contributes to the high content of carbon dioxide. From the capillaries of tissues to the lungs hemoglobin transports carbon dioxide. In the body, hemoglobin in addition, skeletal muscle contains myoglobin, which can connect up to 14% oxygen in the tissues. This reserve in case of oxygen deficiency during intensive muscle work.

White blood cells are blood cells, which are colorless, with the core; diverse in function and are capable of active amoeboid movement. According to structural features distinguish granular (neutrophils, basophils, eosinophils) and nezernistye (lymphocytes and monocytes) leukocytes. Their percentage in the blood called leukocyte formula. The number of leucocytes in 1 mm3 of blood of an adult in the range 4000-9000. The reductions in their number in the blood cause leukopenia. It occurs in various diseases because of the oppression of production of white blood cells. The increase in the number of white blood cells is called leukocytosis. It may be due to physiological redistribution of blood after a meal or in inflammatory diseases occur. Lifetime of leukocytes is dif-

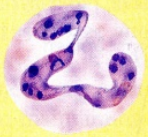
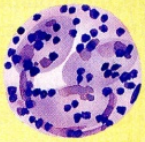
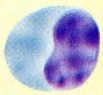
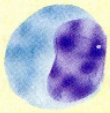
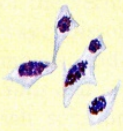
Blood cell	Life span in blood	Function
Erythrocyte 	120 days	O_2 and CO_2 transport
Neutrophil 	7 hours	Immune defenses
Eosinophil 	Unknown	Defense against parasites
Basophil 	Unknown	Inflammatory response
Monocyte 	3 days	Immune surveillance (precursor of tissue macrophage)
B-lymphocyte 	Unknown	Antibody production (precursor of plasma cells)
T-lymphocyte 	Unknown	Cellular immune response
Platelets 	7-8 days	Blood clotting

Figure 5.10.Types of cells.

ferent and can vary from some hours (neutrophils) to 100-200 and more days (lymphocytes). Granular leukocytes are produced in the bone marrow, monocytes - in the liver and spleen, lymphocytes - in thymus, bone marrow, and then proliferate in the spleen, lymph nodes. The main function of white blood cells is their ability to protect the body from infection. Each type of white blood cells perform certain functions. Neutrophils and monocytes are able to

actively acquire and consume bacteria, fragments of cells, solids. This phenomenon is called phagocytosis and intracellular digestion. Eosinophils absorb and neutralize toxins and allergens parasites (viruses, bacteria, protozoa, nematodes and flat). Lymphocytes produce antibodies that make the body immune to infectious diseases.

Platelets is a nuclear-free blood form a round or oval in shape with a diameter of 2-5 microns. They are formed in the bone marrow and live 11.8 days. In 1 mm3 in adult blood contains 180 to 320 thousand platelets. They identified specific granules containing substances involved in blood coagulation.

Blood groups is immunological signs of blood, caused by specific antigens, allowing the blood to divide individuals of one species into groups (Table. 5.6).

FirstKarl Landsteiner described blood group in human in 1900. The red blood cells contain special proteins (agglutinogens) of the two species, which is usually denoted by the symbols A and B antibodies contained in blood plasma (agglutinins). Agglutinins and agglutinogens can glue A, and agglutinins β - agglutinogens B. In human blood never simultaneously meet agglutinin agglutinogen A and A or B and B. Depending on the content of agglutinogens and agglutinins blood of man is divided into four groups.

Table 5.6.Characteristic of human blood group on ABO system

Group	Gene	Genotype	Agglutinines of plasma	Agglutinogenes of erythrocytes
I	0	00	α, β	–
II	A	AA, A0	β	A
III	B	BB, B0	α	B
IV	A,B	AB	–	A,B

Blood groups are determined by certain genes: I group - about the genome, II of - gene A, III - B and IV- gene genes A and B. This explains the appearance of the name "blood group ABO system," since there are other systems (for Rh factor and others.). Determine blood group by erythrocyte bonding reaction (haemagglutination). Blood transfusion is carried out taking into account the compatibility of blood groups. The person who gives blood, called the donor and the one to whom it is poured - recipient. Blood transfusion has become widespread in the medical purposes. Blood coagulation is a biological process, accompanied by the conversion of fluid blood to clot elastic dissolved by the transition in the blood plasma protein fibrinogen to insoluble fibrin. This is a

protective reaction of the body, preventing the loss of blood in violation of integrity of blood vessels. The process of blood coagulation is regulated by the nervous and endocrine systems, and due to the interaction of the components of the vascular wall, platelets and some plasma proteins called coagulation factors. In carrying out this process, platelets begin to adhere to the damaged vascular wall and release enzymes that convert prothrombin protein in the presence of calcium, synthesized in the liver, with the participation of vitamin K, thrombin. Last favors the transition of dissolved protein in the plasma fibrinogen into fibrin, which polymerizes, forms thin threads, retaining erythrocytes. This results in a clot occluding the affected area of the vessel, and the bleeding stops.

Blood clotting time in human ranges from 5 to 12 minutes.Study of the protective properties of the white blood cells wereinitiated byMechnikov, who made the first reports of phagocytosis in 1883. An important role in protecting the body from infection also owns a special plasma protein (antibodies) that are produced by plasma cells (as modified in the lymphocytes of the immune response). Antibodies contained in the globulin fraction of the blood proteins (immunoglobulin’s) and freely circulating plasma current. They provide the body's ability to protect its own integrity and the biological individuality from damaging agents, or immune system. Damaging factors, or antigens, are substances that are perceived as alien -organism and cause a specific immune response - the reaction of antigen. Antibody aimed at neutralization of pathogens, their metabolic products (toxins), etc. There are innate and acquired immunity. Innate immunity is the hereditary traits of the species. Thus, people immune to pathogens of cattle plague, cholera and so on. If the immunity is developed after suffering an infectious disease, it is called acquired. Modern medicine offers a powerful way to create artificial immunity - through protective vaccination, therapeutic sera. After administration of the vaccine (weakened or killed pathogen culture infectious disease) in the body produced antibodies to the respective antigens of the pathogen and the person becomes immune to a specific disease. It is an active acquired immunity. Currently set active vaccine against smallpox, rabies, tetanus, tuberculosis, diphtheria, whooping cough, polio and other infectious diseases, thus reducing the number of people falling ill with them. Treatment by serum is a drug from the blood serum of human or animals recover from any infectious disease. It has ready-made antibodies against a particular pathogen. When administered in therapeutic serum human created passive immunity acquired. Therapeutic serum obtained mainly from horses immunized with which corresponding

toxin. Passively acquired immunity appears simultaneously with the application of therapeutic sera and to successfully treat a number of serious infectious diseases, such as measles, diphtheria.

Alcohol, drugs have a depressing effect on the formation of the human immunity against infectious agents.

5.5.2.Lymphatic system

The lymphatic system is represented by a collection of blood vessels that collect excess fluid from the tissues and organs and diverting it into the venous system. It is formed by the lymph capillaries, lymphatic vessels and lymph nodes. Lymphatic capillaries begin blind endings in the intercellular spaces, their diameter is in several times greater than the diameter of the blood capillaries. As it goes to the lymph vessels. Lymphatic vessels penetrate all tissues and organs. They are formed by the merger of the capillaries, causing the diameter gradually increases. The vessels have a muscular layer of the wall so that they have a certain tone, the ability to contract and relax. In large lymph vessels are valves that prevent backflow of fluid. Lymph nodes are located along lymphatic vessels. This oval formation of specific lymphoid tissues and they are formed by cells that perform a protective function (phagocytosis, antibody formation). In human there are about 460 lymph nodes with a diameter of2-30 mm. Especially a lot of them in the neck, armpits and groin. Lymph movement occurs due to compression of the lymphatic vessels in reducing skeletal muscle and lymph vessel walls, and also due to the suction action during inhalation of the chest. The largest combined oflymphatic into the thoracic duct opening into the veins, whereby tissue fluid is returned to the circulatory system. The lymphatic system provides lymph holding body, maintenance of normal metabolism in tissues, carrying out transportation of nutrients, especially fats, proteins returned from the tissue fluid in blood involved in the immune defense mechanisms of the organism.

5.6. Breath

Breath is a set of processes that provide entry into the body of oxygen and removing carbon dioxide (external respiration), and the use of cells and tissues of oxygen for the oxidation of organic matter to release energy required for their activity (cellular or tissue respiration). When breathing out of the body are also removed some of the end products of the oxidation of organic compounds

and water. Specialized agencies respiratory organs for gas exchange between the organism and the environment form the respiratory system which in human is represented by light, located in the chest cavity, and pneumatic ways, nasal cavity, larynx, nose, trachea, bronchi(Figure5.11). During inhalation air enters through the nostrils into the nasal cavity is divided into two halves osteochondral partition. The nasal cavity is lined with ciliated epithelium which cleans the air from dust. The mucous membrane has a dense network of capillaries through which inhaled air is warmed, and the receptors of the olfactory analyzer, providing the distinction between smells. The left and right halves of the nose shells contain three (upper, middle and lower) forming the nasal passages. In the bottom of the nasal entrance opens outputting channel lacrimal gland. Behind the nasal cavity through the internal nostrils (choanae) communicates with the nasopharynx.

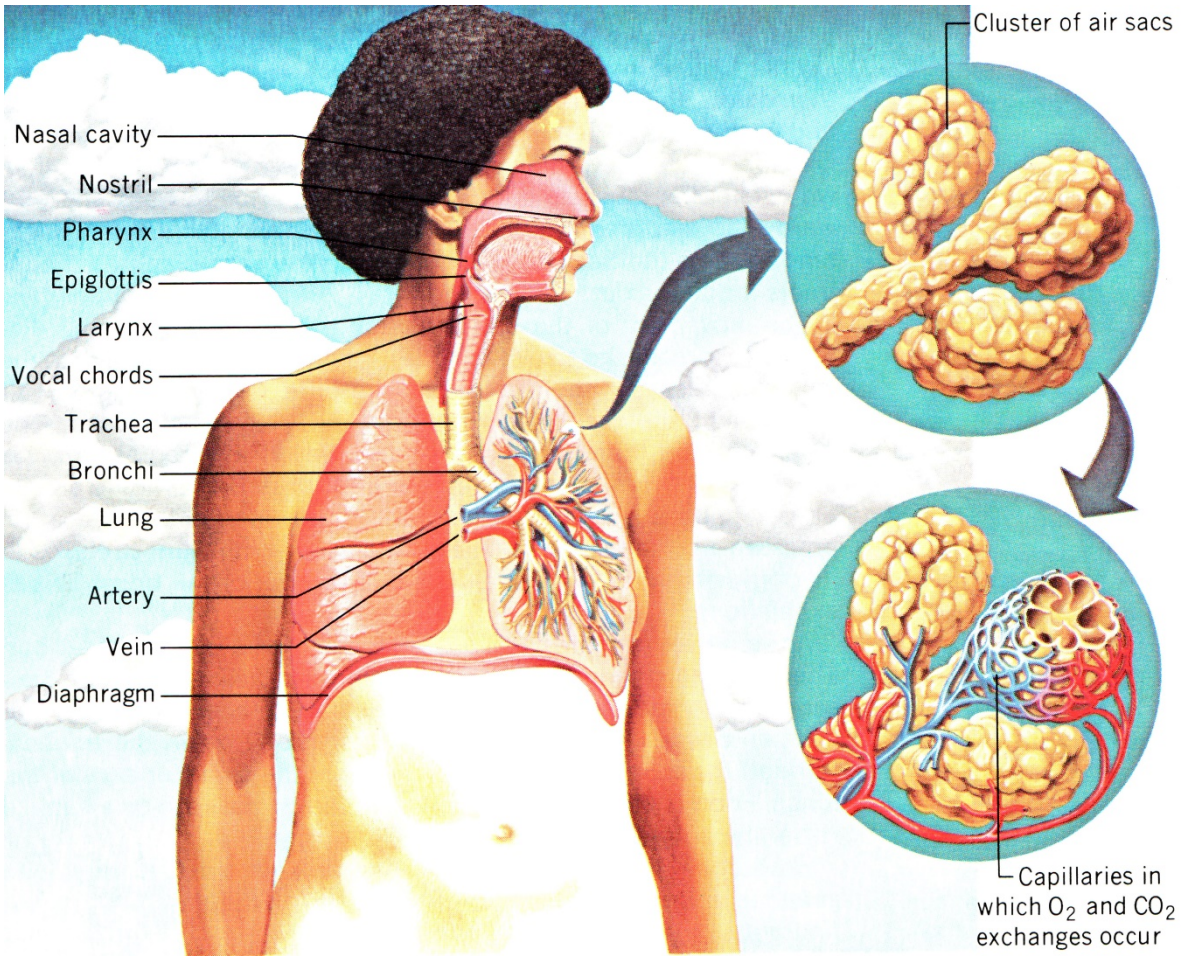


Figure 5.11. Structure and function respiration

Nasopharynx is the upper part of the pharynx which crossed the path of the digestive and respiratory systems. Food passes from the pharynx to the stomach

through the esophagus, and the air - through the larynx into the trachea. At the entrance to the high-rolling food larynx closes special cartilage (epiglottis). The larynx has a view of the funnel formed by the thyroid, cricoid, the two arytenoid cartilage and epiglottis. Between the arytenoid and thyroid cartilage extend the vocal cords (paired elastic folds of mucous membrane) which limit the glottis. The vibrations of the vocal cords during expiration produce sound. The men in the reproduction of articulate speech, in addition to the vocal cords, also take part tongue, lips, cheeks, soft palate and epiglottis. The air from the larynx at the level of VI - VII cervical vertebra goes into the trachea (or windpipe) which has the form of the tube length of 10-13 cm and consisting of cartilaginous half-rings connected by a dense connective tissue membrane. The trachea inside is lined with a mucous membrane of the multi-row ciliated epithelium. At the level of the first attaching edge to the sternum is divided into two trachea bronchial cartilage extending into the lungs.

Inside each lung bronchus branches into bronchioles. Recently transformed into a small tube leading to the air sacs, composed of numerous alveoli (vesicular connective tissue formation, lined with a single layer of squamous epithelium from the inside and covered with a thin film of a substance that prevents wears off). Alveoli braided dense network of capillaries, and their diameter ranges from 0.25 to 15 mm, the total amount exceeds 700 million, and the total surface area of an adult is about 100 m2. The alveoli are the final part of the respiratory tract and account for the bulk of the lungs. Light occupy 4/5 of the chest, leaving space for the heart, great vessels, trachea and esophagus. The mass of each light ranges from 0.5 to 0.6 kg. Lungs are spongy structure, rich in elastic fibers and blood capillaries. Right lung is slightly larger, it has three lobes and the left - two. Each lung, as well as the inner surface of the wall of the chest cavity covered by the pleura (the thin layer of smooth epithelium) which forms the pulmonary and parietal sheets. Between them is the pleural cavity with a small amount (1-2 ml) of pleural fluid to facilitate sliding pleura during respiration. External respiration is provided by inhalation and exhalation. Breathe is performed by cutting the intercostal muscles and the diaphragm, which, stretching the chest, increasing its volume, which helps to reduce pressure in the pleural cavity. When a deep breath, moreover, engage the shoulder girdle muscles, back, abdomen, and others. The light thus stretched, the pressure therein is reduced below atmospheric pressure and air flows into the body. When exhalation respiratory muscles are relaxed, the volume of thorax decreases, the pressure in the pleural cavity is increased, whereby light is

partially fallen down and the air are ejected to the outside environment. With a deep breath and reduces internal intercostal muscles, abdominal muscles, which compress the abdominal organs. Recent begin to put pressure on the diaphragm and additionally speed up the compression of the lungs. As a result, the volume of the thoracic cavity decreases more intense than in normal exhalation. The man at rest inhales and exhales about 0.5 liters of air (tidal volume). After restful breaths a person can still breathe to 1.5 liters of air (additional air volume). Approximately so much he can exhale after tidal (reserve air). The totality of the respiratory, additional backup and air volumes of lung capacity. It represents the greatest volume of air that a person can exhale after a very deep breath. Vital lung capacity in different people is not the same, its value depends on the sex, age of the person, his physical development and is 3.5-4.0 liters. When medical examinations it is determined by a special device a spirometer. Respiratory exchange depends on lung respiration rate, level of oxygen and carbon dioxide concentration in the alveolar air and maintains normal blood gas concentration. The content of gases in inhaled and exhaled air is not the same. In the inhaled contained 20.94% oxygen, about 79.03% nitrogen, about 0.03% of carbon dioxide, a small amount of water vapor and inert gases. The exhaled air is 16% oxygen, the amount of carbon dioxide is increased to 4%, and nitrogen content of the inert gas is not changed, the amount of water vapor increases. Miscellaneous oxygen content and carbon dioxide in the inhaled and exhaled air is due to the exchange of gases in the alveoli. Due to the diffusion of oxygen passes from the alveoli into the capillaries, and carbon dioxide - back. Each of these gases moves from a region of higher concentration to a lower concentration. Thin alveolar epithelium no resistance to gas diffusion, and since the concentration of oxygen in the alveoli is higher than the blood capillaries, oxygen diffuses into the capillaries of the alveoli. In contrast, in the blood concentration of carbon dioxide is higher than in the pulmonary alveoli, and therefore carbon dioxide diffuses from the capillaries into the alveoli.

Gas exchange takes place in the tissues by the same principle. Oxygen from the capillaries, where its concentration is high in the tissue fluid passes from its lower concentration. It penetrates the tissue fluid from the cells and immediately enters into the oxidation reaction, so the cells are practically no free oxygen. According to the same laws of carbon dioxide from the cells through the tissue fluid enters the capillaries where oxygen unstable compound cleaves hemoglobin (oxyhemoglobin) and comes into connection with hemoglobin to form carboxyhemoglobin. The blood flowing from the venous

bodies carbon dioxide is in the connected and in the dissolved state in the form of carbonic acid, which in the pulmonary capillaries easily split into H_2O and CO_2. Carbonic acid may also enter into compounds with the ions of sodium, potassium, plasma forming bicarbonates. In the lungs which receives venous blood, oxygen again saturates the blood, and carbon dioxide from the high pressure zone (capillaries) is transformed into a low-pressure area (alveoli). Regulation of respiration and respiratory hygiene regulationis changing the mode of the respiratory system, aimed at an accurate and timely response to the needs of the organism in oxygen. Nervous regulation of respiration is controlled by the respiratory center located in the medulla oblongata. Inhalation by lung stretch receptors in the walls of the alveoli occurs excitement that comes along parasympathetic nerves in the respiratory center, the center of the inhibition of the inspiratory and expiratory center excitement. As a result, breathing muscles relax, the chest is lowered, its volume is reduced and there is breath.

The regulation of respiration is also involved cortex, providing subtle mechanisms of breathing adapt to changes in environmental conditions. Since the cerebral cortex associated prelaunch changes in breathing in athletes, an arbitrary change in the rhythm and depth of breathing in humans. Humoral regulation of respiration is carried out, firstly, due to the direct effects of CO_2 blood on the respiratory center. An elevated level of CO_2 in the blood increases the excitability of the respiratory center. Second, changing the chemical composition of blood (increased CO_2 concentration, increased acidity of the blood and so on) and excited vascular receptor which receives impulses from the respiratory center, respectively, changing its performance.

Respiratory hygiene is aimed at creating conditions for the normal functioning of the respiratory system. First of all it is necessary to prevent the penetration of pathogens into the respiratory tract. To do this, you must keep the premises clean, wet cleaning, airing. Upon contact with infected patients is recommended to use a gauze mask. Great harm smoking causes respiratory organs, as tobacco smoke contributes to the emergence of various diseases (bronchitis, pneumonia, asthma, etc.). Alcohol, much of which is excreted from the body through the lungs, affects the alveoli and bronchi, depresses the respiratory center, and contributes to the manifestation of lung disease in particularly severe. When working with toxic chemicals or high air pollution conditions necessary to use cotton-gauze bandage or gauze masks, respirators, gas masks.

5.7. Digestion

For normal functioning of the body must be a regular flow of food, representing the totality of organic and inorganic substances derived from the human environment and use them to sustain life. With food person receives nutrients - vital components of food (proteins, fats, carbohydrates, vitamins, mineral salts, water) which are used by the body to build and renewal of cells, tissues and replenish energy expenditure (Figure. 5.12). The nutrients found in plant foods (flour, cereals, bread, fruit, vegetables and others) and animal (meat, milk, eggs, butter and others) origin.

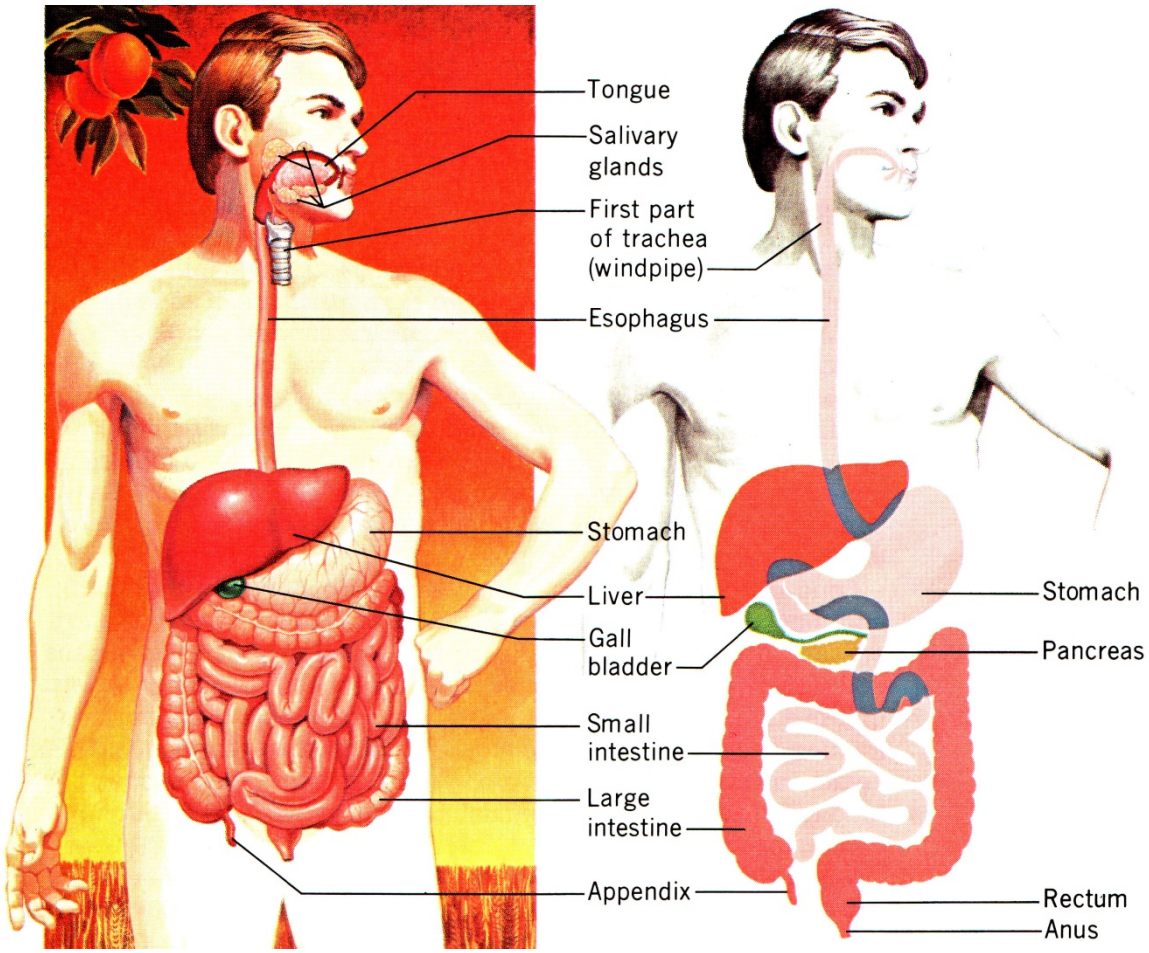


Figure 5.12. The human digestive system

Digestion is the process of mechanical and chemical (enzymatic) food processing in which the nutrients are absorbed and digested in the gut and undigested residues and the final decay products are removed from the body. Chemical processing of food is carried out by enzymes of digestive juices (saliva, gastric, pancreatic, intestinal juice, bile). They are active only at a

certain acidity, temperature and capable of cleaving "well-defined substance. For example, gastric enzyme is active in an acidic environment, and only cleaves proteins intestinal juice maltose enzyme active in alkaline medium, cleaves and carbohydrates. There are cavernous (extracellular), intracellular and membrane (on the border of the extracellular and intracellular environments) digestion. It takes place in the system of organs of the digestive tract.

Digestiveorgans and functions of the digestive organs of the digestive system consist of a channel and the digestive gland (saliva, pancreas, liver and others). The alimentary canal is differentiated into the oral cavity, pharynx, esophagus, stomach, duodenum, small and large intestine. The total length of the alimentary canal is 8-10 m. The wall of the intestinal canal is formed by the outer, middle and inner layers. The outer layer is formed by epithelial (serous) sheath covering the stomach and intestines, and the connective tissue enveloping the pharynx and esophagus. The outer shell has a protective function, for it to fit the body vessels and nerves. The middle layer consists of two layers of smooth muscle which, by cutting, the food is moved along the intestinal tube. The inner layer is glandular epithelium (mucous membrane), acting as the secretion and absorption of nutrients. The oral cavity is limited and the bones of the upper jaw and the muscles. Its upper border forms a hard and soft palate, lower - mylohyoid muscle, located on the sides of the cheeks, and the front - the gums to the teeth and lips. Hard palate has a thick mucous membrane, glued to the periosteum. Behind the solid goes into soft palate formed muscles covered mucosa. Rear front soft palate forms a tab. If swallowed, the muscles of the soft palate, cutting, separate the nose of the pharynx from the mouth. In the side folds of the soft palate are tonsils (clusters of lymphoid tissue, performing a protective role). Tonsils have also at the root of the tongue and in the nose and throat. Through these forms pharyngeal lymphoid ring that holds penetrating with food microbes involved in immunity. In the oral cavity and the teeth are arranged languages.

Tongue is movable muscular organ formed by striated muscle, covered with a mucous membrane, equipped with vessels and nerves. The tongue distinguishes a free front part (the body) and posterior (root). In the tongue of the mucous arranged threadlike, mushroom and leaf buds which terminate in the taste buds. Tongue machining involved in cooking, mixing it and form a bolus, as well as in determining the taste of food and temperature. Taste buds tip of the tongue perceive the sensation of sweet, the tongue - bitter side surfaces - sour and salty. Tongue with the lips and jaws involved in the

formation of speech. The teeth located in the jaws cells are also involved in machining food. An adult human has 32 teeth which are differentiated into incisors (8), canines (4), small indigenous (8) and large root (12). Each tooth is formed by a crown protruding from the gums, the neck, located in and passing the gum at the root, which is immersed in the cell jaw. The tooth is composed of dentine - bone species. The crown is covered with enamel dentine region and in the neck - with dental cement. Inside the tooth has a cavity filled with pulp - loose connective tissue with blood vessels and nerves. The beginnings of teeth are laid during the period of embryonic development. For two years the child has 20 teeth, called the milk to the age of six are beginning to be replaced by permanent. This process ends as a rule, to 16 years. The mucous membrane of the mouth is rich in glands secrete mucus. In the mouth open ducts of three pairs of major salivary glands: parotid, sublingual, submandibular, and many small.

Saliva is the first digestive juice slightly alkaline reaction, acting on the food. It consists of 98-99% water and 1-2% salt and organic substances - mucus lysozyme enzymes. Mucus iscomplex saliva proteins that provide moisture and elasticity of mucous membranes. Lysozyme is an enzyme that promotes the healing of injuries mucous shell. Saliva ptyalin enzyme cleaves starch to maltose, and maltase enzyme breaks it down into glucose. In the mouth the teeth shredded food is moistened with saliva, enveloped mucin and turns into a bolus, which is moving to the throat using a tongue muscles. By reflex contraction of muscles of the pharynx occurs swallowing and food enters the esophagus. In this case the epiglottis descends, closing the entrance to the larynx and soft palate rises, blocking the way into the nasopharynx. In esophageal food moves into the stomach due to the wave-like contraction of the esophagus wall muscles. Stomach - thick-walled expanded portion of the alimentary canal which lies in the abdominal cavity under the diaphragm(Figure 5.13).It consists of three parts-the top (bottom), middle (body) and internal (pyloric region). In the gastric mucosa, there are three main groups of glands: the major secreting enzymes pepsin and chymosin, parietal, releasing hydrochloric acid and additional forming mucus. In acidic medium the enzyme pepsin breaks down proteins into peptides and chymosin - curdled milk protein. Gastric glands secrete 1.5-2.5 liter per day of the gastric juice. The food in the stomach undergoes further mechanical and chemical treatment for 4-8 hours and then passes into the duodenum. Duodenum - the initial portion of the small intestine about 30 cm long, which is a further digestion. Duodenal mucosas

secrete enzymes group acting on proteins, fats, carbohydrates. In addition, here comes pancreatic juice secretion and liver - bile.

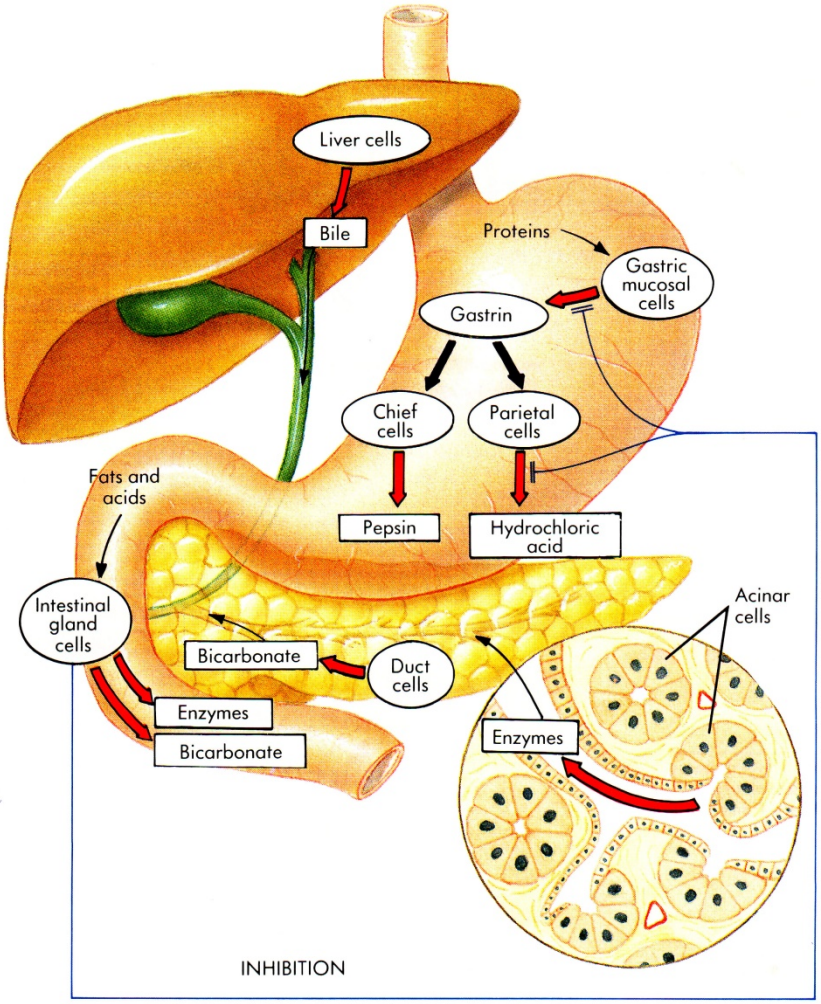


Figure 5.13. Regulation of digestive enzyme production

Pancreas is gland of mixed secretions which located behind the stomach at the level of the second lumbar vertebra. It produced juice which contains enzymes that break down proteins (trypsin), fats (lipase), carbohydrates (amylase and maltase) and nucleic acids (nucleases). The liver is the biggest iron human body, located in the right upper quadrant, weight it up to 1.5 kg. Synthesis in the liver and blood proteins, glycogen, fat-like substances, prothrombin. It serves as a depot of glycogen and blood, neutralizes blood are the end products of the decay of organic substances (toxic substances). The bile is formed in the liver which is involved in the processes of digestion and absorption. It contains no digestive enzymes, but activates pancreatic enzymes and intestinal juice emulsifies fats, which facilitates their absorption and

cleavage. Bile increases the motor activity of the intestine and inhibits the development of putrefaction in it. It accumulates in the gall bladder and then released into the duodenum reflex when entering the food into the stomach.

Small intestine is the narrowed portion of the intestine which is situated between the stomach and the large intestine and consists of the duodenum and ileum. The mucosa contains numerous glands that produce digestive juice, which includes more than 20 enzymes acting on all edible substances and products of incomplete digestion. The mucous membrane of the small intestine is covered with numerous fibers, thereby increasing its suction surface, reaching 43.6 m^2. Each villus is formed by a single layer of epithelium and suitable to her blood, lymph vessels and nerves. The amino acids are absorbed into the blood to the liver and used for the synthesis of proteins or subjected to further transformations. Glucose is also absorbed into the bloodstream and is carried to tissues. Fatty acids previously connected with bile to form a fatty acid salt. These salts are sucked together with glycerin in the epithelial cells of the villi, where the fat to the synthesis of specific human, which are then in the form of tiny droplets enter the lymph. Large intestine is the final part of the human intestine, starting from the small intestine and ends with the anus. The mucous membrane of the intestinal allocates juice containing enzymes and small is not essential to the digestion of food. Many bacterias live in the colon, that cause fermentation of carbohydrates, rotting remnants of undigested proteins, digestion of fiber, which is accompanied by the formation of toxic substances to the body. In the colon, there is intense water absorption, stool formation.

The process of digestion takes place in stages in different parts of the digestive tract. He is under the constant control of neural and humoral mechanisms. The value of the central nervous system in the regulation of digestion has been studied by Pavlov, who made experiments on dogs with fistula of the salivary gland excretory duct and gastric fistula proved that saliva department, gastric reflex occur and are unconditioned alimentary reflexes. They relate mainly to the direct stimulation of receptors food oral, esophageal, stomach. Arisen in the receptors on sensory nerves excitation transmitted to the medulla oblongata, where it is analyzed, and the impulse response by the centrifugal nerves directed to the working bodies (there is a separation of saliva, gastric juice and so on.). With the help of visual, auditory analyzers to external signs of food can be produced and conditioned reflexes. The work of the digestive system is controlled by the autonomic nervous system. In particular,

the parasympathetic division it stimulates gastric motility, intestinal, and sympathetic – depressing(Table5.6).

Table 5.6. Change of nutrients in the digestive tract

Part of the digestive tract, its secret	Nature of the change enzymes	Nutrients	pH	Products of splitting
Mouth cavity, saliva	Mechanical grinding of food, digestion of polysaccharides (glycogen, starch)	Ptyalin, maltase	Neutral	Dextrins (small fragments of molecules of polysaccharides), a small amount of glucose
Gastrer, gastricjuices	Break down proteins, milk curdling	Pepsin, chymosin	Acid	Peptides,coagulatedcasein
Duodenum, pancreaticjuice	Cleavage of proteins, peptides, carbohydrates, fats, DNA,RNA	RNA Trypsin, chymotrypsin, amylase, maltase, lipase nuclease	Alkaline	Pop guides, amino disaccharides, glucose, glycerin, fatty acids, nucleotides
Small intestine, the intestinal juice	Cleavage: disaccharide, fat splitting of fiber peptides, putrefaction of proteins, digestion of carbohydrates by the action of carboxypeptidase bacterial	Aminopeptidase, enterokinase maltase, sucrase, lactase, lipase	Alkaline	Free amino acids, glucose, fructose, galactose, glycerin, fatty acids
Largeintestine, intestinaljuice	Waterabsorption, stoolformation	–	Alkaline	Toxic substances (indole, skatole and others)

Humoral regulation due to release the gastric mucosa into the blood gastrin hormone which stimulates gastric acid secretion, biliary excretion, regulates motor activity of the stomach and intestines. Furthermore, hormones of the anterior pituitary, adrenal cortex affect the synthesis of digestive enzymes and absorption processes on intestinal motility.

Food hygiene is a set of measures providing conditions for normal digestion. It includes diet adherence, the use of diverse enough high-calorie, vitamin-rich food, and aimed at the prevention of gastrointestinal diseases caused by food toxins, pathogens, pathogenic protozoa, flat and round worms.

A person should observe good personal hygiene, to monitor the cleanliness of utensils, vegetables, fruit; use properly cooked food, do not drink unboiled water, and so on.

5.8. Metabolism

The metabolism in the human body is the set of all chemical transformations of substances from the receipt of the digestive tract to form the final decay products. It provides development, livelihoods, self-reproduction of the human body, its relationship with the environment and adaptation to environmental factors. The cells of the body with specific enzymes, reactions of synthesis of specific proteins, fats, carbohydrates, requiring the expenditure of energy. In parallel, the cleavage of organic compounds (peptides, amino acids, di- and monosugars, fatty acids and others). With the release of energy and form the final degradation products (water, carbon dioxide, ammonia, urea and lactic acid and others). Changes in the activity of enzymes that catalyze any stage of assimilation or dissimilation, leads to disruption of the metabolism of certain parts of the body, which is manifested in the form of specific diseases associated with impaired protein, carbohydrates, fat and mineral metabolism.

5.8.1. Exchange of proteins

The main route of metabolism of proteins is their enzymatic digestion into amino acids and the oxidation of the latter. This process begins in the stomach by the enzymes pepsin and chymosin, extends in the duodenum and ending at the small intestine by the enzymes of pancreatic and intestinal juice (trypsin, chymotrypsin, carboxypeptidase, enterokinase and others). Through the epithelial wall of the villi of the small intestine amino acids are absorbed into the bloodstream and are carried to the tissues. Some of them are used for the synthesis of tissue specific proteins, some splits to the final products with the release of energy (1 g protein is 17.6 kJ). All amino acids depending on their relevance to the essential body are divided into (valine, leucine, metiotsinand others) and nonessential (alanine, glycine, proline and others). Essential amino acids are not formed in the body and fed with food alone. Food proteins containing the entire set of amino acids, referred to as high-grade (legumes proteins, meat, milk, fish, eggs). The collapse of the amino acids occurs mainly in the liver and part of the kidney. In the liver, the ammonia is converted to urea

which is excreted through the kidneys and skin. Proteins are hardly deposited in the reserve. Therefore, protein starvation, the body uses proteins of the cytoplasm of cells, which leads to serious violations of nitrogen metabolism. When excess protein in food, they are converted into glycogen and fat. The daily protein requirement is 80 to 163 g depending on the profession.

5.8.2. Exchange of carbohydrates

The main sources of carbohydrates for humans are products of vegetable origin, rich in starch, glucose, fructose (potatoes, cereals, fruits, berries and others). Animal products contain fewer carbohydrates. Carbohydrates are the main source of energy (1 g - 17.6 kJ). In the gastrointestinal tract, they are broken down by enzymes (amylase, maltase, sucrose and others) To glucose, this is absorbed into the bloodstream. Cleavage of carbohydrates begins in the mouth and ends in the small intestine. The excess blood glucose leads to the accumulation of it in the form of glycogen in the liver, muscle involving hormone insulin. By increasing the body's need for energy glycogen is cleaved to glucose involving hormone glucagon. With excess glucose in the body of carbohydrates it can be used for the synthesis of fats. The daily human need for carbohydrates depends on the age of the work and ranges from 450 to 630.

5.8.3. Exchange of fats

Man receives food from animal fats (butter, beef and pork fat, lard and others) and plant (olive, sunflower, cotton seed and other oil) origin. Fats like carbohydrates are an important source of energy (1 g - 38.9 kJ). Fat lysis begins in the small intestine with bile emulsify them, and under the influence of lipase enzymes are broken down into glycerol and fatty acids, which are absorbed into the intestinal epithelial villus wall, where the primary fat synthesis characteristic of humans. They are absorbed into the lymph and are carried to tissues. Together with the fat in the body receives therein soluble vitamins (A, D, E and others). Excess fat deposited in the subcutaneous fat accumulates in the form of inclusions in tissue cells. Fats can be synthesized in the body from breakdown products of proteins and carbohydrates. The daily need of man in fats depends on the stage of its development, profession, lifestyle, and 100-150 of the obese weight fat can reach 50% of human body weight.

5.8.4. Water-salt metabolism

Exchange of water and mineral salts is a prerequisite of vital activity, as they create the internal environment of the organism, maintain osmotic pressure and acid-base balance of the blood plasma, tissue fluid. Water is included in all tissues and is up to 80% of the adult body weight. The daily human need for water is 2.5-3 liters. This need is provided by cooking water (1 L) and drinking water (1 L) and water produced in the body by metabolism of proteins, fats and carbohydrates (0.5 L). Excess water is eliminated from the body through the kidneys (1.2-1.5 L), sweat glands (0.5-0.7 L), the lungs (0.35 L) and bowel (up to 0,15L). Water balance in the body depends on the age. The highest content of its notes in the tissues of the child's body, and the aging of water decreases. All the necessary minerals a person gets from food. They are part of the bone, blood, muscle tissue, etc. Some mineral salts are contained in relatively large amounts (calcium, potassium, sodium, etc.), other - in small (iron, magnesium, etc.) and others - in minimal (copper, manganese, silicon, aluminum, silver, etc.). Mineral salts are constantly removed from the body through the kidneys, sweat glands, intestines.If insufficient intake of minerals in the body can occur severe disorders of mineral metabolism sometimes leading to death. The regulations of water-salt balance in the body play an important role hormones posterior pituitary - vasopressin, adrenal cortex - aldosterone, corticosterone.

5.8.5. Food standards

To ensure all the vital processes of the body must receive regular food nutrients in adequate quantities, provide the body's need of energy and plastic substances. The daily need for nutrients is determined by age, human gender, the sight of his employment, and therefore the set nutritional standards. In their preparation should be noted that the amount of protein, carbohydrate and fat in the daily diet should be in a ratio of 1: 1: 4. In a normal diet includes foods rich in proteins, fats (meat, fish, dairy products), carbohydrates and minerals (bread, vegetables, fruits, berries and others). The average daily rate of food must provide the person 2500-3000 kcal. In drawing up the rules of nutrition should take into account the content of vitamins in foods.

Vitamins are biologically active chemical substance of various natures, which, in minute quantities have a strong effect on the metabolism. The role of vitamins for the functioning of the body established by N.I.Lunin (1853-1937), C. Funk (1884-1967) and other scientists.All of them divided into water-soluble vitamins (C, group B and others) and fat-soluble (A, D, E, K and others). Water-soluble vitamins are rich in vegetable (rose hips, black currants,

gooseberries, nettles, onions, cabbage, etc.), Fat-soluble is animals (butter, liver, fish oil, eggs and others) products. There are several tens of vitamins that have specific effects on the human body (Table5.7). Most of these people

Table 5.7. Some of the vitamins necessary for human

Human	Dailyneedof vitamin	Products containing vitamin	Diseases caused by a lack of vitamin
B_1	2-3 mg	Wholemeal flour, egg yolk, cabbage, onions, carrots, apples, yeast, liver, kidney	Pathological changes in the nervous and the cardiovascular system (the disease beriberi)
B_2	1-2mg	Grains, liver, meat, milk, eggs	Blurred vision, damage to the oral mucosa
B_6	1,5-2,8 mg	Yeast, milk, eggs, beef	Anemia, disease of the skin (dermatitis), convulsions
B_{l2}	2-3 mcg	Liver, kidney	Malignant anemia, damage to the nervous tissue
C	50-100 mg	Fruits of black currant, cranberry, cabbage, tomatoes, onions, garlic	Potatoes, citrus Scurvy (damage to the connective tissue) reduced resistance to environmental factors
A	0,4-0,7 mg	Fish oil, eggs, butter, carrots, spinach	Night blindness, reproductive offspring violation
D	0,02 mg	Fish oil, liver, butter, eggs	Rickets (impaired calcium-phosphorus metabolism)

receiving food, only D and K vitamins are synthesized in the body. The daily need of man for vitaminsis very small but the long absence of their food appears diseases - beriberi. Vitamin A is essential for normal development of the epithelium of the skin, eyes, intestines. Deficiency leads to a violation of his ability to see at dusk (night blindness). Vitamin D is necessary for normal intestinal absorption of calcium and phosphorus. With its lack impaired bone development in the growing organism and manifests itself in the form of the disease (rickets). Vitamin E is involved in the normal reproduction in animals and human, its shortage leads to infertility. Vitamins accelerate biochemical reactions in the body; increase the activity of the hormones and enzymes that participate in the formation of digestive enzymes. They are widely used to improve the body's resistance to infectious diseases, environmental factors.

5.9. Excretory system

In the process of metabolism in the body decomposition products are formed. During accumulating they violate the constancy of the internal

environment of the body and impede its work. Isolation is the process of removing from the body of the final products of life, formed by the decay of organic matter (carbon dioxide, water, urea, uric acid, salt, acetone body and others). With the accumulation of these substances in the tissues there is a risk of poisoning and death of the organism (Figure5.14).

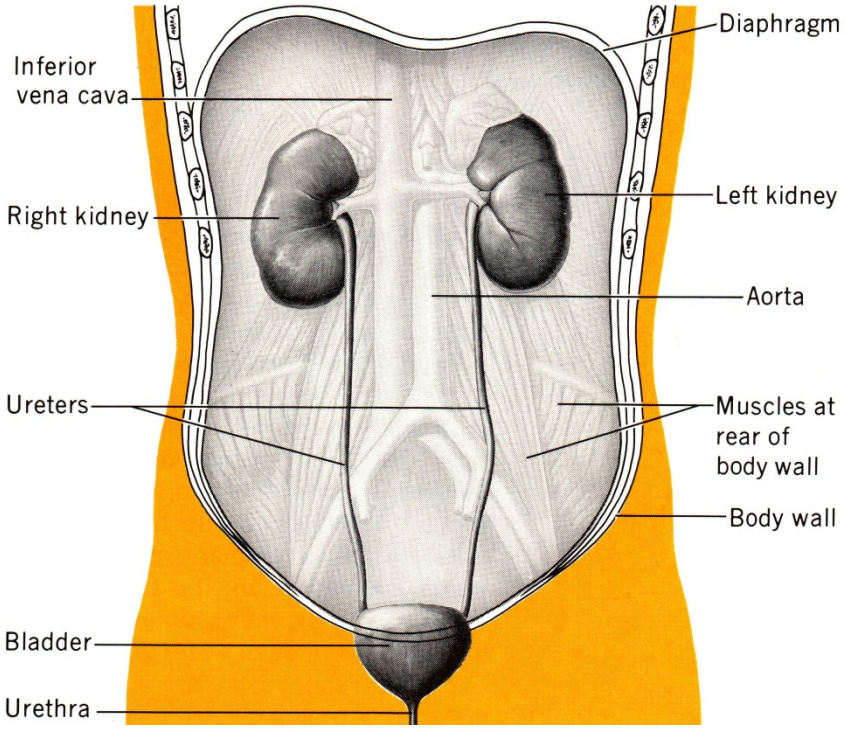


Figure 5.14. The human excretory system

The functions of removing the decay products carry the kidneys and lungs, intestines, sweat glands. This structure kidney bean-shaped organs pairs, about 10 cm in length, disposed on either side of the spine at the level of breast-XII, I and II of the lumbar vertebrae to the back wall of the abdomen. The right kidney is 2-3 cm below the left. On the inside, the concave side of the kidney is funnel-shaped cavity (renal pelvis), which departs from the ureter. This also suited the blood and lymph vessels, nerves, forming so-called gate of kidney. In kidney distinguish the outer (cortical) and internal (cerebral) layers. The cortical layer is disposed on the periphery of the kidney and in the form of columns divides the medulla 15-20 renal pyramids. Each pyramid base outwards and tip - to the renal pelvis. Cortical substance has a reddish-brown color, and the brain - a lighter. The structural and functional unit of the kidney is the nephron.

Nephron begins in the kidney cortex of a small capsule-shaped double-walled cup, inside which there is a ball capillaries (Figure5.15). Between the walls of the capsule there is a cavity from which begins uric canadian. He

squirms and then goes into the medulla called convoluted tubule of the first order. The medulla is rectified tubule forms a loop and returns to the cortex. Here he winds again, forming a convoluted tubule of the second order which flows into the brood in the collecting duct or tube. The last merge to form isa common duct. These ducts pass through the medulla to the tops of the pyramids and open into the cavity of the renal pelvis. The urine from the renal pelvis, ureters and enters them into the bladder.

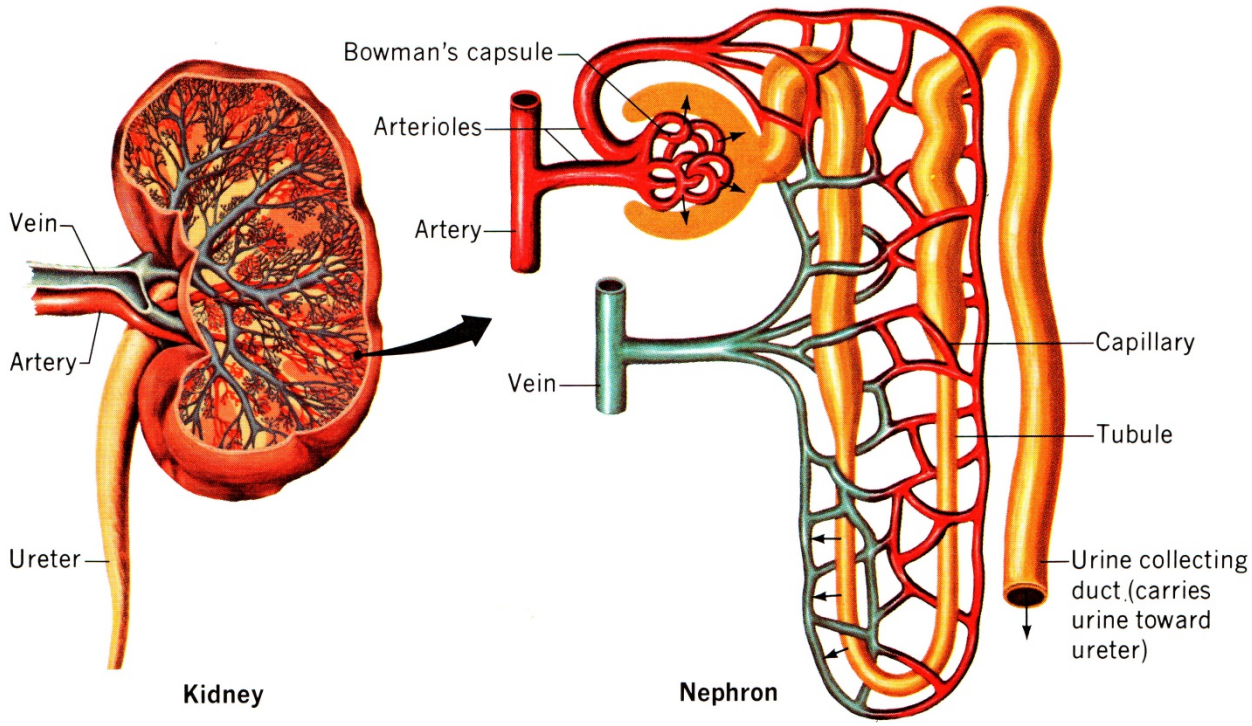


Figure 5.15. A kidney in longitudinal section with nephron

Small arteries, suitable to the capsule, called the bringer of the vessel. It breaks down in the capsule 50 of capillary loops, forming a ball**.** Glomerular capillaries gather in outflow vessel through which blood flows away from the glomerulus. Introducing a vessel coming from the glomerular capillaries, again branches into capillaries which are densely braid convoluted tubules of the first and second order, and then collected in a small vein. Recently, enlarge, form the renal vein which flows into the inferior vena cava. Urine formation proceeds in two phases. The first phase - the filter, there is a filtration substances brought by the blood in the cavity of the capsule of the nephron. High pressure in the glomerular capillaries is provided by a larger vessel lumen bearing than the outflow. In the cavity of the capsule from the blood plasma, flowing through the glomerular capillaries, and all filtered water soluble substance in plasma (inorganic substances, urea, uric acid, glucose, amino

acids), other than proteins. The liquid was filtered into the lumen of the capsule, called the primary urine. In the second phase the water absorption of glucose, amino acids and other organic compounds from the primary urine back into the blood. Uric acid is not absorbed and urea and their concentration in urine increases along the tubule. As a result of reabsorption secondary urine formed in the urinary tubules. The day passes through the kidneys 1500-1700l blood produced 150-170 liters of primary and secondary only 1-1.5 liters of urine. Urine output from the kidneys through the ureters (tube length of 30 cm and a width of 3.6 mm) opening into the bladder. It is a hollow muscular organ with a capacity of up to 750 ml.

Regulation of renal function has nervous and humoral mechanisms. The parasympathatic nerves dilate blood vessels and sympathatic - constrict. This is reflected in the rate of formation of primary urine reabsorption of water, inorganic substances from recycled urine. In addition, the pulses obtained from the kidney of higher nerve centers in the diencephalon. The absorption of water from the primary urine is enhanced by vasopressin - antidiuretic hormone, pituitary, and adrenal hormone epinephrine causes a decrease in the formation of urine, as it reduces the renal vessels. The hormone aldosterone of adrenal cortex controls the reabsorption of sodium and potassium salts in the tubules. To ensure proper kidney function should avoid alcohol, spicy foods, exercise caution when working with toxic substances. Meanings of allocation of metabolic products in the metabolic process of decomposition products are formed. Some of these substances are used by the body, while others are removed. Excreted through the lungs removed carbon dioxide, water, some of the volatile substance (alcohol and others). Allocates intestine is undigested food residues adopted, calcium salts, bile pigments, partly water and some other substances. Sweat glands are removed 5-10% of all end products of metabolism (water, salt, some amino acids, urea, uric acid and others). The main role in the excretory process belongs to the kidneys, which are removed from the body about 75% of end-products of metabolism (ammonia, urea, uric acid, alien and toxic substances produced in the body or made in the form of medicines, and others.). Kidney, displays the body of excess water and mineral salts, are involved in the regulation of blood osmotic properties.

5.10. Skin

5.10.1. The structure of the skin

Skin is the outer covering of the body is 1,5-2 m^2. The skin is formed by the epidermis, the actual skin (dermis) and subcutaneous fat. The epidermis - the surface layer of ectodermal origin of the skin formed by stratified epithelium. It distinguishes superficial and deep horn sprout (main) layers. The surface layer is composed of dead skin cells, which under the influence of environmental conditions constantly exfoliated in the form of flakes of dandruff and replaced by new ones. Germ layer is formed by rapidly dividing cells that contain melanin pigment. Ultraviolet rays intensify its education and deposition, causing the occurrence of sunburn. The biosynthesis of melanin is regulated by the hormone melanotropin which produces by middle lobe of the pituitary. Epidermal derivatives nails are formed by the elements of the stratum cornea. Fingernails grow continuously; pink color depends on their subungual vessels. Actually skin is a connective tissue of mesodermal origin, which lies below the epidermis. It has a lot of elastic fibers that give skin elasticity. In the dermis the hair follicles, sweat and sebaceous glands, blood and lymph vessels, different receptors (Kholodov, heat, pain, tactile) are located. Hair is horny derivatives dermis, consisting of a rod, the root of the hair bulb. The root and onion, surrounded by the hair bag. Due to the pro-bulb comes the growth of hair. Hair color depends on the amount of the pigment melanin which is the cessation of education leads to hair graying. Hair grows across the skin surface except the palms and soles.

Sweat glands - tubular glands are formed by glandular cells, secreting sweat - a watery fluid containing salts, urea, uric acid, ammonia and other substances. Excretory ducts of the glands open onto the surface of the skin and their bodies, having a form of glomeruli located in the dermis. Most of the sweat glands on the palms, soles, armpits. The volume of perspiration varies from 0.5 liters in cold weather, to 2.3 liters on a hot day. The sebaceous glands are formed multilayered epithelium, have the form of bubbles, excretory ducts that open into the hair bag. Sebum is composed of fatty acids, vitamins (A, D, E) and serves to lubricate the hair and skin. Subcutaneous adipose tissue is formed by loose connective tissue between the fibers which are located fat lobules. The accumulated fat in the subcutaneous tissue softens mechanical effects on tissues and organs, protects the body from hypothermia.

5.10.2. The skin's role in thermoregulation

Thermoregulation is a physiological response of the body to maintain optimum body temperature in a constantly changing ambient temperature. Skin

takes active part in maintaining a constant body temperature. An important role in this process belongs to the sweat glands, blood vessels of the skin and subcutaneous fat. Sweating occurs reflex. When the temperature of the medium excited by receptors in the skin that transmits impulses to the center of sweating, located in the medulla oblongata.Sweat secretion increases. In the evaporation of 1 g of sweat lost 2,436 kJ. The blood vessels of the skin at higher ambient temperature reflexively dilate and heat rises, and vice versa, with a decrease in ambient temperature skin blood vessels constrict. As a result of the loss of heat by the body decreases.

Subcutaneous fat is a poor conductor of heat, so the degree of its development depends on the body's ability to retain heat. At higher ambient temperatures isover 35° C, processes of heat impactbrokeswhich leads to heat or sunstroke. The victim frequent respiration, heart rate, headaches, nausea, vomiting, possible fainting. Heat stroke occurs when performing heavy physical labor in hot days with high humidity. Sunstroke can develop during long-term exposure to the sun with her head uncovered due to excessive exposure to infrared rays. Liquids occur burns with a sharp impact on the skin and surrounding tissues to direct sunlight or contact with burning or hot objects. The burns are characterized by redness and swelling of the skin, the appearance of blisters, long-term healing of ulcers. In some cases, it can cause burns to human death. When exposed to low temperatures, the skin in the winter or in continuous operation in the cold in wet clothes, shoes frostbite can occur. Frostbite characterized by paleness of the skin, swelling, occurrence of blisters, skin necrosis. Hardening is the process of improving the mechanisms of thermoregulation at the expense of development of conditioned reflexes in the cooling and overheating. Hardening is reduced to obligatory repetition factors (cold, heat, etc.) and increasing the duration of its effect. Fixed assets hardening - water, air and sun.Thus, a protective skin, excretory, sensitive and thermoregulatory functions. Health skin and clothing is a set of measures to ensure the normal functioning of the skin. The main requirement of skin hygiene - content it clean. Accumulate dirt on the skin makes it difficult function of sweat and sebaceous glands, which leads to dry skin, cracking it, heat violation, the development of diseases. It is necessary to protect the skin from the traumatic effects of mechanical, frostbite, and burns. Clothing should be comfortable, well retain heat and prevent heat transfer.

5.11. Features of breeding and development

Like all living organisms person is inherent in the ability of self-reproduction, so the preservation and continuation of the species. Start for a new body gives the zygote which is formed by the merger of the egg and sperm at fertilization. It is split up, growing and developing in the mother's body. After the birth of a child is need of proper care, providing its normal growth and development. The man, who is dioecious organism to multiply in the course of evolution formed male and female reproductive systems.

5.11.1. The structure of the reproductive system

Male reproductive system includes two testes, accessory genital glands, seminal vesicles, prostate, vas deferens and penis(Figure. 5.16). Testes is oval gland 3-5 cm long, 2-3 cm wide and weighing 15-30 g, are out of the body

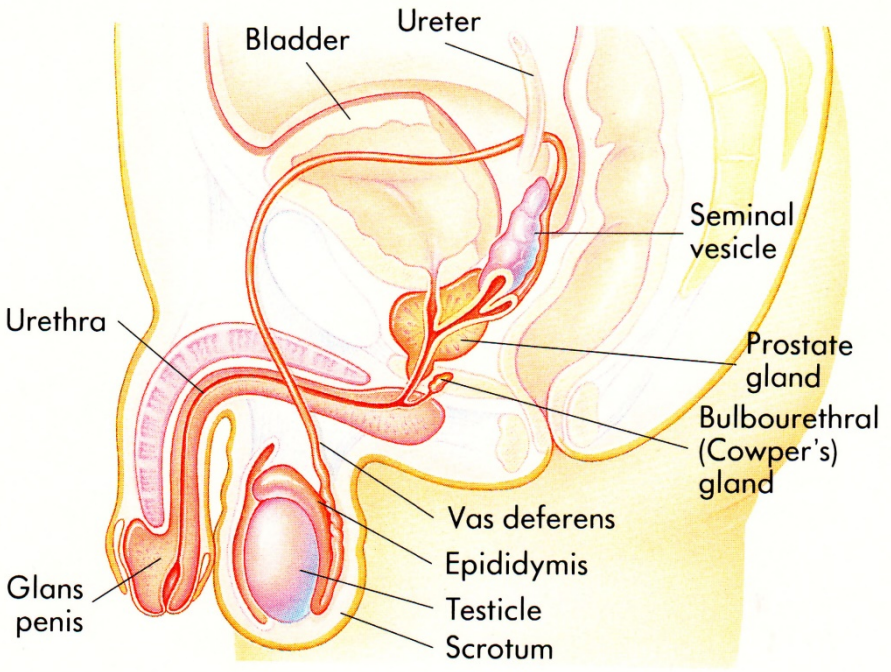


Figure 5.16. Male reproductive organs

cavity in a special skin and muscle formation – scrotum. They consist of thin convoluted tubules; in the cells that produce sperm and sex hormones (testosterone, androgens, and others.) has a stimulating effect on the growth of male sex organs and development of sexual characteristics. Accessory genital glands produce seminal fluid that is used to power and their sperm transport. The seminal vesicles and prostate gland produce secrets which, mixed with sperm to form semen. In one cm^3 sperm contains from 2 to 60 million

spermatozoa’s. The vas deferens coming out of the scrotum into the abdominal cavity and empties into the urethra. It serves to remove sperm.

Female reproductive system is formed by two ovaries, fallopian tubes, uterus and the vagina which are arranged in the pelvic cavity (Figure. 5.17). Ovary is 3-4 cm long, 2-2.5 cm wide and weighing 6,7 g, is composed of two layers. One of them - the cortex - is a place of formation of eggs, sex hormones (estrogen, progesterone); other - the brain - is represented by connective tissue, blood vessels and nerves. Each ovary immersed in fringed funnel passing into the fallopian tubes, or oviducts, and the opening to the uterus. The inner surface is lined with oviduct ciliated epithelium, cilia which, together with the contraction of the muscular wall of the fallopian tubes, pelvic and abdominal muscles to help the promotion of egg in the uterus.

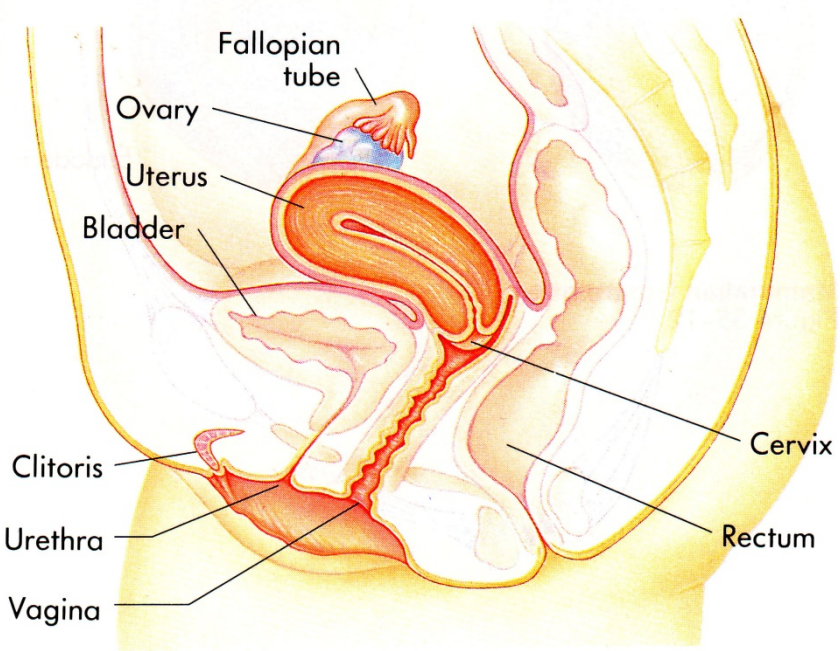


Figure 5.17. Female reproductive organs

Uterus is hollow muscular organ having a pear-shaped and lined the inside mucosa, rich in blood vessels. The narrow end of the uterus in the upper part of the vagina part, representing the continuous muscular tube whose walls are lined inside with soft, thin-skinned mucosa, susceptible to various infections. The entrance to the vagina is located between the folds of skin, called the labia, and closed the special connective septum, or hymen preventing until its rupture infection and contamination of the vagina. Just above the entrance to the vagina is the opening of the urethra. The cortical layers of the ovaries are not mature eggs, and their predecessors, surrounded by epithelial cells and were called primary follicles (vesicles). With the onset of puberty by the ovaries under the

influence of the pituitary hormone follicle matures one. First, it starts to bulge at the surface of the ovary, then its outer wall becomes thinner, bursts and immature egg is released from the follicle. Ovulation is break mature follicle and out of it into the abdominal cavity of immature egg. By reducing muscle oviducts immature egg falls through the funnel fringed in the fallopian tube, where as we move towards the uterus completes its maturation, which is accompanied by a special kind of division - meiosis. Simultaneously, the cavity is filled with the bursting of the follicle cells containing a fatty substance of yellow color, and is transformed into the corpus luteum, which plays the role of the endocrine glands. It produces special female hormones, delaying maturation following follicle of the uterus to embryo adoption. If matured cell is not fertilized, it dies within a few days, and the corpus luteal gradually ceases to resecrete hormones and resorbed. The mucous membrane of the uterus is torn away and pieces of it together with the blood flow to the vagina. This phenomenon is called menstruation. It lasts 3-5 days and is repeated approximately every 28 days. Fertilization occurs normally in the upper third of the fallopian tube. Sperm, trapped during intercourse in the vagina, because of their mobility to penetrate through the uterus into the fallopian tube and meet with the mature egg. One of the sperm is introduced into the egg and fertilizes it. The egg immediately after fertilization, the zygote begins fragmentation and development of the embryo. After 4-5 days embryo elastomers consisting of (128-132) is introduced in the uterine lining and fastened thereto. Next dividing cells of the embryo leads to a gradual increase in their numbers, and then by cell differentiation is the formation of various tissues and organs, the embryo begins during fetal development.

Because of the germ cells formed embryonic membranes. The outer shell has villi which are in contact with the wall of the uterus through the mother's body. Through them carried food and the breath of the embryo. Inside villous shell there is one, thin and transparent, called amniotic. It forms a bubble filled with liquid. The liquid bubble floats germ. By the end of the second month of fetal development villi stored only on the side of the embryonic membrane, which faces the uterus. These villi grow and branch out, plunging into the lining of the uterus, abundantly provided with blood vessels. Gradually formed a special body of the embryo, called "afterbirth" or "placenta". From this moment begins the fetal period of fetal development. The placenta looks like a disc firmly attached to the mucous membrane of the uterus. Her capillaries are in close contact with the blood of the mother's body, abundantly supplying the

uterus. However, the blood of mother and fetus never mixed. The fetus is connected to the placenta, umbilical cord only on vessels which his blood to the child seat. The resulting fetus receives from its mother of nutrients, oxygen and gives products of decomposition and carbon dioxide. The physiological process in the female body that is associated with the development of the unborn child, called pregnancy. It lasts an average of 280 days, or 9 months. This is facilitated by the placenta itself, which is the fourth month of pregnancy begins to play the role of the endocrine glands, highlighting the particular hormone, ensuring the preservation of the fetus in the uterus. After pregnancy comes childbirth - the physiological process of the expulsion of the fetus and placenta (placenta). By the time of birth the fetus in the uterus usually is upside down. For his birth it takes to the cervix is expanded enough space between the bones that form the pelvis of women increased, the amniotic sac burst and the liquid from u urn, flowed out through the vagina. Home birth is associated with the release of the pituitary hormone that causes strong uterine muscles. Then, cut the abdominal muscles, the child pushed into the pelvis, and is born, and then the doctor bandages and cuts the umbilical cord. Signs of pulmonary respiration is the cry of a child. Since then, the child's body's blood begins to be enriched with oxygen through the lungs. After 15-20 minutes the placenta along with the amniotic membrane is separated from and out of the uterus. Periods of post-uterine development Divide the following periods of post-embryonic development of the child: the neonatal period (the first 4 weeks after birth); chest (1 to 12 months); nursery (1 to 3 years); preschool (3 to 6 years); school, or during puberty (from 6 to 17 18 years); adulthood and aging period. The most intense, the child's growth and development observed in the first year of life and during puberty. the proportions of the body vary in the course of growth and development. For example, the ratio of head and body size of newborn 1: 4, whereas in adults of 1: 8. The main features of the person, as compared to animals, are the presence of thought, speech and motor activity, is closely related to employment. For the formation of these features it is very important to proper upbringing of children aged 2 to 4 years. The time interval from seven years to 18 years of age - a crucial period for the physical, mental and moral development of the person. During puberty develop secondary sexual characteristics under the influence of sex hormones (the totality of the features of the body structure and function of organs that distinguish one sex from the other). In girls they appears in the form of the breast, increasing the width of the hips, the deposits of subcutaneous fat, the appearance of menses and others.

The young men indicated the formation of a narrow pelvis, a stronger development of the skeleton, muscles, growth of whiskers and beard, changes in voice, appearance acting on the cartilage of the larynx ("Adam's apple") and others. The formation of the human body ends up to 22-25 years. During the period of maturity of a person is prepared to marry and reproduce. the aging period is characterized by a gradual decrease in the ability of cells to divide, the predominance of assimilation over dissimilation processes, the withering of sexual function, disturbance of the normal operation of all organ systems. The physical and mental labor, physical education, absence of bad habits (smoking, alcohol or drugs), personal hygiene contributes to the harmonious development of man and of his long life.

CONTENTS

Учебное издание

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БИОЛОГИЯ
ДЛЯ ИНОСТРАННЫХ ГРАЖДАН ПОДГОТОВИТЕЛЬНОГО ОТДЕЛЕНИЯ

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