Ministry of Education and Science of Ukraine
V.N. Karazin Kharkiv National University

MEDICAL BIOLOGY

IN TWO PARTS

PART II

Methodical instructions
for self-preparation of 1st year students of the School of Medicine
in the discipline «Medical biology»

Electronic resource

Kharkiv – 2025

UDC: 57: 61(072)
M 46

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Medical biology. In two parts. Part II: methodical instructions for independent work of
M 46 1st year students of the school of medicine in the discipline «Medical biology» [Electronic resource] / compil. S. O. Sherstiuk, S. A. Nakonechna, A. B. Zotova, S. I. Panov. – Kharkiv : V.N. Karazin KhNU, 2025. – (PDF 154 p.)

Methodical instructions for independent work of students in the discipline «Medical biology» developed in accordance with the current programs in Medical biology for students of medical faculties of universities. The manual is designed to work with students in preparation for the course «Medical biology». Each topic contains a list of practical skills and control questions. Topics are illustrated with drawings and diagrams that facilitate the perception of the material and promote its better assimilation. The materials allow students to form a correct understanding of the laws of the Medical biology.

For medical students.

UDC: 57: 61(072)

CONTENT

INTRODUCTION

Medical biology is the science of the foundations of human life, which studies the patterns of individual development and morphological adaptation to environmental conditions in connection with its biosocial essence and the influence of molecular genetic, cellular, ontogenetic, population, and environmental factors on human health.
I. The work program of the discipline «Medical biology» is compiled in accordance with the Standard of Higher Education of the second (master's) level of the field of knowledge 22 «Health care», specialty 222 «Medicine», approved by the Order of the Ministry of Education and Science of Ukraine dated 08.11.2021 No 1197, the Law of Ukraine «On Higher Education» No1556-VII dated July 1, 2014 (with amendments and additions); Regulations on the organization of the educational process at V.N. Karazin Kharkiv National University, approved by the decision of the Academic Council of V. N. Karazin Kharkiv National University (minutes of the meeting No 11 of June 21, 2024), educational and professional program and curriculum of the second (master's) level of higher education «Medicine», field of knowledge 22 «Health care» in specialty 222 «Medicine» for 2024-2025, approved by the decision of the Academic Council of School of Medicine of Kharkiv V. N. Karazin National University (minutes of the meeting No. 7/1 dated April 10, 2024); Statute of V. N. Karazin Kharkiv National University; Code of Values of V. N. Karazin Kharkiv National University and other regulatory normative documents.

II. The program of the discipline is structured into sections. The volume of the student workload is described in ECTS credits - credit credits, which are credited to students upon successful completion of the corresponding section (credit credit). Number of credits: 4. Total number of hours: 120.
III. The course of medical biology is divided into 5 sections:

Section 1. «Cytogenetics».
Section 2. «Classical Genetics».
Section 3. «Molecular Genetics. Mutations».
Section 4. «Medical Genetics. Population Genetics and Evolution».
Section 5. «Human Ecology. Medical Parasitology».

IV. Medical biology as an academic discipline: contains systematized scientific knowledge about the structural and functional organization of living matter and man as its integral component in terms of the needs of modern medicine.

The object of study of medical biology is biological objects and processes that can cause pathological conditions in humans.
The purpose of teaching this academic discipline is:
- to form in higher education students a complete understanding and assimilation of theoretical material on the basic principles and mechanisms of the functioning of the human body as a whole;

- understanding of the processes of a living organism at different levels - from membrane-cellular to systemic, organismal and biogeocenotic;
- acquiring skills in manipulating a living organism and assessing the state of individual systems and the organism as a whole;
- the ability to use acquired skills in clinical practice.

The final program learning outcomes include knowledge of medical biology, which will further form a qualified specialist and will become the main basis for the study of pathophysiological, pathomorphological processes of the body, clinical features and diagnostics of diseases.

The content of the course

Substantial module 4. «Medical Genetics. Population Genetics and Evolution»

Topic 16. Reproduction. Ontogenesis. Regeneration. Transplantation. Types of reproduction: asexual, sexual, and virginal (parthenogenesis). Structure of gametes. Fertilization. Human reproduction. Ontogenesis: types, stages. Embryonic development of human. Differentiation. Gene regulation during ontogenesis. Critical periods of development. Teratogenesis. Teratogenic factors of environment. Minamata disease. Congenitaldefects of development. Classification of defects: hereditary, exogenous, and multifactorial; gametopathies, blastopathies, embryopathies, and fetopathies. Periods of postembryonic development of human. Biological rhythms: day-night, circadian, seasonal, and circannual; their importance. Old age as the final stage of human ontogenesis. Theories of aging. Gerontology and geriatrics.

Topic 17. Human Genetics. Twin Studies, Dermatoglyphics, Pedigree Analysis Methods of genetic investigations. Humans as a specific subject for genetic study: disadvantages and advantages. Twin studies. Concordance and discordance, coefficient of heredity. Dermatoglyphics. Dermal ridge patterns. Pedigree analysis: purposes, rules for pedigree construction, symbols, methods of pedigree analysis. Modes of inheritance of traits, criteria of inheritance of rare nuclear genes.

Topic 18. Single-Gene Disorders. Classification of hereditary diseases: single-gene disorders, chromosome disorders, multifactorial disorders, and mitochondrial disorders. Human molecular diseases (single-gene disorders). Classification of molecular diseases: disorders caused by defects in carbohydrate metabolism, in amino acid metabolism, in protein metabolism, in copper metabolism; enzymopathies; hemoglobinopathies; storage diseases. Phenylketonuria, hemoglobinopathies (sickle-cell anemia, thalassemia), hemophilia, color blindness, brachydactyly, and achondroplasia: genetic characteristics and mode of inheritance. Laboratory diagnostics of gene disorders. Molecular diagnostics; polymerase chain reaction. Screening.

Topic 19. Chromosome Disorders. Genetic Counseling. Chromosome nutations: structural and numerical chromosome aberrations, their mechanisms. Abnormal chromosomes. Mutations in sex and somatic cells, their importance. Mosaicism. Chromosome disorders (Down syndrome, Patau syndrome, Edwards syndrome, Klinefelter syndrome, Turner syndrome [Shereshevsky-Turner syndrome], trisomy X, cat's cry syndrome [cri du chat syndrome]), their main symptoms, laboratory diagnostics. Translocation Down syndrome. Cytogenetic method: karyotyping; normal and abnormal karyotypes. Detection of X- and Y-chromatin as a tool of diagnostics of some hereditary diseases. Genetic counseling. Prevention of inherited and congenital malformations. Prenatal diagnostics of hereditary diseases.

Topic 20. Population Genetics. Population genetics: subject and purposes. A species, a population, human population. Characteristics of population. Isolation, its role in speciation. Idealized population. Hardy-Weinberg law. Influence of mutations, selection and migration on the genetic structure of a population. Genetic drift. Founder effect. Types of mating in populations in the nature, their influence on a population. Inbreeding: causes and consequences. Usage of the Hardy-Weinberg equilibrium in medicine for analysing of the genetic structure of human populations. Topic for independent study.

Substantial module 5. «Human Ecology. Medical Parasitology»

Topic 21. Ecology and Biosphere. Poisonous organisms Ecology. Environment. Abiotic and biotic factors. Ecosystem. Human and biogeocenosis. Anthropogenic ecosystems; agrocenosis. Pharmaceutical drugs in food chains. Human ecology. Influence of anthropogenic factors on health. Stress. Adaptation of human to difficult environmental conditions. Biosphere, its structure and evolution. Anthropogenic migration of elements in environment. Ozone layer. Poisonous fungi, plants, and animals.

Topic 22. Introduction to Parasitology. Protozoans. Sarcodina Principles of classification of living beings. Binary nomenclature. Introduction to medical parasitology. Origin and evolution of parasitism. Ways of penetration of parasites into a host. Classification of parasites. Classification of hosts. Classification of vectors. Interaction between parasites and hosts. Characteristics and classification of protozoans (Protozoa). Phylum Sarcomastigophora, Class Rhizopoda (Lobosea). Entamoeba histolytica, Entamoeba coli, Entamoeba gingivalis. Distribution, morphology, life cycle of Entamoeba histolytica, ways of invasion, pathogenicity; laboratory diagnostics, and control of amebiasis. Different features of Entamoeba histolytica and Entamoeba coli. **Flagellates.** Characteristics of flagellates. The structure of a flagellum. Giardia lamblia [G. intestinalis, G. duodenalis; Lamblia intestinalis]: distribution, morphology, life cycle, ways of invasion, pathogenicity. Laboratory diagnostics and control of giardiasis [lambliasis, lambliosis]. Trichomonads: Trichomonas vaginalis, Trichomonas hominis [T. intestinalis] and T. tenax. Leishmania tropica (old name: L. tropica minor), L. major (old name: L. tropica

major), L. donovani, and L. infantum: distribution, morphology, life cycle, ways of invasion, pathogenicity. Trypanosoma brucei gambiense, T. brucei rhodesiense, and T. cruzi: distribution, morphology, life cycle, ways of invasion, pathogenicity.

Topic 23. Sporozoans. Infusorians. Methods of Diagnostics of Protozoan Diseases Characteristic, structure and reproduction of Sporozoa. Malarial plasmodia Plasmodium vivax, P. ovale, P. malariae, and P. falciparum. Toxoplasma gondii: medical geography, morphology, life cycle, ways of infection, pathogenic influence. Characteristic of infusorians. Nuclear dualism. Sexual process in infusorians. Balantidium coli: medical geography, morphology and life cycle, ways of infection, pathogenic influence. **Flatworms. Flukes:** Fasciola hepatica, Opisthorchis felineus, Clonorchis sinensis, Dicrocoelium dendriticum, and Metagonimus yokogawai Classification of Plathelminthes. General characteristic of the phylum Plathelminthes and class Flukes. Role of covering (tegument). Systems of organs. Developmental stages, morphology of larvae. Parthenogony. Changing of hosts. Adaptation of parasites to hosts. Liver fluke Fasciola hepatica, Siberian liver fluke Opisthorchis felineus, Chinese liver fluke Clonorchis sinensis, lancet fluke Dicrocoelium dendriticum [D. lanceatum], and Metagonimus yokogawai: medical geography, morphology and life cycle, mode of invasion, pathogenic influence. Laboratory diagnostics and prevention of fascioliasis, opisthorchiasis, clonorchiosis, dicrocoeliasis (dicrocoeliosis) and metagonimiasis.

Topic 24. Flukes: Paragonimus ringeri, Schistosoma spp., and Nanophyetus salmincola. **Tapeworms:** Diphyllobothrium latum Lung fluke Paragonimus ringeri [P. westermani]; blood flukes – Schistosoma mansoni, S. haematobium, and S. japonicum; Nanophyetus salmincola [Troglotrema salmincola]: medical geography, morphology and life cycle, mode of invasion, pathogenic influence. Laboratory diagnostics and prevention of paragonimiasis, schistosomiases and nanophyetiasis. Comparative characteristic of flukes. General characteristic of tapeworms. Types of larvae: solid larvae and fluid-filled cysts. The changes in morphology associated with transition to parasitism. Broad tapeworm [fish tapeworm, late tapeworm, Swiss tapeworm] Diphyllobothrium latum: medical geography, morphology and life cycle, mode of invasion, pathogenic influence. Laboratory diagnostics and prevention of diphyllobothriasis.

Topic 25. Cyclophyllidean. Tapeworms Beef tapeworm [unarmed tapeworm] Taenia saginata [Taeniarhynchus saginatus], pork tapeworm [armed tapeworm] Taenia solium, dwarf tapeworm Hymenolepis nana: medical geography, morphology and life cycle, mode of invasion, pathogenic influence. Laboratory diagnostics and prevention of beef tapeworm infection, pork tapeworm infection, cysticercosis, and hymenolepiasis. Differential diagnosis of taeniid infestations. Dog tapeworm [caseworm] Echinococcus granulosus and Echinococcus multilocularis [Alveococcus multilocularis]: medical geography, morphology and life cycle, mode of invasion, pathogenic influence. Laboratory diagnostics and prevention of echinococcosis and

alveococcosis. Special treatment of echinococcosis and alveococcosis, which is associated with biology of causative agents. Comparative characteristic of tapeworms according to their danger.

Topic 26. Oviparous Nematodes. General characteristic of roundworms. Special features of life cycles of nematodes associated with molting of larvae. Aromorphoses in roundworms' evolution. Giant intestinal roundworm [maw worm] Ascaris lumbricoides, whipworm Trichuris trichiura [Tricho-9 cephalus trichiurus], old world hookworm [assassin worm, tunnel worm] Ancylostoma duodenale, new world hookworm Necator americanus, dwarf threadworm Strongyloides stercoralis, and pinworm [seatworm, threadworm] Enterobius vermicularis: medical geography, morphology and life cycle, mode of invasion, pathogenic influence. Migration of larvae. Special features of life cycle of dwarf threadworm. Laboratory diagnostics and prevention of ascariasis, trichuriasis [trichocephaliasis, trichocephalosis], ancylostomiasis, necatoriasis, strongyloidosis and enterobiasis. Treatment and prophylactic measures in the case of enterobiasis. **Viviparous Nematodes.** Methods of Diagnostics of Helminthoses. Segmented Worms: Medicinal Leech Pork worm [trichina] Trichinella spiralis: medical geography, morphology and life cycle, mode of invasion, pathogenic influence. Natural and synanthropic foci of trichinosis. Laboratory diagnostics and prevention of trichinosis [trichinelliasis, trichinellosis, trichiniasis]. Rodents and methods of deratization. «Larva migrans disease»: Toxocara canis and Ancylostoma braziliense. Dragon worm [guinea worm, Medina worm, serpent worm]. Dracunculus medinensis, Bancroft's filaria Wuchereria bancrofti, Brugia malayi, blinding filaria Onchocerca volvulus, eye worm Loa loa, Dirofilaria immitis and D. repens: medical geography, morphology and life cycle, mode of invasion, pathogenic influence. Circadian rhythm of larvae of filariae. Laboratory diagnostics and prevention of dracunculiasis [dracunculosis, dracontiasis] and filariases (bancroftian filariasis [bancroftosis], brugian filariasis (Malayan and Timorian filariases), onchocerciasis [onchocercosis], loiasis [loaiasis], and dirofilariasis). Special features of diagnostics and treatment of dracunculosis. Transmissible helminthoses and helminthoses characterized by natural foci. Mollusks, arthropods and chordates as intermediate hosts of helminths. Importance of arthropods in the life of nematodes. The principles and procedures of microscopic diagnostical methods for investigation of excrements, water, soil, etc. Scatological analysis: method of native smear, Kato's technique, Fülleborn's method, Graham's method (adhesive tape), their advantages and disadvantages. Special features of the structure of eggs of flukes, tapeworms, and roundworms. Microscopic examination of urine, blood, and phlegm on helminthoses. Method of trichinelloscopy. Immunodiagnosis of helminthoses. K. I. Skryabin's doctrine on deworming, devastation, and disinfection of environments (elimination of eggs and larvae of helminths). Characteristic of the phylum Annelids (Latin name Annelida) and class Hirudinea. Leeches. European medicinal leech [German leech, Swedish leech]. Hirudo medicinalis: biology, usage in medicine.

Topic 27. Arthropods. Arachnids. Ticks and Mites General characteristic of Arthropods. Classification of the phylum Arthropoda and the class Arachnida. Special features of morphology, feeding, and reproduction of arachnids. Poisonous arachnids (scorpions, spiders). Karakurte Latrodectus tredecimguttatus, black widow spider Latrodectus mactans, wolf spider Lycosa sp. Medical importance of ticks and mites as vectors of causative agents of diseases. Ticks that are vectors of diseases: systematics, life cycles, hosts. Transovarial way of transmission of causative agents. Ixodid ticks (hard ticks, ticks of the Ixodidae family): taiga tick Ixodes persulcatus, castor-bean tick I. ricinus, brown dog tick Rhipicephalus sanguineus, Pacific Coast tick Dermacentor occidentalis, and Hyalomma marginatum. Argasid ticks (soft ticks, ticks of the Argasidae family): Ornithodorus spp. Mites of the Gamasoidea superfamily, Dermanyssidae family: tropical rat mite Ornithonyssus bacoti and house mouse mite Allodermanyssus sanguineus. Diseases that are transmitted by ticks and mites. Mites of the order Acariformes as causative agents of diseases. The Sarcoptidae family: itch mite [mange mite]. Sarcoptes scabiei – morphology, life cycle, pathogenic influence, diagnosis and prevention of scabies [sarcoptic mange]; Norwegian scabies [Norwegian itch]. The Demodicidae family: follicle mite Demodex folliculorum – morphology, pathogenic influence, diagnosis and prevention of demodicosis [demodectic mange]. The Epidermoptidae [Pyroglyphidae] family: house dust mites (Dermatophagoides pteronyssinus and others) as inhabitants of houses, their medical importance.

Topic 28. Insects: Lice, Cockroaches, Bugs, Fleas. General characteristic of the class Insecta. Special features of morphology, feeding, and reproduction of in-sects. Types of mouthparts and types of legs of insects. Progressive and regressive changes in the organization of insects depending on habitat. Types of development of insects (with complete and incomplete metamorphosis); development of an insect in a pupal form. Lice: morphology, life cycle, feeding. Head louse Pediculus humanus capitis [Pediculus capitis], clothes louse Pediculus humanus humanus [Pediculus humanus corporis, Pediculus vestimenti], and crab louse [pubic louse] Phthirus pubis [Phthirus inguinalis]. Medical importance of lice; modes of invasion of a man with transmitted diseases. Control of lice. Cockroaches, bugs (bed bugs and triatomine bugs), and fleas: morphology, development cycles, and modes of feeding. German cockroach Blattella germanica, oriental cockroach Blatta orientalis. Bed bug [bedbug] Cimex lectularius and big bedbug [giant bed bug] Triatoma sanguisuga. Human flea Pulex irritans and rat flea Xenopsylla cheopis. Medical importance of cockroaches, bugs and fleas, their role as infection vectors; modes of invasion of a man with diseases. Control of cockroaches, bugs, and fleas.

Topic 29. Dipterans. Medical Importance of Arthropods. General characteristic of the order Diptera. Differences between flies and mosquitoes. Blood-sucking insects: characteristic, importance as intermediate hosts of helminths and vectors of infectious diseases. Dermatozoonoses. The Culicidae family: malaria mosquito Anopheles and mosquitoes that do not transmit malaria (Culex, Aëdes, Mansonia, Culiseta). The Simuliidae family (black flies): black fly [sand fly, buffalo

gnat] Simulium. The Phlebotomidae [Psychodidae] family (sand flies): sand fly Phlebotomus papatasii, Lutzomyia. The Ceratopogonidae family (midges [biting midges]): Culicoides. Morphological features of mosquitoes and flies, breeding places, medical importance (mosquito-bite dermatitis, mosquito-borne diseases). The Muscidae family: housefly [house fly, common house fly, typhoid fly] Musca domestica, little housefly Fannia canicularis, stable fly Stomoxys calcitrans. The Sarcophagidae family (flesh flies): Wohlfahrtia magnifica. The Tabanidae family (tabanids, gadflies): horse fly [gadfly] Tabanus, deer fly Chrysops, rainfall tabanid Haematopota pluvialis. The Glossinidae family: tsetse fly Glossina. The Oestridae family (nostril flies, botflies): bot fly Oestrus ovis, warble fly Hypoderma bovis. Myiases. Control of bloodsucking dipterans. Usage of DDT, repellents, electrically heated fumigation mats, Gambusia fish. Control of flies that are mechanical vectors of diseases. Medical importance of arthropods: arthropods as intermediate and final hosts of parasites, as causative agents and vectors of diseases, poisonous arthropods; usage of products of apiculture. Examples of anthroponotic and zoonotic diseases, diseases with natural focus, transmissible diseases, natural reservoirs and vectors.

Practical skills from the course «Medical Biology».
Preparation for the licensing exam «KROK-1».

Thematic plan of practical lessons.

	Unit 4.	
16.	Reproduction. Ontogenesis. Regeneration. Transplantation	2
17.	Human Genetics. Twin Studies, Dermatoglyphics, Pedigree Analysis	2
18.	Single-Gene Disorders	2
19.	Chromosome Disorders. Genetic Counseling	2
20.	Population Genetics	2
	Unit 5.	
21.	Ecology and Biosphere. Poisonous organisms	2
22.	Introduction to Parasitology. Protozoans. Sarcodina. Flagellates. Methods of Diagnostics of Protozoan Diseases.	2
23.	Sporozoans. Infusorians. Flatworms. Flukes: Fasciola hepatica, Opisthorchis felineus, Clonorchis sinensis, Dicrocoelium dendriticum, and Metagonimus.	2
24.	Flukes: Paragonimus ringeri, Schistosoma spp., and Nanophyetus salmincola. Tapeworms: Diphyllobothrium latum.	2
25.	Cyclophyllidean Tapeworms. Laboratory diagnosis of helminth infections.	2
26.	Oviparous Nematodes. Viviparous Nematodes. Segmented Worms: Medicinal Leech. Laboratory diagnosis of helminth infections.	2
27.	Arthropods. Arachnids. Ticks and Mites.	2
28.	Insects: Lice, Cockroaches, Bugs, and Fleas.	2

29.	Dipterans. Medical Importance of Arthropods.	2
	All	**58**

Types of individual work of students

	Unit 4.	
15	Stem cells, prospects for their use in medicine. Immunological method, somatic cell hybridization method.	**1/2**
16	Molecular genetic mechanisms of ontogenesis. Experimental study of embryonic development. The problem of determination and interaction of blastomeres. Embryonic induction. Regulation in the crushing process and its violation.	**1/2**
17	Evolution of the sexual process. Peculiarities of human reproduction in connection with its biosocial essence. Peculiarities of the postnatal period of individual human development in connection with its biosocial essence.	**1/2**
18	Regeneration and its types: physiological and reparative. The importance of regeneration for the homeostasis system. Transplantation and immunity. Types of tissue transplantation. Transplant rejection, ways to overcome rejection.	**1/2**
19	Evolutionary teaching. Phylogeny of the main organ systems of vertebrates. Development of evolutionary theories. Views of Lamarck and Darwin on evolution. Synthetic theory of evolution. Factors of evolution. Teaching about macro- and microevolution. Peculiarities of the action of evolutionary factors in human populations.	**1/2**
20	Relationship between ontology and phylogeny. Biogenetic law (F. Muller, E. Haeckel), its interpretation by O. Severtsov. Human evolution; evidence of the evolutionary origin of man. Human races as a reflection of adaptive patterns of human development. Criticism of racism.	**1/2**
	Total	**3**
	Unit 5.	
21	The origin of human. Human races as a reflection of the adaptive patterns of human development. Human ecology. The main provisions of V. I. Vernadskyi's teaching on the organization of the biosphere. Modern concepts of the biosphere. Evolution of the biosphere. Humanity as an active geological force. Anthropogenic migration of elements. Ozone Layer.	**1**
22	Noosphere; protection of the biosphere in national and international scientific programs; concepts of biofield and biological rhythms; valeology Characteristics of mushrooms, plants and animals poisonous to humans.	**1**

23	Outstanding scientists-parasitologists: V. O. Dogel, V. M. Beklemishev, E. N. Pavlovsky, K. I. Skryabin, O. P. Markevich, L. V. Gromashevskyi, and others.	**1**
24	Methods of laboratory diagnosis of diseases caused by parasitic protozoa. Material taken for the diagnosis of protozoa. Cultivation of Leishmania on an artificial nutrient medium. Endemic and naturally occurring diseases.	**1**
25	Blood mammals are the causative agents of human parasitic diseases. Therapeutic and preventive measures in the prevention of infectious diseases. Circadian rhythms of viviparous nematodes. Molluscs, crustaceans, insects and chordates are intermediate hosts of helminths. The importance of arthropods in the life of nematodes.	**1**
26	Transmissible and naturally occurring helminthiasis. Coprological analysis. Principles and content of the main macro- and microhelminthoscopy methods of examination of feces, water, soil, etc. Methods of ovohelminthoscopy: native smear, thick smear according to Kato, Fülleborn and Kalantarian methods, Graham's method (sticky tape): essence, advantages and disadvantages.	**1/2**
27	Microscopic examination of urine, blood and sputum for helminthiasis. Immunodiagnostics of helminth infections. K. I. Scriabin's teachings on deworming, devastation and decontamination of the environment from helminth eggs and larvae.	**1/2**
28	Ticks are inhabitants of human homes and their medical importance. Principles of determining the species of an unknown organism using identification tables. Methods of fighting cockroaches, bedbugs and fleas.	**1**
29	Gnus and its components: characteristics, importance as intermediate hosts of helminths and carriers of pathogens of human diseases. Methods of combating blood-sucking Diptera. Use of DDT.	**1**
	Total	**8**

Substantial module 4. «Medical Genetics. Population Genetics and Evolution»

Topic 16. Reproduction. Ontogenesis. Regeneration. Transplantation.

Reproduction- is self-reproduction, the ability of organisms to form their own kind, increasing the number of cells or organisms. This is the most important property of living things, a necessary condition for the existence of the species and the succession of successive generations in the middle of the species.

The classification of forms of reproduction is based on the division of cells: asexual (mitotic) and sexual (meiotic). Forms of reproduction can be provided in the form of the following scheme:

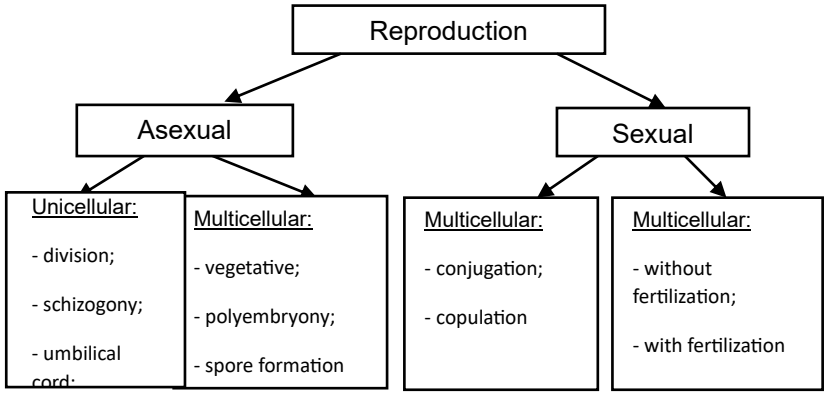


Fig. 1. Reproduction scheme.

Asexual reproduction of unicellular organisms

In unicellular plants and animals there are the following forms of asexual reproduction: binary division, endogonia, multiple division (schizogony) and umbilical cord.

Binary division characteristic of unicellular (sarcoid, flagellar, ciliates). First, there is a mitotic division of the nucleus, and then in the cytoplasm there is a constriction, which eventually divides the cells into two. In this case, the daughter cells receive an equal amount of information. Organoids are usually evenly distributed.

Schizogony, or multiple division - form of reproduction, which occurs in unicellular organisms, for example, in the causative agent of malaria - Plasmodium falciparum. In schizogony, the nucleus is repeatedly divided without cytokinesis, and then the entire cytoplasm is divided into particles, concentrating around the nuclei. From one mother cell many daughters are formed at once.

Umbilical cord is where the mother cell first forms a small tubercle (navel), which contains a nucleoid. The navel grows, reaches the size of the mother's face and then separates from her. This form of reproduction is observed in yeast, and among unicellular animals - in sucking ciliates.

Spore formation occurs in some unicellular animals and bacteria. Spores as one of the stages of the life cycle consists of cells with a shell that protects against adverse environmental conditions. Spores in plants are one way of asexual reproduction.

Asexual reproduction of multicellular organisms

*At **vegetative reproduction*** in multicellular animals, a new organism is formed from a group of cells that separate from the mother organism. Vegetative reproduction occurs only in the most primitive multicellular animals: sponges, some intestinal, flat and ring worms.

A special form of vegetative reproduction is to recognize ***polyembryony,*** in which the embryo is divided into several parts, each of which develops into an independent organism. Polyembryony is common in wasps (riders), which lead a parasitic lifestyle in the larval stage, among mammals - in armadillos. This category of phenomena includes the formation of monozygotic twins in humans and other mammals.

Spore formation is known in many eukaryotes (mushrooms, algae, ferns, plantains, horsetails). In plants and fungi, spores are formed in specialized organs - sporangia. Spores of plants and fungi, in contrast to spores of bacteria, serve not only to survive the unfavorable period and spread, but also to reproduce.

Sexual reproduction characterized by the presence of a sexual process - the fusion of two gametes. The formation of gametes in multicellular organisms is preceded by a special form of cell division - meiosis. As a result of meiosis, gametes are formed that have not a diploid but a haploid set of chromosomes. Therefore, in the life cycle of organisms that reproduce sexually, there are two phases - haploid and diploid. The duration of these phases in different groups of organisms is different: in fungi, mosses and some protozoa is dominated by haploid, in higher plants and multicellular animals - diploid. The biological significance of meiosis is given below.

Various forms of sexual process in unicellular organisms can be combined into two groups: conjugation, in which special germ cells (sexual individuals) are not formed, and gametic copulation, when sexual elements are formed and they are paired.

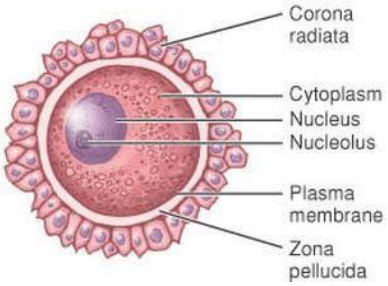
Conjugation - a peculiar form of sexual process, which is characteristic of ciliates - animals such as Protozoa. Their characteristic feature is the presence of two nuclei: a large nucleus and a small micronucleus. Infusoria usually reproduce by division in half, with the micronucleus dividing mitotically. During the sexual process - conjugation - ciliates come together in pairs, a cytoplasmic bridge is formed between them. In the nuclear apparatus of each of the partners, the macronucleus dissolves, and from the micronucleus as a result of meiosis, four haploid nuclei are formed, one of which divides by mitosis (the other three are destroyed), and stationary and migrating nuclei are formed. Each of them contains a haploid set of chromosomes. The migrating nucleus passes into the cytoplasm of the partner. In each of them, the stationary and migrating nuclei merge to form the so-called syncarion (Gr. Syn - together, karyon - nucleus), which contains a diploid set of chromosomes. After a series of complex rearrangements, ordinary macronucleus and micronucleus are formed from syncarion.

After conjugation, the ciliates diverge, each of them retains its independence, but due to the exchange of karyoplasm, the hereditary information of each individual changes, which, as in other cases of sexual intercourse, can lead to new combinations of properties and characteristics.

Copulation is called the sexual process in unicellular organisms: two individuals acquire the properties of gametes and merge to form a zygote. When two sex cells of the same structure merge, this process is called isogamy (some algae, protozoa, etc.). Fusion of male and female gametes, which differ in shape, size and structure (anisogamy), occurs more often. If the female gamete (egg) is large, immobile, and the male (sperm, sperm) is much smaller, then this form of anisogamy is called oogamy (multicellular animals, plants, some fungi).

The structure of gametes (gametes).

Gametes are highly differentiated cells. In the process of evolution, they have adapted to perform specific functions. The nuclei of both male and female gametes contain the same hereditary information that is necessary for the development of the organism. However, other functions of the egg and sperm are different, so they are very different in structure.



Oocytes immobile, have a spherical or slightly elongated shape. They contain all the typical cellular organelles, but differ in structure from other cells, because they are adapted to realize the possibility of development of the whole organism. Eggs are much larger than somatic cells.

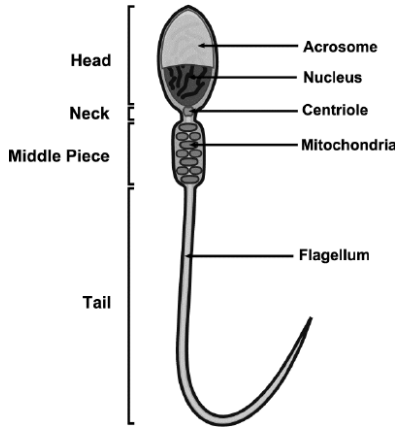
Fig. 2. Oocyte.

The intracellular structure of the cytoplasm in them is specific to each species of animal, which provides species (and often individual) features of development. The eggs contain a number of substances that are necessary for the development of the embryo. These include nutrients (yolk). In some species of animals, so much yolk accumulates in the eggs that they can be seen with the naked eye (eggs of fish and amphibians, eggs of reptiles and birds). Of modern animals, the largest eggs are in the herring shark (29 cm in diameter). In birds, what is called "yolk" in everyday life is considered an egg;

For example, the diameter of a mouse egg is 60 μm, and that of a cow is 100 μm. The human egg is 130–200 μm in diameter. Oocytes are covered with shells that perform a protective function, provide the necessary type of metabolism, in placental mammals are used to connect the embryo with the uterine wall, as well as perform other functions.

*Sperm (sperm)*have the ability to move, which to some extent provides the opportunity to meet gametes. In terms of external morphology and small amount of cytoplasm, sperm are very different from other cells, but they have all the major organelles. A typical sperm has a head, neck and tail. At the front end of the head is an acrosome, which consists of a modified Golgi complex. The bulk of the head is

occupied by the nucleus. In the neck are the centrioles and the spiral thread formed by mitochondria.



Examination of sperm under an electron microscope revealed that the cytoplasm of the head has not a colloidal but a liquid-crystalline state. This achieves the resistance of sperm to adverse environmental conditions. For example, they are less damaged by ionizing radiation than immature germ cells.

Sperm size is always microscopic. They are the largest in newts - about 500 microns, in domestic animals (dog, bull, horse, sheep) - from 40 to 75 microns. The length of human sperm varies between 52-70 microns.

Fig. 3. Spermatozoon.

All sperm have the same (negative) electric charge, which prevents them from sticking together. Animals have a lot of sperm. For example, during sexual intercourse, a dog secretes about 60 million of them, a ram - up to 2 billion, a stallion - up to 10 billion, a man – about 200 million.

Thus, germ cells are significantly different from somatic cells:

- in germ cells a haploid set of chromosomes, in somatic cells - a diploid one;
- in germ cells the nuclear-cytoplasmic ratio is different: in sperm it is high, in the ovum - low;
- the shape and size of germ cells are different than in somatic;
- germ cells have a low level of metabolic processes;

oocytes are characterized by cytoplasmic segregation (regular redistribution of cytoplasm after fertilization).

Fertilization.

Sexual reproduction of animals and plants is accompanied by fertilization - the fusion of two gametes: male and female. As a result, a fertilized egg is formed - a zygote, which gives rise to the development of a new generation of organisms. There are two methods of fertilization: external and internal. Almost all aquatic vertebrates (fish, amphibians, etc.) lay eggs (eggs) and sperm in the water, where fertilization takes place. Exceptions are aquatic mammals (pinnipeds, cetaceans), live-bearing fish and some amphibians, which are characterized by internal fertilization.

In terrestrial animals, fertilization occurs in the female's reproductive system, and the embryo develops either in the middle of its body (intrauterine development in mammals) or in eggs covered with a shell (insects, reptiles, birds, oviparous mammals). Eggs are warmed by the heat of the mother, sunlight or heat released by the decay of

organic residues. The embryo develops outside the body of the female, the egg contains large reserves of nutrients that ensure the development of the embryo.

During fetal development, the egg contains a minimum amount of nutrients.

In humans, fertilization can occur immediately after the egg completes the maturation stage. During this period, it is covered with a layer of follicular cells, containing a haploid set - 23 chromosomes.

During fertilization, two important processes occur: activation of the egg, ie excitation to development, and syncariogamy, ie the formation of the diploid nucleus of the zygote due to the fusion of haploid nuclei of germ cells, which carry the genetic information of the two parent organisms.

Biological essence of fertilization:

As a result of combining haploid sets of chromosomes, the diploid number of chromosomes is restored.

Fertilization ensures the continuity of the material connection between generations of organisms.

As a result of a combination of hereditary features of two organisms, new traits are formed in the offspring - there is material for selection, the variability of the offspring increases, the combinatorial variability increases.

Selectivity of fertilization (fertilization only within the species) ensures the preservation of the species as a whole.

Parthenogenesis.

A special form of asexual reproduction is ***parthenogenesis*** (from the Greek πάρθένος - virgin, γένεσις - birth), ie development from unfertilized eggs. This form of reproduction was discovered in the middle of the eighteenth century. Swiss naturalist S. Bonnet. Today not only natural but also artificial parthenogenesis is known.

Natural parthenogenesis characteristic of individual plants, worms, insects, crustaceans. In some animals, any egg can develop both without fertilization and after it. This is the so-called optional parthenogenesis. It is found in bees, ants, in which females develop from fertilized eggs and males from unfertilized ones. In these animals, parthenogenesis arose as a device for regulating the quantitative ratio of the sexes.

As obligatory, i.e. obligate parthenogenesis, eggs develop without fertilization. This type of parthenogenesis is known, for example, in the Caucasian rock lizard. This species has survived due to the emergence of parthenogenesis, because the meeting of two individuals living on rocks separated by deep crevices is difficult. Individuals of this species are currently represented only by females that reproduce parthenogenetically.

Artificial parthenogenesis was studied by O A Tikhomirov. He studied the development of unfertilized silkworm eggs by irritating them with a thin brush or acting with a weak solution of sulfuric acid for a few seconds. BL Astaurov in 1940-1960 developed an industrial method of obtaining parthenogenetic offspring in the silkworm.

Ontogenesis (from the Greek. on, genus, ontos - essence, and genesis - origin, origin) (individual development of the organism) - the process of development of the organism from its inception to the end of life. The term "ontogenesis" was introduced by the German zoologist E. Haeckel in 1866.

Ontogenesis has the following important characteristics:

- the presence of germ cell cells that give rise to gametes;
- individual development is carried out on the basis of genetic programs obtained by the zygote from the germ cells of the parents;
- *process dynamics,* during which the organism gradually changes its characteristics, remaining the same unified and integral system;
- due to the long process of phylogenetic development of each species;
- ontogenetic processes are characteristic of multicellular organisms, although some features are known for unicellular;
- ontogenesis in multicellular is due to progress, in which the state and conditions of the previous stage affect the events that occur in subsequent stages of development;
- all events of ontogenesis are closely connected with a certain space (body) and time (unidirectionality of processes).

There are several periodizations of ontogenesis. According to one of them, based on the ability to reproduce, ontogeny can be divided into: pre-reproductive, reproductive and post-reproductive periods.

Pre-reproductive period characterized by development from the zygote to the mature organism. During this period, the most complex morphological processes and functional transformations take place, most of the hereditary information is realized.

Reproductive period associated with the possibility of sexual reproduction. By this time, the body is fully phenotypically formed and has a stable functioning of all organs and systems.

Post-reproductive period characterized by the gradual aging of the body, weakening or complete cessation of reproduction. Regenerative and adaptive capabilities are gradually declining.

According to another periodization, based on embryogenesis, there are preembryonic (gametogenesis and fertilization), embryonic (after fertilization - zygote stage, blastula, gastrula and differentiated embryo) and post-embryonic (after birth and stage).

Pre-embryonic period also called progenesis (previous ontogenesis). The basis of progenesis is gametogenesis - the formation and formation of mature germ cells. No less important is fertilization.

Embryonic period begins from the moment of fertilization of an ovum. The period of embryonic development is divided into stages of zygote, blastula, gastrula and differentiated embryo. The process of fetal development of the human embryo lasts an average of 280 days.

Fertilization - the fusion of male and female gametes, resulting in the restoration of the diploid set of chromosomes characteristic of this species, and there is a qualitatively new cell - the zygote (fertilized egg, or unicellular embryo).

Fragmentation- sequential mitotic division of the zygote into cells (blastomeres) without the growth of daughter cells to the size of the mother. From surface blastomeres in the future there is a trophoblast, which connects the embryo with the mother's body and provides its nutrition. Internal blastomeres form an embryoblast, from which the embryonic body and some extraembryonic organs (amnion, yolk sac, allantois) are formed.

Crushing leads to the formation of a dense cluster of cells - morula, after which begins the formation of blastocysts - an empty bubble filled with fluid. The blastocyst is in the uterine cavity in a free state for two days, after which it descends into the uterus, where implantation begins.

Implantation (Latin implantatio - ingrowth, rooting) - the penetration of the embryo into the mucous membrane of the uterus. Simultaneously with implantation, gastrulation begins (formation of embryonic leaves).

Gastrulation (from the Latin gaster - stomach) - a complex process of chemical and morphogenetic changes, accompanied by reproduction, growth, directed movement and differentiation of cells, resulting in the formation of embryonic leaves: outer (ectoderm), middle (mesoderm) and inner (endoderm) - sources of rudiments of tissues and organs. One part of the cells turns into the rudiments of tissues and organs of the embryo, the other - into extraembryonic organs.

Embryonic histogenesis- the process of emergence of specialized tissues from poorly differentiated cellular material of embryonic rudiments. The result of histogenetic processes is the formation of major groups of tissues - epithelial, connective, muscular and nervous. Their formation begins in the embryonic period and ends after birth. The sources of post-embryonic tissue development are stem and semi-stem cells (non-differentiated cells with high potential for development and transformation into various specialized cells).

Ectoderm (epiblast) gives rise in particular to the epidermis and its derivatives, the epithelium of the oral cavity, trachea, lungs and bronchi, neurons and neuroglia of the brain and spinal cord and the like.

Differentiation of the primary endoderm leads to the formation of a single layer of epithelial epithelium of the stomach, intestines and their glands, epithelial structures of the liver and pancreas. Differentiation of the primary mesoderm gives rise to striated muscle tissue, bone and cartilage, skin dermis, renal epithelium, gonads, uterus, blood cells and more.

Thus, by the end of the embryonic period the bookmark of the basic embryonic rudiments of fabrics and bodies comes to an end and the embryo gets the

basic features characteristic of the person.

Human embryos before the formation of the rudiments of organs are called embryos, and later - the fetus. In the human fetus, the organs begin to function and organ systems are formed. There is a very rapid growth of the fetus. Prenatal development ends with childbirth, but before birth the body is under the protection of embryonic membranes and is unable to perform basic functions independently. Only after birth are connections established with the new environment and its autonomous existence.

Extraembryonic organs- these are organs that develop in the process of embryogenesis outside the body of the embryo, perform various functions, ensure the growth and development of the embryo. Some of these organs that surround the embryo are also called embryonic membranes. These organs include the amnion, yolk sac, allantois, chorion, placenta.

Amnion - a temporary organ that provides an aquatic environment for the development of the embryo, protects it from mechanical damage and prevents harmful agents from entering the fetus.

Yolk sac deposits nutrients (yolk) necessary for the development of the embryo, but this structure is involved in the nutrition of the embryo for a very short time, because from the third week of development the connection of the fetus with the mother's body is established. The first blood cells and the first blood vessels of the fetus are formed in the yolk sac.

Allantois in humans does not reach significant development, but its role in providing nutrition and respiration of the embryo is still great, because the vessels of allantois deliver oxygen, and allantois secretes metabolic products of the embryo. In embryogenesis, allantois is reduced and together with the shortened yolk sac is part of the umbilical cord.

Umbilical cord, or umbilical cord, connects the embryo (fetus) with the placenta and at the same time prevents the penetration of harmful agents from the placenta into the embryo.

The villi of the chorion or villi secrete proteolytic enzymes that destroy the mucous membrane of the uterus during implantation. Later, the development of the chorion takes place in parallel with the development of the placenta.

Placenta (*baby place)*consists of two parts: embryonic, or fetal, and maternal. The fetal part is represented by a branched chorion and an amniotic membrane attached to it from within, and the maternal part is represented by a modified mucous membrane of the uterus, which comes off during childbirth.

The main functions of the placenta: 1) respiratory, 2) transport of nutrients, water, electrolytes and immunoglobulins, 3) excretory, 4) endocrine, 5) participation in the regulation of myometrial contraction.

Post-embryonic period begins after birth. Contains a juvenile stage and an adult.

Juvenile period -the life of an individual begins from the moment of exit from

the embryonic membranes and ends with puberty and the beginning of reproduction. This period is characterized by intensive growth, the final development of the skeleton and the proportions of the body, the completion of the development of the reproductive system.

Adult period characterized by the stability of all organs and systems, sexual maturity and active reproduction. It also includes the period of old age, which is characterized by the gradual extinction of all functions, reduced regenerative abilities, cessation of reproduction. This period ends with the death of the organism.

CRITICAL PERIODS OF DEVELOPMENT IN ONTOGENESIS. TERATOGENES

During ontogenesis, especially embryogenesis, there are periods of higher sensitivity of some cells to certain environmental factors. This was first noticed by the Australian physician N. Gregg in 1944. Russian embryologist P G Svetlov in 1960 formulated the theory of critical periods of development and tested it experimentally. The essence of this theory is to state the general position that each stage of development of the embryo as a whole and its individual organs begins with a relatively short period of qualitatively new restructuring, accompanied by the determination and differentiation of cells.

Exogenous damaging factors in critical periods can be chemicals, including many drugs, ionizing radiation (eg, X-rays in diagnostic doses), hypoxia, starvation, drugs, nicotine, viruses, and others. Many birth defects appear due to exposure to toxic substances consumed by a woman during pregnancy. Such developmental anomalies are not inherited, but can occur only with repeated exposure to the damaging factor. Such factors are called teratogens (from the Greek. «One that leads to injuries»). Chemicals and drugs that cross the placental barrier are especially dangerous for the embryo in the first 3 months of pregnancy because they are not metabolized and accumulate in high concentrations in the tissues and organs of the embryo. Drugs disrupt brain development.

In general, in human ontogenesis there are several critical periods of development: in the pre embryonic period, embryogenesis and postnatal life. These include:

1) the development of germ cells - oogenesis and spermatogenesis;
2) fertilization;
3) implantation (7-8 days of embryogenesis);
4) development of axial rudiments of organs and formation of a placenta (3-8th week of development);
5) stage of enhanced brain growth (15-20th week);
6) the formation of the main functional systems of the body and the differentiation of the reproductive system (20-24th week);
7) birth;

8) the period of birth (up to 1 year);
9) puberty (11-16 years).

Topic 17. Anthropogenetics. Twin, dermatoglyphic and genealogical methods

Modern clinical medicine can no longer do without genetic methods. Various biochemical, morphological, immunological, electrophysiological methods are used to study hereditary traits in humans. Due to advances in genetic technology, laboratory genetic diagnostics can be performed on a small amount of material that can be sent by mail (a few drops of blood on a filter paper), or even on a single cell taken at an early stage of development.

The following methods are used in solving genetic problems: genealogical, twin, cytogenetic, somatic cell hybridization, molecular genetic, biochemical, dermatoglyphic method, modeling, genome sequencing, population-statistical, etc.

Genealogical method

The main method of genetic analysis in humans is to compile and study pedigrees. Genealogy - family history, a set of information about the origin of the individual; establishment of closely related relations between individuals and drawing up of pedigree schemes. This method was introduced into science in the late nineteenth century by F. Galton.

This is the most universal method of studying human heredity. It is always used when hereditary pathology is suspected, allows to establish in the majority of patients:

- hereditary nature of the trait;
- type of inheritance and allele penetrance;
- the nature of gene coupling and chromosome mapping;
- intensity of the mutation process;
- deciphering the mechanisms of gene interaction.

This method is used in medical and genetic counseling.

Its essence is to clarify family ties and trace the presence of normal and pathological signs among close and distant relatives in the family. It consists of two stages: genealogy and genealogical analysis.

Data collection begins with proband - a person whose pedigree must be compiled. It can be a sick or healthy person - a carrier of any symptom, or a person who sought the advice of a geneticist. The proband's brothers and sisters are called siblings.

When compiling genealogical tables use symbols, proposed by G. Just in 1931.

After assembly **pedigree** it is accompanied by a written explanation - a pedigree legend. The following information should be reflected in the legend:

- results of clinical and out-of-clinic examination of the proband;

- information about the personal examination of the proband's relatives;
- comparison of the results of the proband's personal examination with the information of the survey of his relatives;
- written information about relatives living in another area;
- conclusion on the type of inheritance of the disease or symptom.

After compiling the pedigree, the second stage begins - genealogical analysis, the purpose of which is to establish genetic patterns.

Pedigree analysis allows us to conclude about the nature of the trait (hereditary or not), the type of inheritance (autosomal dominant, autosomal recessive or sex-linked), zygote proband (homo- or heterozygous), the degree of penetrance and expressiveness of the gene.

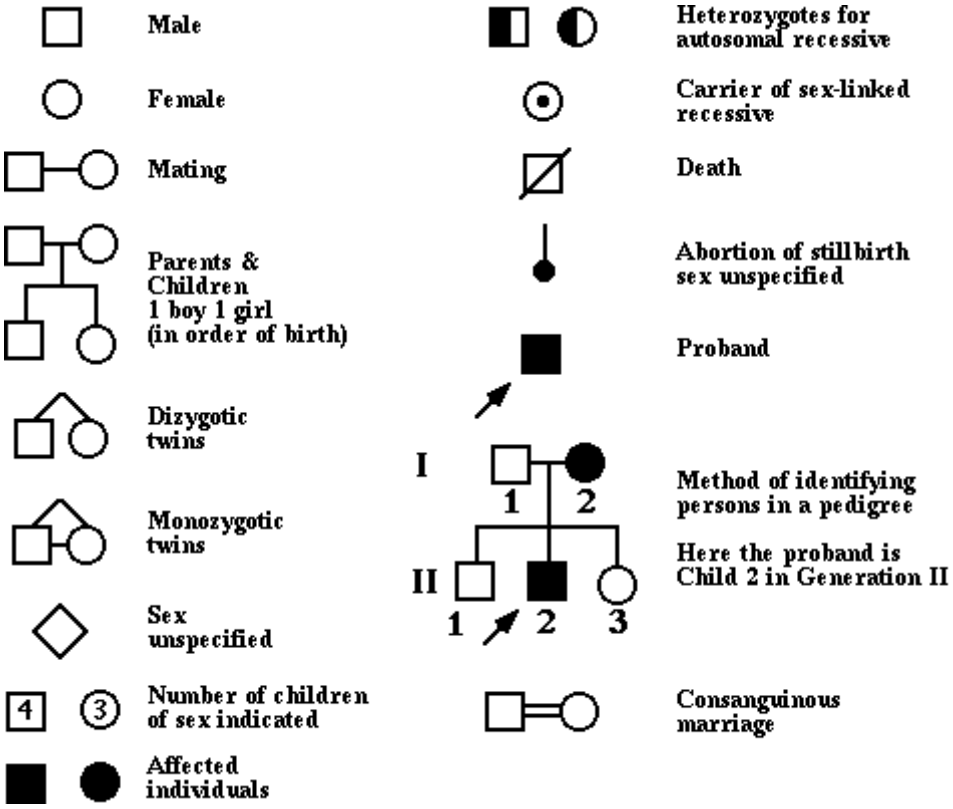


Figure 4. Genetic symbols for genealogy.

Analysis of pedigrees in different types of inheritance shows that all diseases determined by the mutant gene are subject to the classical Mendel's laws.

The twin method

This method is to study the patterns of inheritance of mono- and dizygotic twins. Currently, it is widely used in the study of heredity and human variability to determine the relative role of heredity and environment in the formation of normal and pathological signs. It allows you to identify the hereditary nature of the trait, to determine the penetrance of the allele, to assess the effectiveness of some external factors on the body (drugs, training, education).

The essence of the method is to compare the manifestation of the trait in different groups of twins with regard to the similarity or difference of their genotypes. Monozygotic twins that develop from a single fertilized egg are genetically identical because they have 100% of the common genes. Therefore, among monozygotic twins there is a very high percentage of concordant pairs, which develop a trait in both twins. Concordance is the percentage of similarity on the basis of the studied feature. Comparison of monozygotic twins, brought up under different conditions of the post-embryonic period, allows us to identify signs in the formation of which a significant role belongs to environmental factors. On these grounds, there is a discordance between the twins, i.e. a difference.

To assess the role of heredity in the development of a trait, calculations are made according to the formula:

Coefficient of heredity (H)

$$H = \frac{Kmt - Kdt}{100\% - Kdt} \times 100\%$$

Kmt – for monozygotic twins
Kdt – for dizygotic twins

Coefficient of environmental influence
E = 100% - H

At H, equal to one, the trait is entirely determined by the hereditary component; at H, equal to zero, the influence of the environment plays a significant role. A coefficient close to 0,5 indicates approximately the same effect of heredity and environment on the formation of the trait.

For example, the concordance of monozygotic twins in schizophrenia is 70%, dizygotic - 13%. Then

H=(70-13) ÷(100-13)=0,65 or 65%

The influence of the environment is determined by the formula

C = 100% -H

Then C = 100% - 65% = 35%. Thus, in the case of schizophrenia, the influence of heredity prevails, but environmental conditions also play a significant role.

Concordance of some human traits in identical (OB) and fraternal (DB) twins,%

Signs	Concordance (%)	
	ABOUT	DB
Normal:		
Blood groups (AB0)	100	46
Eye color	99.5	28
Color of hair	97	23
Pathological:		
Clubfoot	32	3
Lip gap	33	5
Schizophrenia	70	13
Hypertension	26.2	10

Based on the data in the table, it can be seen that for many diseases, along with the hereditary component, the environmental conditions under which the genotype is realized in the phenotype play a significant role.

Difficulty twin method is associated, first, with a relatively low birth rate of twins in the population (1:86 - 1:88), which complicates the selection of a sufficient number of pairs with this trait; secondly, with the identification of monozygotic twins, which is of great importance for reliable results.

Dermatoglyphics method

Dermatoglyphics(from the Greek. derma - skin, glyphe - to draw) – is the definition of the relief of the skin on the palms (palmoscopy), fingers (dactyloscopy), soles (plantoscopy). Unlike other parts of the body, there are epidermal protrusions - ridges that form complex patterns. It is established that patterns are an individual characteristic of a person and do not change during life. Dermatoglyphic studies are important in determining the zygote of twins, in the diagnosis of many inherited diseases, as well as in some cases of disputed paternity, in forensic medicine, in forensics to identify a person.

Fingerprinting.

Papillary lines on the pads of the fingers are studied on the prints, which are applied to the paper after lubricating the fingers with printing ink. A detailed study of the patterns is performed using a magnifying glass. Papillary lines of different directions never intersect, but may converge at certain points, forming triradii, or deltas.

Despite the individual uniqueness of the patterns, there are three main types: arc A (English arch - arc); loops L (English lor - loop) and curl patterns W (English whorl - curl). Arc patterns are very rare (6%), there is only one direction of papillary lines in this pattern. Loop patterns are the most common (about 60%). This is a closed pattern on one side, in which the lines do not reach the opposite edge. Curly patterns are the most common (34%). They have the form of concentric circles, ovals, spirals. Curls

have two deltas. There are also three types of patterns on the toes, but in a different ratio (higher percentage of arcs). Tactile patterns on the soles of humans are reduced compared to monkeys and occupy a smaller area.

Fig. 5. Finger patterns: 1) curl, 2) loop, 3) arc.

Palmoscopy.

The relief of the palm is very complex, it has a number of fields, pads and palm lines. The central palmar fossa is surrounded by six elevations - pads. At the base of the thumb - tenor, at the opposite edge of the palm - hypotenuse, opposite the interdigital spaces are interdigital pads. At the base of the II, III, IV and V fingers are finger triradii - places where three directions of papillary lines converge. They are denoted by the Latin letters a, b, c, d. Near the bracelet fold, which separates the hand from the forearm, is the main (axial) palmar triradius (t). If you draw lines from the triradii a and d to t, the angle of the palm atd is formed (Fig. 1.3), normally it does not exceed 57 °.

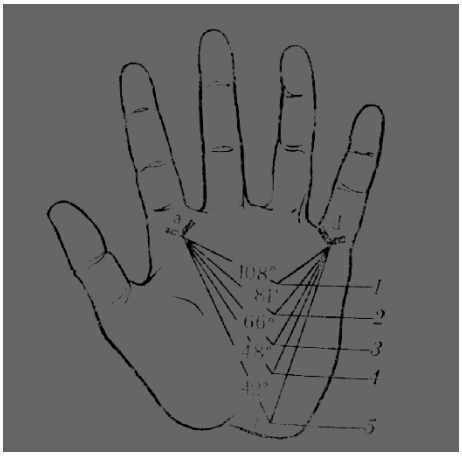


Fig. 6. The angle atd is normal and with chromosomal abnormalities:
1 - Patau syndrome;
2 - Down syndrome;
3 - Shereshevsky-Turner syndrome;
4 - norm;
5 - Klinefelter's syndrome

The formation of dermatoglyphic patterns may be influenced by some damaging factors in the early stages of embryonic development. Thus, with the intrauterine action of rubella virus in a child there are certain deviations in the patterns, which are similar to those in Down's disease. The method of dermatoglyphics is used to clarify the diagnosis of chromosomal syndromes in people with karyotype changes. Less indicative data of dermatoglyphic analysis in diseases of genetic nature.

Topic 18. Genetic diseases.

Genetic diseases are called hereditary diseases that are caused by gene mutations.

The reason is a violation of the chemical structure of the gene (DNA molecule). Therefore, genetic diseases are called molecular. Classical gene mutations are inherited as mendelian traits. They are caused by a mutation in one gene (monogenic diseases). Generative mutations are considered complete forms. Mosaic forms are also known, when mutations occur in the early stages of zygote fragmentation in a single cell. Such an organism will be mosaic by this gene: some cells will contain a normal allele, some - mutant. Mosaic forms of genetic diseases can be diagnosed by modern molecular genetic methods.

There are monogenic and polygenic diseases:

Monogenic - diseases caused by a single mutant gene.

Polygenic - diseases are determined by multiple genes, the manifestation of which depends on environmental factors.

Monogenic diseases are inherited according to Mendel's laws. Depending on the type of inheritance, the following monogenic diseases are distinguished: autosomal dominant, autosomal recessive, X-linked dominant, X-linked recessive, Y-linked.

Autosomal dominant diseases caused by a mutation in the dominant gene in the autosome. The pathological sign occurs in every generation. The gene is phenotypically manifested in both homozygous AA and heterozygous AA states under conditions of complete penetrance and expression. In homozygotes the course of the disease is more severe than in heterozygotes. Recessive homozygotes aa do not get sick. Autosomal dominant diseases include: Marfan's syndrome, achondroplasia, Huntington's chorea, renal polyposis, aniridia (absence of iris), hypercholesterolemia, Steinert's disease, polydactyly (6 or more fingers), brachydactyly (shortness of breath).

Autosomal recessive diseases caused by mutation of a recessive gene in the autosome. Type of inheritance - autosomal recessive. Only recessive homozygotes (aa) get sick, heterozygotes (Aa) do not get sick, but are carriers of a pathological gene. This group of hereditary diseases includes: phenylketonuria, galactosemia, cystic fibrosis, spinal muscular atrophy, primary hemochromatosis, amaurotic idiocy, and others.

X-linked dominant diseases caused by a mutation in the dominant gene on the X chromosome. Feature - a sick father (XAY) all daughters will be sick, and all sons - healthy. This group of diseases includes: hypophosphatemia (vitamin D-resistant rickets), Goltz syndrome (focal dermal hypoplasia), Coffin-Lowry syndrome (mental retardation and bone and cartilage abnormalities).

Vitamin D-resistant rickets (hypophosphatemia)- rickets, which can not be treated with vitamin D. Hypophosphatemia can be detected immediately after birth, and signs of rickets appear in the late first – early second year of life, when children begin to walk. The most pronounced are the changes in the lower extremities, the curvature of the long tubular bones. Characterized by short stature, limited mobility in large joints, dolichocephaly, dysplasia (impaired formation) of the nails. The disease is caused by a decrease in the reabsorption of phosphates in the tubules of the kidneys.

X-linked recessive diseases caused by a mutation in a recessive gene on the X chromosome. Type of inheritance - X-linked recessive. This group of diseases includes:

hemophilia, color blindness, Duchenne muscular dystrophy, Lesch-Nihan syndrome, and others.

Hemophilia is a classic example of an X-linked recessive abnormal gene that appears phenotypically in men. In heterozygous women, its action is suppressed by the dominant allele of normal blood clotting. Hemophilic parents never pass on the hemophilia gene to their sons. Therefore, their children are healthy, but all daughters are born carriers of the disease. There are various clinical manifestations of hemophilia – from light bleeding to mass hemorrhage. Probably, it depends on different mutations of one gene. The two most common forms of hemophilia are A and B. They are characterized by the absence of various antihemophilic globulins in the blood plasma. The frequency ratio of hemophilia A and B is 5: 1. Both forms of hemophilia occur with a frequency of 1: 5000 newborn boys.

Daltonism is one of the most common inherited diseases inherited from the X chromosome. It is characterized by a violation of color perception (mainly red and green). The principles of its inheritance are the same as hemophilia.

Y-linked diseases. The mutant gene is localized in a non-homologous region of the Y chromosome. Inheritance – exclusively through the male line. Examples - hypertrichosis, ichthyosis.

Monogenic diseases are also divided into groups depending on the nature of the disorders:

- enzymopathy (fermentation);
- defects of structural and transport proteins;
- violation of circulating blood proteins;
- genetic diseases with unknown primary biochemical defects.

According to the **WHO classification,** monogenic or molecular diseases are divided into the following groups, which are defined by the disorder:

1) amino acid metabolism: phenylketonuria, tyrosinemia, alkaptonuria, homocystinuria, cystinuria, Hartnup's disease, tryptophanuria, maple syrup disease, histidinuria, histidinemia, etc.;
2) carbohydrate metabolism: galactosemia, fructosemia, glycogenosis, carbohydrate malabsorption syndrome, mucopolysaccharidosis;
3) lipid metabolism: hyperlipoproteinemia, sphingolipidoses (Niemann-Pick disease), gangliosidosis (Tay-Sachs disease);
4) steroid metabolism: adrenogenital syndrome;
5) purine and pyrimidine metabolism: Lesch-Nayan syndrome;
6) metabolism in connective tissue, bones and muscles: Marfan's disease;
7) structures of heme and porphyrin: hemoglobinopathies, sickle cell anemia, thalassemia;
8) metabolism in erythrocytes and violation of their structure: hereditary microspherocytosis;
9) anomalies of metal metabolism;
10) diseases characterized by a defect in the transport of various substances;
11) diseases characterized by structural abnormalities: functions of enzymes and plasma proteins.

The basis of genetic diseases are mutations of the corresponding genes, which lead to the synthesis of enzymes with altered activity. In homozygotes the activity of the enzyme is low, which leads to a violation of specific metabolism, in heterozygotes the activity is often ≈ 50%, so the diseases are mostly inherited by AR or XR type.

Metabolic changes occur according to the scheme:

Substance → G(excess) → B(lack) → G(lack)

↓ enzyme mutation

D(excess)

Therefore, when the enzyme mutates, there is an excess of some substances (G, D) and a lack of other products (B,G).

Enzymopathy (enzymopathy) is the most numerous group of genetic diseases. The enzyme either changes its structure and functional properties, or is not formed at all. In this case, the biochemical reaction involving this enzyme is blocked.

In this case, there may be: 1) insufficient formation of the products of this reaction or more distant products of its transformation; 2) accumulation in the body of the substrate of the blocked reaction or its precursors; 3) change of the main direction during the reaction and increased formation of products, which are normally present in small quantities.

Diagnosis of enzymopathies is carried out using biochemical methods. Early diagnosis and medical or dietary correction make it possible to treat and prevent the development of these inherited diseases.

Phenylketonuria- hereditary disease - enzymopathy caused by a genetic deficiency of the enzyme phenylalanine hydroxylase, which is necessary for the conversion of the amino acid phenylalanine into tyrosine. This leads to the accumulation of phenylalanine, phenylpyruvate and phenylacetate in the blood, cerebrospinal fluid, tissues and their toxic effects on the CNS. Children are born healthy, but with the entry of phenylalanine with breast milk gradually develops mental retardation. As disturbance of phenylalanine metabolism leads to decrease in tyrosine level, at patients decrease in pigmentation of skin, hair, an iris is observed. The incidence of phenylketonuria in European populations averages 1: 10,000 newborns. The type of inheritance is autosomal recessive. The phenylalanine hydroxylase gene is located on chromosome 12.

Clinical diagnostic signs: blonde hair, blue eyes, skin without pigment, «mouse» odor (due to the excretion of phenylalanine in the urine); after 6 months, drowsiness, weakness, loss of all acquired psychomotor functions, convulsions, the formation of mental retardation to idiocy.

The diagnosis is made on the basis of clinical examination and the results of biochemical detection of phenylpyruvate in urine and phenylalanine in the blood. Treatment -diet therapy: exclusion from the diet of products containing phenylalanine (eggs, meat, milk). Early diagnosis and diet therapy prevent the development of the clinical picture of the disease.

Albinism- hereditary disease - enzymopathy caused by a deficiency of the enzyme tyrosinase, which catalyzes the reactions necessary for the formation of black

pigments - melanins. The absence of melanin in the melanocytes of the skin is manifested by insufficient (or absent) pigmentation of the skin, hair, hypersensitivity of the skin to sunlight, impaired vision. Type of inheritance - autosomal recessive.

Alkaptonuria- hereditary disease of autosomal recessive type of inheritance, which is caused by genetically determined deficiency of the enzyme homogentisic acid oxidase. A characteristic manifestation of the disease is excessive excretion of homogentisic acid in the urine, which with the addition of alkalis becomes dark. Homogentisic acid accumulates in connective tissue. Articular cartilage becomes yellow-orange (ochronosis), the cartilage of the auricles and nose darkens, arthritis develops.

Hereditary diseases - disorders of carbohydrate metabolism - include galactosemia, mucopolysaccharidosis.

Galactosemia **-** disorder of galactose metabolism, which comes with food and is formed during the hydrolysis of lactose. Type of inheritance A - P, in homozygotes the enzyme activity is 3-12% of normal, in heterozygotes - 50%. Frequency 1:35 ... 150 thousand births. Galactosemia is characterized by heterogeneity (different variants of gene mutations). For example, with a frequency of 1: 100 ... 200 thousand there is a galactosemia with a mild clinical picture. Phenotypically (clinically) manifested jaundice of newborns, vomiting, diarrhea, the development of mental retardation, liver disease, dystrophy. At early diagnosis, the child is prescribed a special (as in phenylketonuria) diet - the exclusion of breast milk and other products that contain lactose or galactose. Development is normalizing.

Mucopolysaccharidosis- hereditary diseases. Disorders of glycosaminoglycan metabolism (GAG), accumulation of GAG due to mutations in lysosomal enzymes (hydrolases). Genetic heterogeneity is determined by mutations in different genes that encode different enzymes. Type of inheritance AR, XR. Phenotypically (clinically) manifested in developmental disorders (dwarfism, facial defects, joint immobility, brain shrinkage, early mortality 12-20 years). Many mucopolysaccharides are excreted in the urine. The most common is Gurler's syndrome (gargoylism), Hunter's syndrome (mucopolysaccharidosis, type II).

Hereditary defects of lipid metabolism - ***sphingolipidoses*** - disorders of lipid breakdown and disorders of plasma lipid metabolism. Type of inheritance AR, XR. Frequency of different forms from ≈ 1: 4000 newborns to 1: 300 000, the frequency in different populations can vary significantly. Hereditary diseases of purines and pyrimidines. An example is Lesch-Nayan syndrome. Frequency 1: 300000. The type of inheritance can be XR, AR. Metabolic disorders - a lack of an enzyme needed for DNA synthesis. Uric acid accumulates in the urine of patients. Phenotypic disorders: mental retardation, sympathetic paralysis, purine metabolism disorders, aggressive behavior, urolithiasis.

Hereditary defects in vitamin metabolism - ***homocystinuria*** - a genetic defect in the coenzyme of vitamins B6 and B12 (pyridoxine-dependent enzymopathy). A - P type of inheritance. Frequency in populations - 1: 50000. Characteristic phenotypic diversity, which is determined by heterogeneity. There are eye lesions (lens ectopia),

skeletal changes, mental retardation, dilation of blood vessels, thrombosis, CNS dysfunction, dementia.

Violation Biosynthesis of steroid hormones occur with a frequency of 1: 5000 ... 10000; AR type of inheritance.

This group includes: adrenogenital syndrome (mutations in genes that control the synthesis of androgens - male hormones; testicular feminization, which does not form androgen receptors). In these diseases, the process of sex differentiation is disturbed (pseudohermaphroditism), anomalies and malformations of the genitals (hypospadias, hypoplasia.).

Hemoglobinopathies- a group of hereditary diseases in which the protein chains of hemoglobin (Hb) are disrupted, which leads to changes in their functions and properties. Such diseases include: methemoglobinemia, erythrocytosis, sickle cell anemia, thalassemia.

The most well-known disease is sickle cell anemia, which occurs with a high frequency in the regions of malaria. Type of inheritance - autosomal, incompletely dominant. The mutant gene (S) causes the synthesis of hemoglobin S, which changes the shape of erythrocytes (Fig.) And weakly attaches oxygen, resulting in anemia and hypoxia. Heterozygotes have both normal HbS and mutant HbS, but they do not have malaria.

Thalassemia- diseases in which the content of protein – globin in the molecule of hemoglobin (Hb) decreases. Type of inheritance A – P or due to deletions. To diagnose the type of thalassemia using molecular genetic method, electrophoresis.

Collagen diseases- At the heart of these diseases are genetic defects in the biosynthesis and breakdown of collagen (a structural component of connective tissue). This group includes Ehlers-Danlos disease, which is characterized by genetic polymorphism, type of inheritance AD, AR; Marfan's disease (AD type of inheritance). Phenotypically pleiotropic action of mutant genes is manifested by hypermobility syndrome, increased skin elasticity, internal bleeding, changes in joints, blue sclera. Primary defects -disruption of collagen biosynthesis or processing of fibrils and collagen.

Hereditary genetic diseases with an unknown primary biochemical defect include:

1) ***Achondroplasia*** (AD type of inheritance, frequency 1: 100 000; occurs due to de novo mutations). Phenotypically manifested by skeletal disorders (violation of the formation of cartilage in the epiphyses of the tubular bones, skull bones).

2) ***Cystic fibrosis*** (AD or AR type of inheritance, frequency 1: 2500 newborns). At the heart of the pathogenesis of all forms - damage to the endocrine glands (secretory cells of the bronchi, pancreas, intestines, sweat glands, liver), accompanied by the secretion of thick secretions, inflammatory and sclerotic changes in the organs. The main forms are pulmonary and intestinal. Diagnosis - special comprehensive tests (determination of Na content in secretions, determination of the activity of digestive enzymes ...). It is believed that a significant number of cases in children are not diagnosed.

3) ***Myopathies (muscular dystrophies)*** - a group of inherited diseases in which striated and smooth muscles are affected. The type of inheritance can be XR, AD, AR.

Myopathies are characterized by muscle damage that progresses with age, clinical polymorphism.

Biochemical methods

Biochemical methods can diagnose hereditary diseases caused by gene mutations that cause metabolic disorders or their structure, as well as polymorphism in molecular diseases.

There are two directions:

1) the study of metabolic products of genetically determined processes (increase or decrease in the concentration of certain metabolic products indicates a change in the activity of the enzyme, its mutations);

2) establishment of violations of the structure of transport proteins, enzymes.

Biochemical diagnosis of hereditary disorders is performed in 2 stages. At the first (sifting) stage the most probable cases of diseases are selected by express methods, at the second - the diagnosis is specified by more difficult methods. Microbiological testing is usually used for rapid diagnosis.

Biochemical methods are also used in prenatal or postpartum diagnosis of monogenic diseases, which allows timely detection of pathology and prescribes specific medical measures (preventive or curative).

Genetic engineering

Genetic engineering – a set of experimental methods by which genes are transferred from one organism to another in order to give the latter new hereditary traits. There are no taxonomic barriers to genetic engineering. It allows you to manipulate genetic material from different sources and according to a given program to construct in vitro functionally active recombinant (hybrid, chimeric) DNA molecules that do not occur in nature. The prefix «re» means that DNA is not created de novo (anew), but is formed by combining fragments of existing molecules. Chimeric recombinant DNA molecules are called because they can combine seemingly incompatible genes from different organisms. The theoretical basis of genetic engineering is the universality of the genetic code.

Genetic engineering includes the following stages:

1) obtaining genes by artificial (chemical or matrix) synthesis or by isolating them from natural sources; 2) inclusion of the gene in the vector DNA molecule, ie the creation of recombinant DNA molecules; 3) introduction of a vector DNA molecule with the included gene into the recipient cell; 4) creating conditions for the expression of the transferred gene and its stable inheritance; 5) selection of cells with a valid transferred gene - molecular cloning.

Artificial gene synthesis by chemical means first carried out in 1969 by the Indian scientist G. Koran and colleagues. This was a yeast alanine tRNA gene with 77 nucleotide pairs. But the synthesized gene did not contain a regulatory part and therefore was functionally inactive. Later, these authors synthesized a functionally active gene - the gene for suppressor tyrosine tRNA E. coli with a length of about 200 nucleotide pairs. Chemical synthesis of genes was facilitated by the development of methods for establishing the primary structure of DNA, i.e. the sequence of nucleotides

in its molecule (sequencing). The method of chemical gene synthesis has opened wide opportunities for artificial synthesis of human genes. The human growth hormone gene (somatotropin) and the human insulin gene are obtained by chemical synthesis.

Artificial gene synthesis by matrix carried out using the enzyme reverse transcriptase (revertase). The enzyme is able to build copies of DNA on various RNAs, including synthetic ones. Matrix can synthesize almost any gene on the mRNA template. In this way, the human interferon gene is synthesized - a valuable drug used to fight viral infections.

The method of isolating a gene from natural DNA is based on the incubation of total DNA with various restriction endonucleases (restrictions). Restrictases are enzymes («molecular scissors'») that cut a DNA molecule at specific sites into fragments (restriction). The fragments are separated by electrophoresis, isolated in pure form and determine the nucleotide sequence.

After obtaining genes by synthesis or isolation from natural sources, the next step in genetic engineering is to incorporate the required gene into the vector DNA molecule. The role of vectors is performed by plasmids, bacteriophages, some viruses, and mitochondrial DNA. Plasmids are most often used as vectors. Plasmids – extrachromosomal small circular DNA molecules capable of autonomous replication; they are located in the cytoplasm of a bacterial cell or integrated into its chromosome and are then called episomes. Episomes are reproduced as part of a chromosome. The circular DNA vector molecule is cut by restriction enzymes into linear fragments. Fragments of vector DNA and fragments of foreign DNA with their complementary («sticky» ends) are able to combine into one recombinant (hybrid) DNA molecule. Phosphodiester compounds bonds between nucleotides are formed by ligase enzymes. Transfer of necessary genes (transgenosis) is provided in various ways: transformation (if the vector is a plasmid), transduction (vector is a bacteriophage).

Transgenic plants and animals (organisms with foreign genes) have been obtained by genetic engineering methods. Transgenic animals are used in biomedicine as models of human diseases (mice with the cancer gene, pigs with human heart disease, cows with human immunoglobulins in the blood). The problem of obtaining human blood proteins in the milk of transgenic animals is solved.

Genetic engineering owes much of its success to the creation of gene banks (libraries). A gene bank is a set of genes derived from recombinant molecules. The geneticist can select in the library of genes the genes necessary for research by means of specially developed genetic, biochemical, radioisotope or immunological methods. Gene banks of Drosophila, Escherichia coli and many other organisms, including humans, have been created.

Genetic engineering was born in 1972, when American geneticists P. Berg, G. Boyer and S. Cohen created in vitro the first recombinant DNA, which combined genetic material from three different sources: the complete genome of the oncogenic monkey virus SV40, part of the genome of the moderate bacteriophage X (lamda) and the genes of the galactose operon of Escherichia coli (E. coli). However, the engineered recombinant molecule has not been studied for functional activity, as the authors feared that genetic engineering methods could lead to the creation of organisms dangerous to

human health. Interference with the genotype of the organism can lead to unintended consequences for humans, plants, animals and the environment as a whole. For example, the bacterium Escherichia coli, which is harmless under normal conditions, can transmit oncogenic animal viruses to the human intestine. Specially designed biological agents that infect living things are considered biological weapons. At the International Conference on Biosafety in Asilomar (USA) in 1975, rules were developed, compliance with which eliminates the likelihood of harmful effects of genetic engineering. In 1985, the Information Working Group on Biosafety was formed.

Biotechnology

Biotechnology (Greek bios - life, techne - master, logos - science) – a science that studies the application of living organisms or biological processes in industry. Biotechnological methods have long been known to mankind. Microorganisms are widely used in such industries as winemaking, baking, brewing (brewing), and cheese-making. In order to obtain biologically active substances (antibiotics, hormones, enzymes, vaccines), modern biotechnology is based on the application of the latest advances in genetic engineering in the field of recombinant DNA molecules. In the pharmaceutical industry, a new industry has emerged – the DNA industry. In the microbiological industry, transgenic strains of Escherichia coli bacteria (E. coli) are used, in the genome of which human genes encoding the synthesis of human insulin, interferon, and somatotropin have been introduced by genetic engineering methods. And bacteria in industrial conditions synthesize these drugs. Microbiological synthesis is an extremely efficient process. Thus, to obtain 5 mg of somatotropin (growth hormone), you need to use the brains of 500,000 sheep for 5 years, while a similar amount of hormone is given to 9 liters of broth suspension of Escherichia coli.

Prospects for chemotherapy

Gene therapy is a method of introducing a DNA fragment into the cells of a sick person in order to replace the function of a mutational gene and treat hereditary diseases. Back in the late 60's it was discovered that animal and human cells are able to absorb exogenous DNA, integrate it into their genome, after which the expression of the introduced genes, in particular in the form of synthesis of previously missing proteins and enzymes. Methods for delivering DNA to cells using viruses and other carriers have been developed.

The first attempt at gene therapy in the clinic was made by M. Klein in 1983, when he introduced a normal p-globin gene in patients with p-thalassemia. Later, a method of gene therapy for hereditary adenosine deaminase deficiency (severe immunodeficiency) was developed: the normal gene was introduced into the patient's bone marrow cells and after their transplantation the enzyme activity was restored, so that the patient's condition improved. Clinical experiments on cancer gene therapy were performed. Genes that labeled (labeled) malignant cells were introduced into the leukocytes of patients with malignant melanoma and late stages of cancer so that they could be recognized by the immune system. In half of the patients, the size of the tumors decreased by half or more. Gene therapy methods have been developed for 40

diseases. In the near future, this method will be spread because it has deciphered the human genome.

Topic 19. Chromosomal diseases. Medical and genetic counseling.

Depending on the role of heredity and the environment, all diseases can be divided into three groups: 1) hereditary diseases; 2) diseases with hereditary predisposition (multifactorial) and 3) non-hereditary diseases.

Hereditary diseases- diseases caused by a gene, chromosomal or genomic mutation. The manifestation of the pathological effect of the mutation is almost independent of the environment. The latter can only change the severity of symptoms and the severity of their course.

Diseases with hereditary predisposition develop in people with a certain genotype under the influence of environmental factors.

Non-hereditary diseases- diseases caused by environmental factors (injuries, burns, infectious diseases). But even in these diseases, heredity affects the course of the pathological process.

There are genetic and clinical classification of hereditary diseases. The genetic classification is based on the etiological principle, namely: the type of mutation and the nature of interaction with the environment.

All hereditary pathology can be divided into **5 groups:**

1) genetic diseases; 2) chromosomal diseases; 3) diseases with hereditary predisposition (multifactorial); 4) genetic diseases of somatic cells; 5) diseases of genetic incompatibility of mother and fetus. Actually hereditary diseases are divided into two large groups: genetic and chromosomal.

Genetic diseases- diseases caused by gene mutations. They are passed down in a number of generations according to Mendel's laws.

Chromosomal diseases *caused* by chromosomal and genomic mutations. Most chromosomal diseases caused by aneuploidy are not inherited at all (lethal effect), and chromosome rearrangements are transmitted with additional recombination that occurs in the meiosis of the aberration carrier.

Diseases with hereditary predisposition *can* be monogenic and polygenic. Their implementation requires not only the appropriate genetic constitution of the individual, but also a factor or set of environmental factors that play the role of triggers in the formation of pathology.

Genetic diseases of somatic cells are associated with the appearance of specific chromosomal aberrations in somatic cells in somatic cells, which cause the activation of oncogenes. These diseases include retinoblastoma, Wilms' tumor (kidney cancer).

Diseases of genetic incompatibility of mother and fetus develop as a result of the mother's immune response to fetal antigens (hemolytic disease of the newborn).

Chromosomal diseases

Chromosomal diseases include various forms of pathology that are clinically manifested by many malformations, the genetic basis of which are chromosomal

(changes in chromosome structure) or genomic (changes in the number of chromosomes) mutations.

Most chromosomal diseases usually occur as a result of new mutations and are not inherited for generations. The phenotypic basis of chromosomal diseases is determined by disorders of early embryonic development, so pathological changes that occur in the prenatal period of development cause the elimination of the embryo, fetus or determine the clinical picture of the disease in the newborn (except for some disorders of sexual development that occur during puberty).

Some of the most common chromosomal diseases have been described as clinical developmental syndromes, before their association with chromosome changes was established. These are Down's disease (1866), Klinefelter's syndrome (1942), Shereshevsky-Turner syndrome (1925, 1938). The connection between mech diseases and changes in the number of chromosomes was proved only in 1959. At present, more than 500 chromosomal diseases have been identified - disorders of the number and structure of chromosomes.

The role of chromosomal pathology is significant in prenatal death of embryos and fetuses (40%), about 6% of stillbirths have chromosomal abnormalities. 3-4 out of 1000 newborns have chromosomal pathology, among children with congenital malformations about 40% have chromosomal abnormalities.

The occurrence of chromosomal diseases is associated with disorders of chromosome divergence during the first and second divisions of anaphase of meiosis, as well as with the occurrence of chromosomal aberrations (deletions, duplications, translocations and other structural disorders). Chromosomal diseases re-emerge due to mutations in the gametes of one of the healthy parents or in the zygote in the early stages of fragmentation. If the mutation originated in gametes, it is a complete form of the disease, if at the stage of zygote fragmentation - a mosaic form of the disease, in which some cells will have a normal karyotype, and others - mutational. Organisms - mosaics can have 2-3 or more cell clones. The pathology is determined by the number of altered cells and the nature of the mutation (by autosomes, gonosomes, or partial monosomies or trisomies). In the full form of chromosome changes are present in all cells of the offspring. In contrast to genes, chromosomal mutations cover a much larger amount of genetic material and are characterized by multiple lesions, which are manifested by mortality and congenital malformations. Patients with chromosomal diseases occupy almost 25% of the bed stock worldwide. The cytogenetic method is used to diagnose chromosomal diseases. Quantitative and structural chromosome abnormalities are visible under a microscope.

Genomic mutations, which are associated with an increase or decrease in haploid chromosome sets, are incompatible with human life. In the clinic there are only heteroploidy - trisomy, rarely tetra- and pentasomy, one variant of monosomy, nullisomy is incompatible with life. There are chromosomal diseases caused by changes in the number of autosomes, and chromosomal diseases associated with a violation of the number of sex chromosomes.

Chromosomal diseases caused by changes in the number of autosomes: Down syndrome, Edwards syndrome, Patau syndrome.

Down syndrome **(trisomy - 21).** The clinical picture of the syndrome was first described in 1866 by the English physician L. Down, who called the disease a "Mongoloid idiocy." In 1959, the French scientist I. Lejeune found an extra chromosome 21 in the karyotype of patients. The karyotypes of patients were **47, XX, +21 or 47, XY, +21**. Frequency 1: 1100, and in some regions -1: 700-1: 800 newborns. The risk of having children with Down syndrome increases with the age of the mother. The frequency of their birth is not affected by gender, racial, geographical and population differences. The complex of congenital malformations characteristic of Down syndrome determines the clinical picture "all children from one family".

Clinical diagnostic signs: short stature, various degrees of mental retardation, craniofacial anomalies: oblique incision of the eyes, short neck, epicanthus (hanging fold of skin near the inner corner of the eye), flat face, small short nose, large tongue, small deformed ears (fig. .). Muscular hypotension, loose joints, transverse folds on the palms, and the clinodactyly (curvature) of the little finger are also characteristic. Congenital malformations of the internal organs (heart), reduced immunity are often the cause of death of these children.

Cytogenetic variants of the syndrome are diverse. The main share (94%) are cases of complete trisomy 21 as a result of chromosome mismatch in meiosis. The contribution of maternal disparity is 80% of paternal - 20%. Approximately 4% of patients have a translocation form (translocation of chromosome 21 most often to chromosome 13 or 22) and 2% - mosaicism due to mitotic disparity, when one part of the cells has a normal number of chromosomes (46) and the other - aneuploid (47). The translocation form does not depend on the age of the mother, so there is a high risk of rebirth of a sick child in the family.

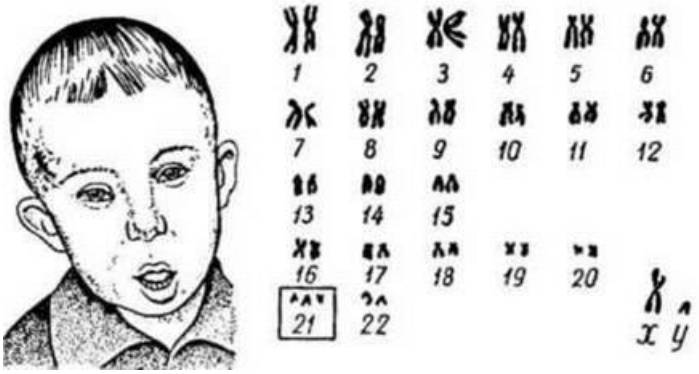


Fig. 7. Down syndrome (trisomy 21) and karyogram of the patient.

Patau syndrome **(trisomy-13).**Karyotype **47, XX, +13 or 47, XY, +13**. Frequency 1: 5000 - 1: 7000 newborns. *Clinical diagnostic signs:* cracks of the upper lip and palate, reduced skull volume, skewed, low forehead, microphthalmia (small size of the eyeball), anophthalmia (absence of one or both eyeballs), swollen, deformed auricles, polydactyly heart, other internal organs. Cytogenetic examination is crucial in the diagnosis. The prognosis for life in Patau syndrome is unfavorable: most children die in the first weeks or months. The average life expectancy is 130 days: 60% of patients die within the first 3 months after birth, only about 10% of children live more than a year.

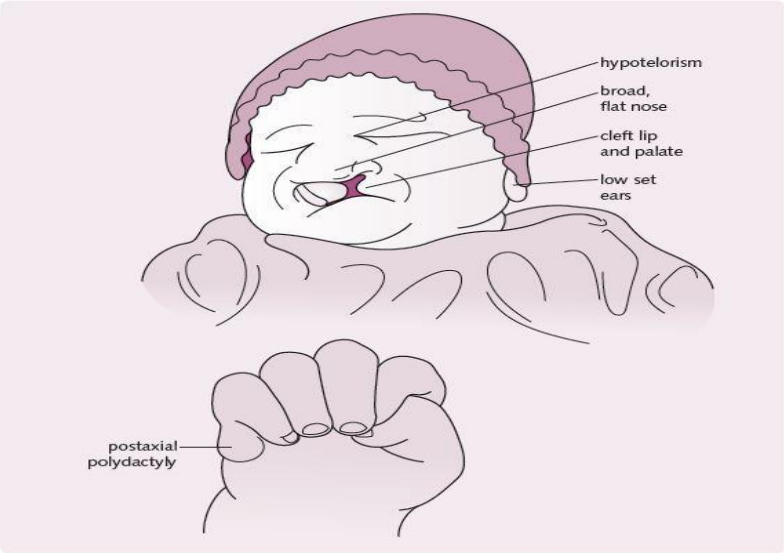


Fig. 8. Patau syndrome (trisomy 13).

Edwards syndrome **(trisomy-18).**Karyotype **47, XX, +18 or 47, XY, +18**. Frequency 1: 5000-1: 7000. The ratio of boys and girls is 1: 3. The reasons for the predominance of sick girls are still unknown. *Clinical diagnostic signs:* dolichocephalic skull (predominance of the longitudinal diameter of the head over the transverse), small mouth and lower jaw, narrow eye slits, deformed auricles, flexor position of the hands, abnormal foot («rocking foot»). The syndrome is characterized by congenital defects of the heart, skeletal system, kidneys, genitals. Children usually die before 2 months. Diagnosis - cytogenetic study.

Chromosomal diseases caused by changes in the structure of autosomes - "cat cry" syndrome.

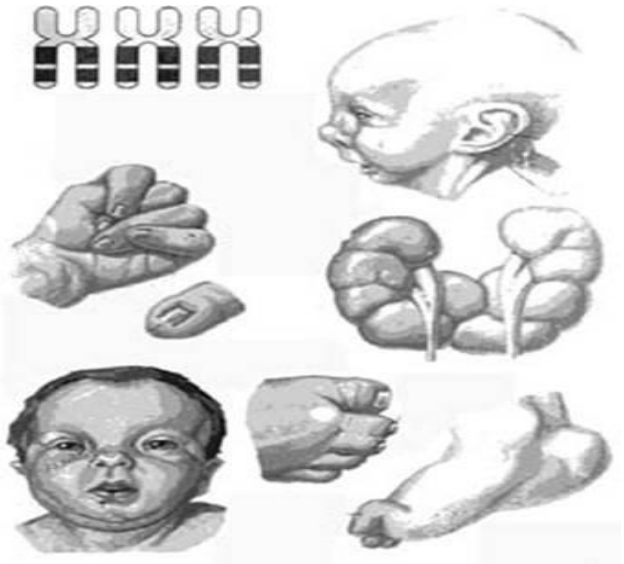


Fig. 9. Edwards syndrome (trisomy 18).

Cat Scream Syndrome **(syndrome 5p- - deletion of the short arm of the fifth chromosome).**The frequency of this pathology among newborns is 1: 50,000. Gender ratio - boys: girls - 1: 1.6. The main *phenotypic features* of the syndrome are low birth weight (about 2600 g), microcephaly, round, "moon-shaped" face in the first years of

life and a narrow face at an older age, antimongoloid autopsy, epicanthus, hypertelorism, strabismus, cataract, foci retina, optic nerve atrophy, flattened back of the nose, high palate, in some patients with a slit; microretrognathia. The auricles are deformed and are located below normal, sometimes with a particular depth. Defects of the musculoskeletal system are often noted: clinodactyly of the little fingers, syndactyly of the toes, clubfoot, muscular hypotension, divergence of the abdominal muscles, umbilical and inguinal hernias. The *pathognomonic symptom* is a kind of cry at birth, resembling the lament of a cat. It is present in children of the first year of life and is associated with both CNS disorders and changes in the larynx (reduction of the epiglottis, narrowing of the larynx, swelling of the mucous membrane). At a syndrome 5p – deep mental retardation (imbecility and idiocy), underdevelopment of language, the expressed delay of physical and motor development, paresis of extremities is usually present. Pathological and anatomic research finds a diffuse atrophy of a brain, a cerebellum, a hydrocephalus, is more rare than defects of heart, kidneys, lungs, and dysplasia of a thymus. The prognosis for life in partial trisomies and monosomies of chromosome 5 depends on the severity of symptoms; most patients live to adolescence.

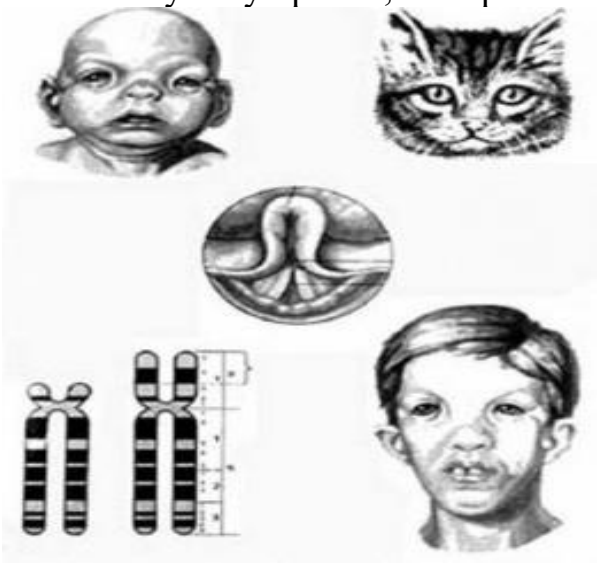


Fig. 10. Cat Scream Syndrome (syndrome 5p- deletion).

Chromosomal diseases caused by changes in the number of sex chromosomes: **Shereshevsky-Turner syndrome, Klinefelter's syndrome, triple-X syndrome, Y-chromosome dyssomy syndrome.**

Shereshevsky-Turner syndrome **(monosomy -X).**Karyotype **45, HO.** There are *no sex chromatin bodies* in the cells. Frequency 1: 2000-1: 5000. The syndrome was described by the Russian clinician MA Shereshevsky (1925) and G. Turner (1938). *Clinical diagnostic signs:* the syndrome is manifested in women; short stature, short neck with excess skin and pterygoid folds (sphinx neck), low limit of hair growth on the back of the head, thorax thyroid-shaped with widely spaced nipples, ovarian underdevelopment. Heart defects are diagnosed in almost a quarter of patients, most often it is coarctation of the aorta, pulmonary artery stenosis, nonunion of the interventricular septum, and ductus arteriosus. Kidney pathology is less common. In

adolescence, very often there is a short stature (150-153 cm), male body type. The prognosis for life is favorable. Patients have no offspring,

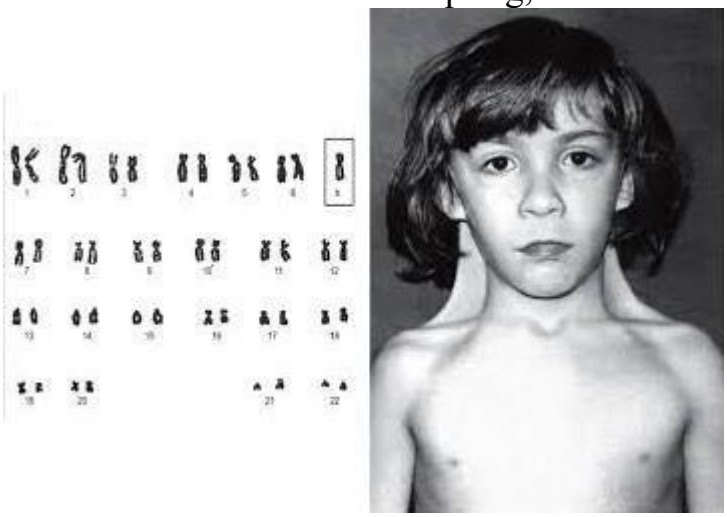


Fig. 11. Shereshevsky-Turner syndrome (monosomy -X).

Klinefelter's syndrome. Karyotype **47, XXY.** Frequency 1: 400. The syndrome is found only in *males,* mainly during puberty. *Clinical diagnostic signs:* tall stature, long limbs, eunuchoidism, gynecomastia (enlargement of the mammary glands), lack of spermatogenesis, underdevelopment of the gonads. Sex chromatin bodies are found in 80% of cases. Sometimes patients with Klinefelter's syndrome have 48 and 49 chromosomes (48, XXXY; 49, XXXXY). The more X chromosomes in the karyotype, the higher the likelihood of developing mental retardation.

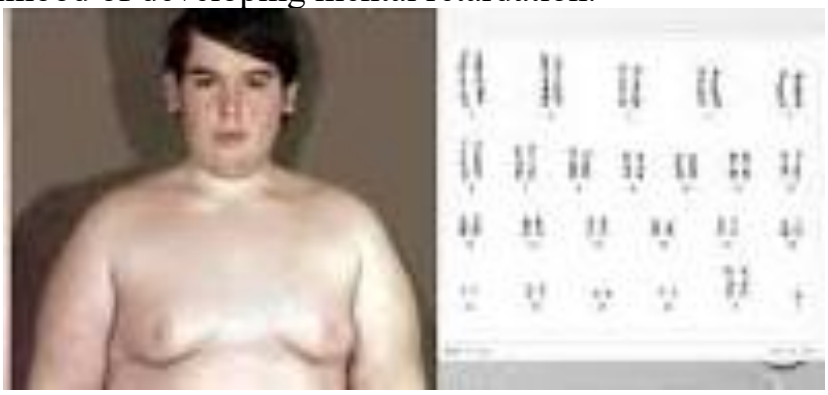


Fig. 12. Klinefelter's syndrome (trisomy - XXY).

Triplo-X syndrome (trisomy-X). Karyotype **47, XXX**. The vast majority of such *women* have normal physical and mental development and are detected by chance during the examination. Only some of them have impaired reproductive function. Most women have normal fertility, although the risk of miscarriage and chromosomal aberrations in the offspring increases. In cells - two bodies of sex chromatin. As the number of X chromosomes increases, the degree of deviation from the norm increases. Mental retardation, craniofacial anomalies, abnormalities of the teeth, skeleton and genitals have been described in women with tetra- and pentasomies. However, women even with tetrasomy on the X chromosome have offspring.

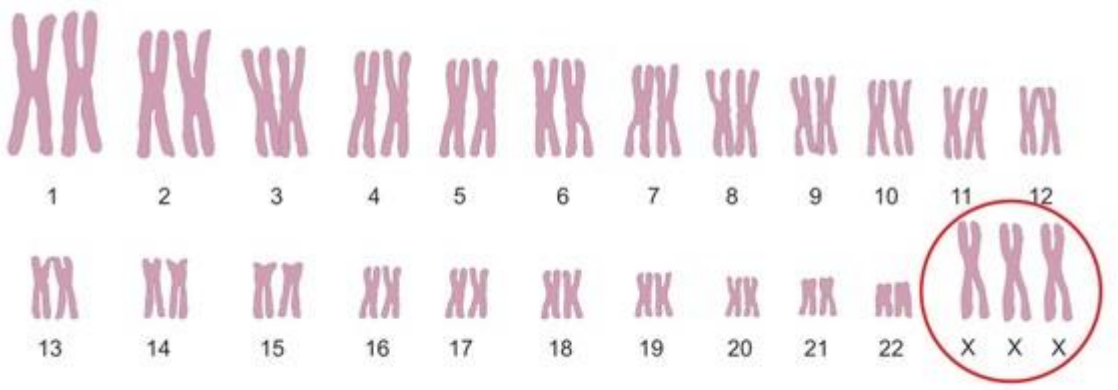


Fig. 13. Triplo-X syndrome (trisomy-X).

***Y-chromosome dyssomy syndrome*.** Karyotype **47, XYY.** Frequency 1: 1000. The syndrome is manifested in *males.* In terms of their mental and physical development, such men do not differ from normal people. No noticeable deviations in sexual and hormonal status were detected. However, some clinicians have indicated an increased degree of aggression in some of them.

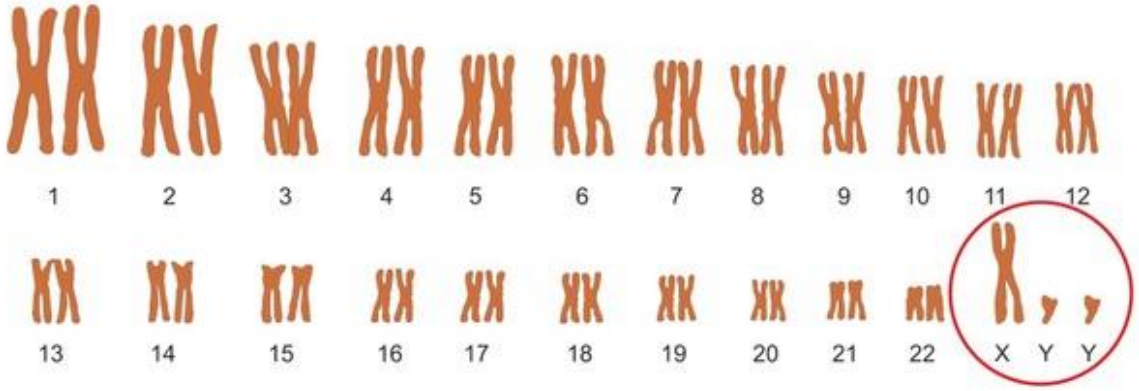


Fig. 14. Y-chromosome dyssomy syndrome (XYY).

Cytogenetic method

The main method of determining chromosomal diseases is cytogenetic, which includes:

a) karyotyping (establishment and analysis of karyotype); b) differential staining of chromosomes; c) determination of sex chromatin (Y-chromatin, X-chromatin).

This is a method of human genetics that is based on the study of human chromosomes with a microscope. The method is used for: 1) study of karyotypes; 2) diagnosis of human chromosomal diseases; 3) mapping of chromosomes; 4) study of the mutation process in human populations; 5) solving some evolutionary issues.

Study of human karyotype (karyotyping).

In order to study the human karyotype, mitotic (metaphase) chromosomes (prophase and metaphase) chromosomes are studied. There are direct and indirect methods of studying them. In the direct method, fresh biopsy material is examined immediately after receipt (bone marrow, tumors, embryonic tissues, chorion, gonadal cells), in the indirect method - after pre-cultivation on nutrient media. Currently, the

human karyotype is most often studied in the culture of peripheral blood leukocytes. Prepare preparations of metaphase plates.

The main method of identification of human chromosomes continues to be the method of their systematization by cutting each chromosome from a photomicrograph of the metaphase plate and pasting them on paper according to the Denver classification. Chromosomes are divided into 7 groups, within which a pair of homologous chromosomes is established. This is how the idiogram (karyogram) of chromosomes is obtained. The Denver system is based on the size of chromosomes and the location of the primary constriction.

However, the identification of chromosomes only on these indicators is very difficult. In fact, it is possible to establish to which group the chromosome belongs, and within the group to determine its location and number is quite difficult. At the Paris Conference on the Standardization of Human Chromosomes (1971), the Swedish geneticist T. Caspersson (1969) proposed a method of differential chromosome staining, which greatly increased the possibilities, allowed to accurately determine homologous chromosomes and chromosome structure disorders - chromosomal aberrations (fluorescent aberration methods). mustard gas and its derivatives).

Determination of sex chromatin.

There are X- and Y-sex chromatin (c). X-sex chromatin **(Barr's body)** is one of the two X-chromosomes of a woman that is heterochromatized in the early stages of embryogenesis and becomes genetically inactive, which reduces the dose of genes. Most often, X-chromatin is examined in the nuclei of epithelial cells of the oral mucosa, where it has the appearance of a hemispherical lump of heterochromatin, which is adjacent to the inner membrane of the nucleus. Sex chromatin is also found in neutrophilic leukocytes in the form of a drumstick protruding on the surface of one of the segments of the nucleus. (Fig.) The number of lumps of sex chromatin (or drumsticks) per unit is less than the number of X chromosomes in somatic cells, which is expressed by the formula: a = n — 1, where a is the number of lumps of X chromatin, n is the number of X chromosomes. In a healthy woman (XX) 60-70% of somatic cells contain one Barr body, in trisomy on the X chromosome (XXX) - two Barr bodies, in monosomy on the X chromosome (X0) Barr bodies are absent. Most healthy men (XY) do not have a single Barr body in their somatic cell nuclei, but up to 8% can occur in modern populations.

Y-chromatin (F-body) is a Y chromosome in the nuclei of male somatic cells. To detect Y-chromatin, somatic cells are stained with fluorochromes and examined under a fluorescent microscope. The Y chromosome differs from all other chromosomes by the intense green glow of its long arm. In the nucleus of a somatic cell of a healthy man, one area of fluorescence is visible, in polysomy Y (XYY) - two, etc.

The method of sex chromatin determination is used in the following situations for: 1) sex determination in case of hermaphroditism; 2) determination of sex before birth (with amniocentesis); 3) diagnosis of hereditary diseases caused by imbalance of sex chromosomes; 4) establishment of hereditary pathology of children with intellectual disabilities; 5) detection of hereditary pathology in primary and secondary

amenorrhea in women; 6) in infertility in men and women; 7) in forensic practice (according to studies of blood stains, it is possible to establish the sex of the person to whom this blood belonged).

Significance: determination of sex chromatin allows to carry out without full karyotyping, which requires a lot of time, rapid diagnosis of the number of sex chromosomes.

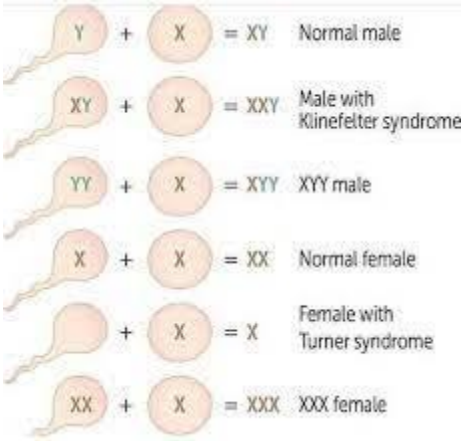


Fig. 15. Determination of sex X-chromatin.

The cytogenetic method allows to establish: a) the number of chromosomes in the karyotype; b) the genetic sex of the organism; c) the presence of chromosomal aberrations and their localization.

The use of the cytogenetic method in MGC makes it possible to diagnose chromosomal pathology in a timely manner and prevent the birth of a child with chromosomal syndromes.

In addition, biochemical methods can be used to diagnose chromosomal diseases, as these diseases have a «gene dose» effect, resulting in changes in the concentration of some enzymes. For example, in trisomy 21 (Down syndrome) the activity of superoxide dismutase enzymes increases 1.5 times. The dose effect is set for 30 genes located on different chromosomes.

Phenotypic analysis (eg, portrait diagnosis) and dermatoglyphics are important for the diagnosis of chromosomal pathology.

Topic 20. Population genetics.

Darwin's doctrine established in science the idea that each species is a historical category, a qualitative stage of evolution. Each species originated from another and exists until conditions change. Under new conditions, the species will either die or change, giving rise to a qualitatively new or new species.

Species – a set of individuals that are similar in morphological and physico-biochemical characteristics, karyotype, have a common origin, interbreed with each other and give fertile offspring and inhabit a certain area (area).

A biological species, which consists of numerous individuals that have genetic family ties, but differ in combinations of hereditary traits, constitutes a holistic

biological macrosystem. Gene pool - a set of all genes (genotypes) of a population, species in a certain period of time.

Individuals of any species are distributed in their range not evenly, but in separate stable clusters – populations. Population - a set of individuals of one species that inhabit a certain area, interbreed with each other and to some extent for some reason isolated from other similar groups.

Each population has a certain range, age and sex; the number of individuals in a population can range from a few hundred to several thousand. The smaller the population, the greater the risk of its extinction or death from any accidental causes.

Not only species of animals and plants consist of populations. The human population is a group of people who occupy one territory and marry freely. Factors that limit people in marriage can be geographical, social, religious, and so on. Large populations of people do not consist of one, but of several anthropological groups, which differ in origin and settle in large areas.

Small populations, the number of which does not exceed 1500 - 4000 people, are called demos. They are characterized by a high frequency of related marriages (80 - 90%). Even smaller human populations of no more than 1,500 are called isolates, in which related marriages make up more than 90%.

Genetic processes in populations.

In some cases, the population may simultaneously include individuals with both dominant and recessive traits that are not under the control of natural selection. The question arises: why is the recessive allele not replaced by the dominant? This question was solved purely mathematically for the ideal population in 1908 independently by the mathematician J. Hardy and the physician W. Weinberg. The pattern they discovered is called Hardy-Weinberg law.

The ideal population is characterized by the following features: immensity, free crossing (panmixia), no mutations in this gene, no migration in the population, no selection (on the basis of the gene encoded by this gene). In an ideal population, the ratios of genotypes of dominant homozygotes (AA), heterozygotes (Aa) and recessive homozygotes (aa) remain constant.

If the frequency of gene A is denoted by p, and the frequency of gene a by q, then q will be equal to 1-p. In F_2 and in subsequent generations, the frequency of genotypes AA, Aa and aa will be determined by Newton's formula:

$$(p + q)^2 = p^2 + 2pq + q^2,$$

Where p is the frequency of the dominant allele A; q is the frequency of the recessive allele a; p^2 is the frequency of dominant AA homozygotes; 2pq - frequency of heterozygotes Aa; q^2 is the frequency of recessive homozygotes aa. The values of p^2, 2pq, and q^2 remain constant. This explains the fact that in the presence of conditions that are inherent in the ideal population, individuals with recessive traits are stored next to individuals who have dominant traits.

In real populations, the above conditions are not feasible: real populations are limited in number, panmixia is never absolute, there are migrations of individuals and

the mutation process. However, this does not diminish the significance of Hardy-Weinberg's law. It establishes well-defined relationships between alleles in a population. Using the formulas of Hardy-Weinberg's law allows you to calculate the genetic composition of the population at present and identify trends in its changes.

Using Hardy-Weinberg's law, it is possible to calculate the saturation of the population with certain genes, to calculate the frequency of heterozygous genotypes in humans.

Consider its use in a specific example. In the settlement at inspection on a rhesus factor 16% of individuals with a rhesus-negative factor and 84% - with a rhesus-positive were found. It is known that positive rhesus factor is inherited almost monogenically, autosomally, by the dominant type. If the rhesus factor gene is designated C, the Rh + carriers will have the genotype CC and CC. But what part of them is homo- and heterozygous (ie, what is the concentration of the recessive allele)? We use the formula

$$(p + q)^2 = p^2 + 2pq + q^2 = 1 \text{ (or 100\%)}.$$

Homozygotes for the recessive allele q^2 are known, they are 16%. Therefore, $q^2 = 0.16$, hence $q = 0.4$ (or 40%), i.e. of the total number of population genes that determine rhesus affiliation, 40% are recessive.

What is the proportion of the dominant allele? Since $p + q = 1$, and $q = 0.4$, then $p = 0.6$, i.e. in a population of 60% of dominant alleles.

In order to find the percentage of combinations in the population of SS and CC genes, we calculate: $p^2 = (0.6)\ 2 = 0.36$, ie 36% have the SS genotype, $2pq = 2\ (0.6) \times (0.4) = 0.48$, ie 48% have the genotype CC. Thus, in the study group of people, 84% of individuals with rhesus-positive blood were: 36% with CC genotype and 48% with CC genotype, and 16% who had CC genotype were rhesus-negative.

In medical and genetic studies of populations, such calculations are quite common. But in cases where populations are limited in number, Hardy-Weinberg's law does not apply because it is based on statistical patterns that are not met in the case of small numbers. The bulk of humanity consists of large populations in which, according to Hardy-Weinberg law, the balance of genetic composition is maintained. However, this balance is constantly disturbed by the mutation process, migration, gene drift and other factors.

Population as an elementary evolutionary structure.

In the area of any species, individuals are distributed unevenly. Areas of high concentration of individuals alternate with spaces where they are few or none. As a result, there are more or less isolated populations in which random free crossing (panmixia) systematically occurs. Crossbreeding (ie gene exchange) with members of other populations, if it occurs, is much less frequent and irregular. Due to isolation in each population the gene pool peculiar to it which differs from other populations is created. It is the population and must be recognized as an elementary unit of the evolutionary process.

The concept of microevolution

Microevolution, called the evolutionary process that occurs within a species, leads it to differentiation and may culminate in the formation of a new species. But most often the result of microevolution is the formation of genetic polymorphism (the predominance of heterozygotes in the population over homozygotes, in which both alleles are stored in the population with an intermediate frequency and the population is in equilibrium). Microevolution takes place in a short historical time and is available for direct study.

The doctrine of microevolution forms the basis of the synthetic theory of evolution. This doctrine is based on precise methods of studying the evolutionary process in populations (genetic, ecological, mathematical, modeling experiment).

According to the synthetic theory of evolution, a population is an elementary unit of evolution. An elementary evolutionary material is mutation. Species formation begins with an elementary evolutionary phenomenon - the stability and directional change of the genetic composition (genetic constitution or gene pool) of the population.

Population properties: size, degree of isolation from adjacent populations, peripheral or central location of the population within the range of the species, sex and age composition of the population, intrapopulation polymorphism.

Phenomena and processes that change the gene pool of a population are called elementary evolutionary factors. There are undirected and directed evolutionary factors. Non-directional elementary evolutionary factors include: mutation process, population waves, isolation, migration, gene drift. A directed elementary evolutionary factor is the only factor - natural selection. It directs the evolutionary process towards the development of new and improvement of existing adaptations.

The problem of genetic burden in humans is of great importance for medicine. For medical and genetic counseling, it is important to have an idea of the gene saturation of hereditary diseases of the population in certain areas.

Questions for Preparation

1. Diseases with hereditary predisposition. The concept of multifactorial diseases.
2. Methods of studying human heredity. Man as a specific object of genetic analysis.
3. Genealogical and twin methods of studying human heredity.
4. Biochemical method of studying hereditary diseases. Screening programs.
5. Cytogenetic method of studying human heredity.
6. Medical and genetic aspects of the family. Medical and genetic counseling.
7. Prenatal diagnosis of hereditary diseases.
8. Population and statistical method of studying human heredity.
9. Gametogenesis: spermatogenesis, oogenesis. Human germ cells.
10. Fertilization. Features of human reproduction.
12. Ontogenesis, its periodization. Embryonic development, its stages.
13. Provisional organs.
14. Critical periods of human embryonic development. Teratogenic factors.

15. Congenital malformations, their modern classification: hereditary, exogenous, multifactorial; embryopathies and fetopathies; phylogenetically determined and non-phylogenetic.
16. Postembryonic human development and its periodization.
17. Neurohumoral regulation of growth and development.
18. Aging as a stage of ontogenesis. Theories of aging.
19. The concept of gerontology and geriatrics.
20. Clinical and biological death.
21. The problem of organ and tissue transplantation. Types of transplantations.
22. Tissue incompatibility and ways to overcome it.

Substantial module 5. «Human Ecology. Medical Parasitology»

Topic 21. Ecology and biosphere. Poisonous organisms.

Ecology is a science that studies the relationships between organisms and their environment. Violation of the ecological balance can cause ecological danger, ecological crisis and ecological disaster. Humanity faces a variety of environmental problems:

• pollution of the natural environment by waste from industrial and agricultural production;
• climate warming;
• pollution of the atmosphere by acid precipitation;
• desertification of large areas;
• decrease in biological diversity;
• extinction of species;
• loss of entire ecosystems.

In addition to the mentioned problems, in human ecology there are issues of filling ecological niches with unwanted organisms (parasites, pests, pathogens of new diseases, such as bird flu virus, prions, etc.); overpopulation of the Earth, demographic cataclysms; deterioration of the environment in urban and rural areas.

For the first time ecology was defined as «the science that studies the relationship of animals with organic and inorganic nature» in 1870 by the German scientist E. Haeckel in his work «General Morphology of Organisms». In 1895, the Danish botanist E. Warming applied this term to representatives of the plant world. And only in the 20th century. ecology was formed as an independent biological science with its own methods and subject of study.

Objects of research in ecology can be individual organisms, populations, groups, ecosystems and the entire biota of our planet. Therefore, three levels of study are distinguished in ecology: 1) population-species; 2) ecosystem; 3) evolutionary and historical.

The population-species level involves the study of individual reactions of individual organisms, populations or species as a whole to the action of environmental factors.

The ecosystem level of research involves the study of processes caused by the mutual influence of organisms or populations of different species. At this level, extremely complex and time-consuming research is carried out, aimed at clarifying the patterns that determine the existence in space and time of connections between various types of autotrophs and heterotrophs.

The evolutionary-historical level of research involves the establishment of strategic opportunities for the development of research objects under the influence of global (historical scale) fluctuations in environmental parameters, such as age-related fluctuations in weather conditions, changes in soil or relief, etc.

The following research methods are used in modern ecology:
• empirical;
• experimental;
• modeling.

Empirical methods include numerous methods of recording direct observations, measurements using any technical means. But observations alone are not always enough to conduct a weighted data analysis, so experiments are often used.
Experiments are carried out on the basis of theories that require the interpretation of research results. **Experimental methods** include methods that involve control and management of the conditions in which the research object is located. The main thing in performing experiments is the verification of hypotheses, assumptions that have fundamental practical significance.

Modeling methods in ecology include: object modeling, in which the model reproduces the parameters of the originals in a certain way, and symbolic and mathematical modeling, in which the object is reproduced virtually (computer modeling) or in the form of graphs, histograms, diagrams, etc.

In order to predict changes in natural ecosystems caused by natural processes or human activity, environmental forecasting is carried out. The following levels of forecasting are distinguished:
• local (spread over a small area);
• national (applies to a separate state);
• regional (extends to several countries, continent, ocean, etc.);
• global.

Ecological forecast predicts possible changes in ecosystems, based on objective scientific data on the patterns of functioning of living systems and their reactions to the influence of certain factors.

The environment is a set of factors that can directly or indirectly affect the vital activity of organisms. They are often called environmental factors. There are four main types of environment: water, air, soil and internal environment of organisms.

According to the degree of influence on organisms, external factors are divided into:
• vital (light, water, mineral salts, oxygen);
• optional active (smoke, radiation);
• optional neutral (inert gases).

By origin, the following are distinguished:
• biotic;
• abiotic;
• anthropogenic.

According to the nature of the influence, the factors are divided into:
• direct (directly affecting specific indicators of the state of the organism or population);
• indirect (affect indirectly).

Abiotic factors are divided into elementary (temperature, water, atmospheric pressure, air, electromagnetic field) and complex (chemical composition of the substrate (solution, gas), aggregate state of the substrate, sunlight).

Biotic factors are the action of living organisms on each other. They are divided into phytogenic, zoogenic, microbiogenic and mycogenic.

Any impacts caused by human activity in natural ecosystems are considered anthropogenic factors. According to the nature of activity, anthropogenic factors are: agricultural, transport, military, industrial and nature protection.

Each individual factor can be characterized by certain parameters, the values of which can be registered visually or instrumentally. The parameters of each factor can change in space and time. Such fluctuations of parameters affect the vital activity of organisms.

Eurybiont and stenobiont systems are distinguished depending on the range in which an organism or population is able to perceive fluctuations in the parameters of individual factors. Eurybionts are organisms (systems) capable of existing and reproducing within the broad limits of the influence of a factor. For example, a red cockroach (Prusak) can exist and reproduce in conditions of extreme temperatures, lighting, chemical composition of the atmosphere, etc.

Stenobionts are organisms (systems) that can ensure a full-fledged existence only under the conditions of a narrow range of action of individual factors. Thus, all endoparasites are stenobionts with respect to temperature (human roundworm larva), chemical composition of the fluid surrounding the parasite (liver fluke), or other factors.

Abiotic factors

Light is the most important abiotic factor on the planet. Only solar radiation provides the trophic needs of all living things on the planet. The sun emits light in a wide range of wavelengths (from ultraviolet to infrared). The portion of the sun's rays visible to the human eye is 40-50% of the total amount that reaches the Earth's surface. Waves with a frequency of less than 290 nm are harmful to most living organisms, a significant number of these waves are reflected by the ozone layer. Longer waves pass through this layer. Consumers of the Sun's energy are primarily autotrophic organisms, namely green plants.

According to light requirements, organisms are divided into light-loving, shade-tolerant and nocturnal. The first include all photosynthetic plants and some species of animals, for example, diurnal insects. The others include certain types of plants (for example, mosses) and animals. To some extent, such organisms can include humans. Heliophobic are some species of animals that lead a nocturnal lifestyle (bats) or live in caves, soil (moles).

Heat is an essential factor that determines the possibility of biochemical processes, because the proteins-enzymes that control the course of these processes function only within certain temperature limits. Plants are highly dependent on heat because they have very little ability to adjust temperature. Plants belong to ectothermic organisms (those whose temperature depends on the temperature of the environment). Unlike them, endothermic organisms have more powerful mechanisms for controlling their own temperature. Animals are divided into cold-blooded (poikilothermic) and warm-blooded (homoothermic).

With regard to the effect of the temperature factor, living organisms are divided into thermophilic and cold-resistant. The first live mainly in tropical latitudes, the second live in temperate and cold climates. Man, from the point of view of his biological properties, should be classified as a cold-resistant species, taking into account the presence of appropriate adaptation mechanisms. Resistance to the cold of some groups of people is an acquired trait, which is based on physiological adaptive mechanisms.

Ionizing radiation.

In nature, there are many substances containing radioactive elements (radium, thorium) or radioactive isotopes of carbon, hydrogen, potassium and other chemical elements. The evolution of the organic world and man took place against the background of certain doses of radiation that every living being receives. These doses constitute the natural radioactive background. Organisms are to some extent adapted to their influence. The level of the body's perception of the influence of radiation determines its radiosensitivity. This indicator can vary both within the species and within the organism.

Radioactive radiation is the strongest mutagenic factor. In humans, a certain proportion of mutations occurs under the influence of natural sources of radiation. The effect of radioactive radiation on germ cells is especially dangerous. The problems of

the influence of radiation on the state of the environment and human health became extremely relevant in the 20th century.

Water is the environment in which most of the metabolic processes of living organisms take place. The influence of water as an environmental factor is often impossible to separate from the influence of temperature. Thus, high humidity at low temperature or low humidity at high temperature equally limit the functioning of organisms.

Organisms are classified according to humidity requirements:

• hydrophilic (stages of development take place in water) - terrestrial molluscs, mosquitoes;

• mesophilic (exist and reproduce at an average temperature of 20-40 °C) - all mammals, including humans;

• xerophilic (exist in an environment with low air humidity) – reptiles, some rodents.

The lack of water in the body of animals and humans can be regulated thanks to the following mechanisms. Behavioral compensation is based on a reflexively determined search for water sources. Morphological compensation is based on retention in the body of the most important amount of water (in tissues or organs). Biochemical compensation is based on the formation of metabolic water through biochemical reactions (for example, the hump of a camel, where lipids accumulate, serves as a source of metabolic water).

According to the ability of organisms to withstand fluctuations in humidity, they are divided into *hydrostable* (have more perfect mechanisms for compensating for the lack and excess of water) and *hydrolabile* (less perfect) species.

Acidity level of water and soil solution.

Increased acidity affects organisms directly or indirectly. In the first case, the mechanisms of osmotic pressure regulation and the work of individual enzymes deteriorate. In the second case, low pH values can cause the accumulation of toxic ions (aluminum, lead, etc.) in the cells. For aquatic and soil animals, an acidic environment can mean a decrease in available food resources due to inhibition of the development of food sources in the soil. Fluctuations in the acidity and salinity of the soil can affect the health of people living in the area.

Thus, plant products grown on alkaline soils contain less iron, manganese and phosphorus due to the fact that these elements are in such soils in a bound form, inaccessible to plant roots. Fish grown in water bodies with high acidity accumulate excess aluminum. Through trophic chains, certain chemical elements enter the human body, accumulate in it in significant quantities, and this is the cause of the development of diseases.

Air is the habitat of many species of organisms and at the same time a source of oxygen, carbon dioxide, and sometimes nitrogen. Oxygen is a resource for both plants and animals, and carbon dioxide is only for photosynthetic plants. According to the requirements for the presence of free oxygen in the surrounding environment, all

organisms are divided into anaerobic (exist in an oxygen-free environment - some bacteria, endoparasites) and aerobic (exist in an oxygen environment - most animals).

Biotic factors are the most complex category of environmental factors, which is due to the complexity of the manifestations of vital activity. Organisms are able to influence each other and the environment. The set of relationships between living organisms is divided into three directions: competition, antibiosis, and symbiosis. The basis of such interaction is the need to use common natural resources.

Competition is one of the most common forms of interaction between organisms, which manifests itself in mutual limitation of resource use, competition for livelihoods and conditions for reproduction.

Antibiosis is an extreme manifestation of biotic factors, the result of which is the destruction of an organism (population, species). Among heterotrophic organisms, antibiosis manifests itself in the form of herbivory (herbivores and the plants they feed on are in antibiosis), predation (carnivores and the animals they feed on are in a state of antibiosis) and allelopathy (the influence of some plants on others as a result of their release) various substances, including those capable of suppressing the vital activity of plant organisms). The phenomenon of allelopathy is characteristic of lower eukaryotes and prokaryotes.

Symbiosis is a way of coexistence of representatives of different species, which requires co-adaptation (mutual morphological and functional adaptations developed in the process of evolution of organisms).

Species that enter into symbiosis are called symbionts.

There are several forms of symbiosis:

a) mutualism - a form in which both organisms have a certain benefit from each other (for example, Escherichia coli, settling in the intestines of a person, uses its contents as a source of nutrition, in return giving the person some useful products of their vital activity, vitamins of group B, such coexistence is not harms neither humans nor bacteria);

b) commensalism - a form in which one of the organisms benefits from coexistence, and the other does not, but this coexistence does not harm it (for example, the existence of an intestinal amoeba in the human intestine does not affect the state of human health);

c) parasitism - a form of symbiosis in which one of the organisms uses another as a source of food, a place of residence and at the same time causes harm to the latter without causing its death (for example, human ascaris in the intestines of a person); d) amensalism - a form of interrelationships between organisms of different species, in which one species suppresses the vital activity of another, but is not affected in return.

Anthropogenic factors

By their nature, anthropogenic factors are divided into:

• chemical (harmful gases: methane, carbon monoxide, pesticides, carcinogens, heavy metal ions, etc.);

• physical (changes in the electromagnetic field, noise pollution, etc.);

• combined;
• climatic (general warming caused by an increase in the concentration of carbon dioxide);
• relief-forming (erosion and landslides caused by agricultural production or construction).

By duration of action:
• permanent (changes in the groundwater regime caused by construction);
• periodic (plowing, deforestation, etc.).

According to the consequences they can cause, they are divided into:
• inconspicuous (for example, a change in the concentration of organic matter in seawater);
• catastrophic (radiation pollution of the environment, oil spills during tanker accidents, fires, powerful explosions);
• adaptive (changes in the salt composition of soil, drinking water, etc., in the course of life activities of individual populations);
• signal (expressed in a change in the habitats of individual species, for example, after the reduction of toxic emissions into the atmosphere, birds of prey that could be observed only outside industrial zones return to cities).

Ecosystems

The first definition of an ecosystem was given by the English scientist A. Tansley in 1935. An ecosystem is a set of populations of autotrophic and heterotrophic organisms connected by trophic and energy ties, a common territory or water area. An ecosystem is an open system, has the ability to self-regulate and can exist for a long time. Organisms (populations) within the ecosystem are connected by common resources.

An ecosystem is an elementary structural and functional unit of the biosphere, within which manifestations of the circulation of substances and energy take place. An ecosystem can be natural or artificially created (for example, the interior of a spaceship).

Natural ecosystems are formed spontaneously through the competitive mutual exclusion of species (populations) in the course of their selection of ecological niches. An ecological niche is a set of environmental parameters that characterize the place of a species in the ecosystem. Each species has a spatial niche (certain volume of space), which depends on the size of individuals, their mobility, number, and a trophic niche, which is determined by the food needs of the species.

The trophic niche is wide in those species that have a variety of food preferences (omnivores), and narrow in specialized species (for example, the endoparasite of the human roundworm).

There are two main habitats for ecological niches of organisms on the planet: water and air. The soil environment, underground and internal environment of organisms (the habitat of endoparasites) are also distinguished.

The most important types of relationships between organisms in an ecosystem are trophic and energetic, because they determine the parameters of the environment within the ecosystem. Each ecosystem occupies a certain biotope. A biotope is a part of the territory or water area in which homogeneous abiotic conditions exist, and which is occupied by a biocenosis. An ecotope is a biotope that has acquired certain changes as a result of the activity of living organisms.

Within the ecosystem, a biocenosis is formed - a historically composed set of populations of various types of organisms (plants, animals, fungi, microorganisms) united by a common biotope, which are characterized by adaptability to environmental conditions, certain relationships, and direct or indirect connections. Biocenosis is a dynamic system that is constantly changing qualitatively and quantitatively. A historically compiled set of populations of organisms united by a common biotope, but without taking into account the existing relationships between them, is called biota.
The complex of terrestrial biocenosis and ecotope is called biogeocenosis.

The trophic structure of ecosystems is based on the nutritional needs and life strategy of the participants. They are divided into three main categories: producers, consumers and reducers.
Producers are autotrophic organisms that synthesize organic substances using external energy sources (energy from the sun for photosynthetic green plants and prokaryotes or energy from redox reactions for prokaryotes-chemotrophs). The biomass of producers is the primary production of ecosystems. The total mass of all producers of the biosphere is about 95% of the mass of all living organisms.

Consumers are heterotrophic organisms that consume living biomass of autotrophs or heterotrophs. Consumers of the first, second and higher orders are distinguished depending on food needs. Consumers of the first order are heterotrophs that depend on autotrophs and eat the biomass of producers (herbivorous animals: sheep, cows, hares, bullfrogs, caterpillars). Consumers of the II order are consumers of biomass of primary consumers (wolf, swallow). Tertiary consumers are predators that eat secondary consumers (they are not present in all types of ecosystems). Parasites and omnivorous heterotrophs, which include humans, have a special status.

Depending on the food consumed, consumers are divided into phytophages (plant eaters), zoophages (carnivores), necrophages (consumers of corpses), coprophages (consumers of excrement). Omnivorous consumers can consume food of various origins. For example, a raccoon dog feeds on animal and vegetable food, and in difficult conditions can be necrophagous and coprophagous

Reducers are heterotrophic or mycotrophic organisms that feed on dead organic matter of plant origin (saprophages) or semi-decomposed organic matter (detritophages). These organisms break down complex organic compounds into simple organic and inorganic compounds. Bacteria and fungi are reductants. Aerobic reductants reduce nitrogen to the molecular state, sulfur to hydrogen sulfide. Anaerobes produce methane, hydrogen, and various carbon-containing compounds.
The sequence of transformation of matter and energy within the ecosystem is ensured by the presence of trophic chains. A trophic chain is a series of living organisms connected by trophic links.

Biogeocenoses

Biocenosis is an interconnected set of organisms inhabiting a certain area of the habitat - a biotope, interconnected in food chains, influencing each other.
Biogeocenosis is a complex sustainable self-regulating natural system that unites biocenosis and biotope. All biogeocenoses can be divided into three groups: natural, agrocenosis, urbanocenosis.

Natural ones are characterized by a large variety of wild species of plants and animals. These coenoses are found in different landscape and geographical zones (tundra, forest-tundra, taiga, mixed and broad-leaved forests, steppes, etc.) and are therefore quite diverse.

The second group - rural communities, or agrocenoses, are characterized by small remnants of wild nature, significant territories occupied by cultivated plants, a large number of domestic animals (the species composition of which is limited) and cultivated plants.

The third group - urban and industrial cenoses, or urban cenoses, are characterized by large crowds of people, a relatively small area of artificially planted plants, poverty of fauna, often pollution of the environment by industrial and transport emissions.

Spaceships are a special type of biocenosis. Space biology is the youngest branch of biological science, which studies the effect of space factors on terrestrial organisms. The task of space biology also includes the study of possible extraterrestrial life forms. The expansion of space exploration poses the task of creation closed systems that ensure human existence in outer space.

Topic 22. Introduction to parasitology.

Parasitism (Greek parasitos – parasite) is a form of relationship between organisms of different species, in which one organism (parasite) uses another (host) as a source of food and a place to live, causing harm, but not destroying it.

An elementary parasitic system includes two components: a parasite organism and a host organism.

For a parasite, the host organism performs the following functions:

- a place of residence;
- a source of nutrition;
- «protects» the parasite;
- creates conditions for reproduction;
- regulates the relationship between the parasite and the host's habitat.

A parasite usually has a harmful effect on the host, causing disease.

This property of a parasite is defined as **pathogenicity** (Greek pathos – suffering, genesis – development).

Forms that are not capable of causing disease are called non-pathogenic.

A person infested with parasites can become a source of infection not only for others, but also for himself. This phenomenon is called **autoinvasion.**

Re-infection of a person with a parasite that he was previously infected with and recovered from is called reinvasion.

The source of the invasion can be carriers of parasites - sick animals, humans. For example, a person suffering from ascariasis, trichocephalosis, diphyllobothriasis or other helminthiasis constantly releases eggs into the environment. People who have had amebiasis, giardiasis, can excrete cysts of dysentery amoeba, giardia and contribute to the infection of others.

According to the unified nomenclature of invasive diseases, which are designated by the zoological name of the pathogen, the ending «az» or «oz» is added to the generic name of the parasite (amoeba - amebiasis, leishmania - leishmaniasis, trichomonad - trichomoniasis, etc.).

Forms of manifestation of parasitism are extremely diverse. Parasitism is not always the only form of existence of an organism, therefore it is divided into facultative and obligate.

Facultative parasites (from the Latin facultatis – possibility) usually live freely in nature, but accidentally get into the body of another species (host) and lead a parasitic existence (some roundworms, predatory leeches).

Obligate (from Latin obligatus – obligatory), or ***true parasites*** – organisms for which a parasitic lifestyle is an obligatory form of existence.

Among infectious and invasive diseases, *anthroponoses, anthropozoonoses and zoonoses* are distinguished.

Anthroponoses are diseases that are characteristic only of humans (amoebiasis). ***Zoonoses*** are diseases that are characteristic of animals.

Anthropozoonoses (zooanthroponoses) - diseases whose pathogens affect both animals and humans (leishmaniasis, echinococcosis).

Classification of parasites:

Parasites are organisms that use organisms of another species (host) as a source of food and habitat, causing them harm and entrusting the hosts with the full or partial regulation of their relationships with the environment.

Parasites are classified as:

- *Depending on the location:*

1) Ectoparasites (external parasites) - exist on the surface of the host's body: on the surface of the skin, in the thickness of the skin, in cavities that communicate with the external environment (lice, ticks).

2) Endoparasites (internal parasites) live in the internal organs, tissues, cavities, cells of the host's body (dysenteric amoeba, ascaris).

- Depending on the duration of contact with the host, parasites are temporary and permanent:

Temporary parasites are usually associated with the host only for the feeding period, and spend most of their lives in the external environment (mosquitoes, argasi mites).

Among the **permanent parasites,** there are relatively permanent ones (they spend only a certain stage of their development on the host) and absolutely permanent ones, which spend their entire lives on the body or inside the host and cannot exist at any stage of their development in the external environment (malarial plasmodia, lice).

- Depending on the number of potential hosts, they are distinguished:

• **monoxenous** - adapted to life in the body of one host (human roundworm - a parasite of only humans),

• **heteroxenous** - adapted to life in the body of many species (trichinella - a parasite of over 100 species of mammals).

Classification of hosts

Hosts are *definitive, intermediate and reservoir*.

Definitive (final, definitive) host - an organism in which the parasite is in the sexually mature stage and reproduces sexually.

Intermediate host - an organism in which the parasite is in the larval stage or reproduces asexually.

If there are two intermediate hosts, the second is called **additional.**

A reservoir host is an organism in which the parasite remains viable, accumulates, but does not develop.

On the part of the host, in response to the penetration of the parasite, a complex of protective reactions develops. It has been established that parasitic disease does not always develop. Susceptibility to invasion is influenced by age, physiological state of the organism, and state of the immune system. The influence of the host on the parasite is a cellular reaction, tissue reaction, humoral reaction. The host organism is a first-order environment for the parasite (E.N. Pavlovsky).

The external environment in which the host exists is a second-order environment. The external environment affects the parasite with biotic and abiotic factors not directly, but through the host organism.

The life cycle of a parasite is a set of developmental stages, after which the parasite reaches sexual maturity and becomes capable of giving rise to the next generation.

A parasite carrier is a person or animal in whose body the parasites live, but do not cause clinical manifestations of the disease.

The source of the pathogen (parasite) is an organism that is the place of its natural residence and reproduction.

The mechanism of pathogen transmission (the penetration of parasites into the host) is the way in which the pathogen moves from the infected to the susceptible organism. The main mechanisms of pathogen transmission are:

1) **fecal-oral** - the parasite at a certain stage of its development is excreted with the host's feces, and its invasive stage is introduced into the host's body through the mouth with unwashed hands, contaminated food (dysenteric amoeba);

2) **transmissible** - the parasite enters the host's body through a blood-sucking vector (malarial plasmodium);

3) **contact** - the host becomes infected through contact with a sick person, or with the things of a sick person.

Routes of infection - the way the parasite enters the host's body.

The main routes of infection:

oral - through the mouth (when eating food, etc.);
percutaneous - through the skin;
airborne - through the respiratory system;
contact-household - when in contact with a patient or his belongings;
transmissive - when bitten by vectors;
transplacental - through the placenta from mother to fetus;
sexual - during sexual contact;
hemotransfusional - with accidental transfusion of infected blood; contaminating - with passive penetration of the pathogen into the host's body.

Autoinvasion - repeated self-infection of the host with a parasite that is already parasitic in the body.

Reinvasion - repeated infection of a person with parasites that were previously infested, but after recovery.

Autoreinvasion - repeated self-infection with one's own parasites without their release into the external environment.

Pathogenicity - the potential ability of a given type of parasite to cause an invasive process, a parasitic disease. Pathogenicity is a specific feature, that is, this parasite causes only a certain parasitic disease (hairy head causes trichocephalosis).

Invasive stage - the stage of the parasite's life cycle that, upon entering the host's body, causes disease.

The invasive process is the sum of all protective and pathological reactions of the body that occur in response to the penetration and action of the parasite.

Virulence is the degree of pathogenicity.

Invasive (parasitic) disease is the extreme stage of the development of the invasive process, manifested by certain clinical signs. The effect of the parasite on the host is mechanical, toxic, and feeds on the host.

Extensiveness of invasion - the relative number of individuals infected with a parasite in the population.

Intensity of invasion - the number of parasites in one individual, organ, cell.

Communicable diseases

The agents of communicable diseases, both infectious and invasive, are transmitted from one host to another by vectors.

There are obligately transmissible and facultatively transmissible diseases. The pathogens of obligately transmissible diseases are transmitted only through a vector (malaria, typhus and relapsing typhus). The pathogens of facultatively transmissible diseases are transmitted both with the help of a vector and without it, by other means (plague, tularemia).

The plague pathogen can be transmitted to humans by transmission (through flea bites), as well as by contact (when skinning infected rodents), and by airborne droplets (in the case of the pulmonary form of the plague).

Carriers are specific and mechanical.

Specific (obligate) vectors are those in whose body the pathogen undergoes a development cycle. They are mainly blood-sucking arthropods. For example, the malaria mosquito is a specific vector of the malaria pathogen. In the body of mechanical vectors, the pathogen does not undergo a development cycle, but only moves with their help in space.

Thus, pathogens of various diseases can be found on the body coverings, paws, and in the intestines of a housefly.

Subkingdom Protozoa

Protozoa are single-celled animal organisms. The vast majority are microscopic in size. The total number is over 65,000 species. They are widespread in various environments - fresh and sea water, soil. Many species lead a parasitic lifestyle.

Classification of protozoa – human parasites.

Subkingdom Protozoa			
Type Sarcomastigophora		Type Apicomplexa	Type Infusoria
Class Sarcoidea	Class Flagellate	Class Spores (coccidia)	Class Ciliates
Amoeba	Leishmania Trypanosomes Giardia Trichomonads	Plasmodium Toxoplasma	Balantidium

The body of protozoa consists of cytoplasm, nucleus and cell membrane (a thin pellicle that preserves the properties of living cytoplasm and a dense cuticle).

Two layers are distinguished in the cytoplasm:

1) an outer, transparent, denser layer (ectoplasm) and

2) an inner, granular layer (endoplasm).

The endoplasm contains general-purpose organelles (mitochondria, endoplasmic reticulum, ribosomes, etc.) and special-purpose organelles that perform the functions of movement (pseudopodia, flagella, cilia), digestion (digestive vacuoles), secretion (contractile or pulsating vacuoles), and protection (trichocysts in ciliates).

Through contractile vacuoles, excess water and liquid dissimilation products are released, osmotic pressure is maintained at a constant level, and the cell is supplied with oxygen. Protozoa have one or more nuclei. The nucleus has a typical structure of the nucleus of a eukaryotic cell. Protozoa reproduce asexually and sexually. In some species, asexual and sexual reproduction alternate (metagenesis).

Nutrition: heterotrophic, absorption of food by phagocytosis and pinocytosis, or osmotic; mycotrophic.

The most characteristic property of protozoa is the ability to form cysts (encysting) under adverse conditions.

At the same time, the protozoa stop moving, acquire a spherical shape, lose the organelles of movement or pull them inside the body and become covered with a dense shell. The metabolic processes in the cyst slow down. In the encysted state (anabiosis), the protozoa can tolerate sharp changes in environmental conditions (drying, cooling, exposure to chemicals), while maintaining viability.

When favorable conditions return, the cysts open (excystation) and the protozoa emerge from them as active vegetative forms. The cell of the protozoa during the period of active life is called a trophozoite.

Type Sarcomastigophora.

Class Lobozea.

Amoebas are the most simply organized protozoa. The cytoplasm is separated from the external environment only by a membrane, so the body does not have a permanent shape. The organelles of movement and food capture are pseudopodia (false legs). The method of capturing and digesting food is called phagocytosis.

They reproduce mainly asexually - by dividing into two parts. Under unfavorable conditions, they form cysts. The medically important Amoeba series includes the pathogenic dysenteric amoeba and several types of non-parasitic amoeba (intestinal, oral, etc.).

Amoeba dysenterica (Entamoeba histolytica) is the causative agent of amebiasis, or amoebic dysentery. It was discovered by the St. Petersburg scientist F.O. Lesh in 1875. The only source of infection is humans.

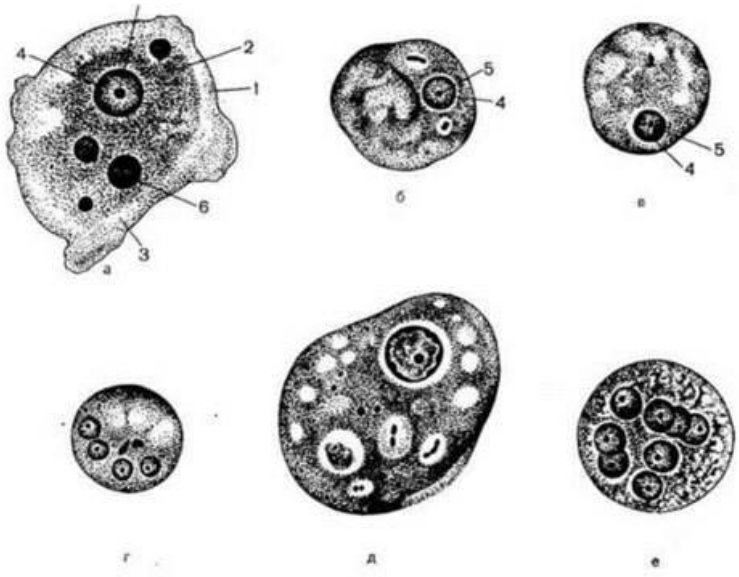


Fig.16. Dysentery (Entamoeba histolytica) and intestinal (Entamoeba coli) amoebas:

a - Entamoeba histolytica forma magna with phagocytized erythrocytes; b, c - Entamoeba histolytica forma minuta; d - four-nucleated cyst of dysentery amoeba; 1 - ectoplasm; 2 - endoplasm; 3 - pseudopodia; 4 - nucleus; 5 - karyosome; 6 - phagocytized erythrocytes in digestive vacuoles; Entamoeba coli: vegetative form (e) and its eight-nucleated cyst (e).

Geographic distribution - everywhere, but more often in countries with hot climates.

Localization: large intestine.

Morphology. Parasitic only in humans. The following forms are found in the life cycle: 1) cyst; 2) small vegetative form (forma minuta); 3) large vegetative form (forma magna) and 4) tissue form.

Life cycle. Cysts are excreted into the external environment with the feces of infected people. They enter the human body through the mouth (fecal-oral mechanism of infection, alimentary route of infection) with unboiled water, unwashed vegetables and fruits, through contaminated hands, and are spread by flies and cockroaches (mechanical vectors).

The invasive stage: a quadrinucleate cyst. In the human intestine, the cyst shell dissolves and a 4-nucleate amoeba emerges from it, which quickly divides into eight single-nucleate small vegetative forms - f.minuta (7-15 microns in diameter), which live in the lumen of the large intestine, feed mainly on bacteria, and do not cause disease (non-pathogenic).

They encyst in the lower parts of the intestine. Sometimes an infected person secretes cysts for years without showing signs of the disease. Such people are called cyst carriers. They pose a very great danger, because they serve as a source of infection for others. One cyst carrier secretes up to 600 million cysts per day.

However, in some people under certain conditions (hypothermia, overheating, vitamin deficiencies, infections, helminthiasis) f. minuta penetrates the intestinal wall, where it multiplies intensively. Amoebas that are localized in the tissues of the intestinal wall are a tissue form of dysenteric amoeba. It is pathogenic, causing damage to the mucous membrane with the formation of ulcers (amoebiasis).

In this case, the walls of blood capillaries are destroyed and bleeding into the intestinal cavity occurs. The penetration of amoebas into the intestinal mucosa and its destruction is associated with the ability of dysenteric amoeba to secrete proteolytic enzymes that dissolve tissue proteins.

When amoebic lesions of the intestine appear, small vegetative forms located in the intestinal lumen transform into a large vegetative form (f. magna), which feeds on erythrocytes. It is characterized by large dimensions (30-40 microns) and the structure of the nucleus: the chromatin of the nucleus forms radial structures, in the center of the nucleus there is a large lump of chromatin - the karyosome. The large vegetative form is characterized by blunt, wide pseudopodia and jerky movements. Cessation of bleeding and, accordingly, the inability to feed on erythrocytes leads to the transformation of the large vegetative form into a small one, which begins to encyst.

Pathogenic action. Amebiasis is an anthroponosis, an acute protozoan disease that progresses to a chronic stage. The source of infection is a sick person or cystonosis. With amebiasis, frequent bowel movements (up to 10-20 times a day) with impurities of blood and mucus are observed. Penetrating into blood vessels, amoebae can enter the liver, lungs, and brain with blood, forming abscesses (suppuration) there. The disease can be fatal if left untreated.

Laboratory diagnostics. The material is feces, which must be fresh. Smears are examined under a microscope. A large vegetative form with phagocytized erythrocytes is detected in acute amebiasis and tetranuclear cysts in chronic amebiasis and in practically healthy cyst carriers. The size of the cysts is 10-15 microns.

Prevention. Personal - washing hands before eating and after using the toilet; heat treatment of food and drinking water, thorough washing of vegetables and fruits used in raw food; protection of food and water from dust and from flies and cockroaches.

Intestinal amoeba (Entamoeba soli). Non-pathogenic, commensal, does not cause disease, lives in the lumen of the large intestine, morphologically similar to dysenteric amoeba. It also forms vegetative forms and cysts, but does not secrete a proteolytic enzyme and does not penetrate the intestinal wall. It feeds on bacteria and food debris. Phagocytized erythrocytes are not observed in its cytoplasm. There are many vacuoles in the endoplasm. The cyst usually contains 8 nuclei, the size of the cysts is 13-25 microns.

Oral amoeba (Entamoeba gingivalis). The first parasitic amoeba found in humans. Often found in carious teeth and in the white plaque that covers the teeth. Feeds on bacteria and leukocytes. Does not form cysts. Pathogenic significance is doubtful.

Free-living amoebae. Among free-living aquatic amoebas (Naegleria, Acantamoeba, Hartmanella), there are mutant forms that, when ingested, cause diseases of the central nervous system (meningoencephalitis).

Phylum Sarcomastigophora.

Class Zoomastigophora.

Species: Trypanosomes: Trypanosoma brucei gambiense, Trypanosoma brucei rhodesiense, Ttypanosoma cruzi;

Leishmania: Leishmania tropica minor, Leishmania tropica major, Leishmania brasiliensis, Leishmania mexicana, Leishmania donovani, Leishmania infantum;

Giardia: Lamblia intestinalis;

Trichomonas: Trichomonas vaginalis, Trichomonas hominis, Trichomonas tenax.

The class Flagellates includes protozoa that have organelles of movement - flagella (one or more) - threadlike outgrowths of the cytoplasm. Flagella are located at the anterior end of the animal's body. The base of the flagellum is always connected to a kinetoplast - an organelle that performs energy functions and contains a lot of DNA.

In addition to the outer membrane, the body of flagellates is covered with a membrane (pellicle) and has a fixed shape. Sometimes a wavy cytoplasmic membrane is formed between the flagellum and the pellicle - the undulating membrane. The latter makes wave-like movements and is an additional organoid of movement. A number of flagellates also have a supporting organelle - the axostyle - in the form of a dense string that runs through the middle of the cell.

Nutrition in plant forms of flagellates occurs autotrophically (inherent chlorophyll) through photosynthesis, animal forms feed heterotrophically. They reproduce mainly asexually (longitudinal division); sexual reproduction occurs in most species. Most species exist in a vegetative form, and some are capable of forming cysts.

Distributed in marine and freshwater bodies, many have switched to a parasitic lifestyle.

Of the genus Trypanosoma, three species are pathogenic for humans: **Trypanosoma brucei gambiense** (Gambian trypanosome), **Trypanosoma brucei rhodesiense** (Rhodesian trypanosome), **Trypanosoma cruzi.**

Geographical distribution: Trypanosoma brucei gambiense - Central and West Africa; Trypanosoma brucei rhodesiense - Southeast Africa.

Localization: brain, cerebrospinal fluid, liver, spleen, kidneys, heart, lungs, bone marrow, lymph nodes, serous membranes. The brain is mainly affected.

Morphology. Trypanosoma brucei gambiense, Trypanosoma brucei rhodesiense have a sinuous shape pointed on both sides. Length 30-40 microns. Stages that parasitize humans have one flagellum, an undulating membrane and a kinetoplast.

There are three types: trypanosomal form (the membrane ends at the anterior end of the body, the flagellum protrudes forward, forming a long free end), critidial form (the flagellum begins in front of the nucleus, is directed forward, forms a short undulating membrane and a free end), and metacyclic form (similar to critidial, but does not have a free flagellum).

The movement of trypanosomes is active, using a flagellum, an undulating membrane and body flexion.

Life cycle. Parasite of humans and mammals. Transmission mechanism is transmissive. Source of infection - sick humans and animals. Trypanosoma brucei

gambiense more often affects humans, pigs and dogs; Trypanosoma brucei rhodesiense - wild animals - antelopes and rhinoceroses.

The specific vector is the blood-sucking tsetse fly: for Trypanosoma brucei gambiense, the tsetse fly Glossinapalpalis is the most common vector, which lives near human settlements; for Trypanosoma brucei rhodesiense, it is Glossina morsitans, which lives in open savannas and savanna forests. In this regard, sleeping sickness, the causative agent of which is Trypanosoma brucei gambiense, occurs in anthropogenic foci of cultural landscapes. 10,000 new cases of infection are registered annually.

East African trypanosomiasis is less common, in natural conditions. Hunters, tourists, seasonal workers are mainly affected, about 1,500 people are infected annually. Outside the range of the tsetse fly, African trypanosomiasis does not occur. According to the latest data, it is humans who are the main reservoir of the pathogen.

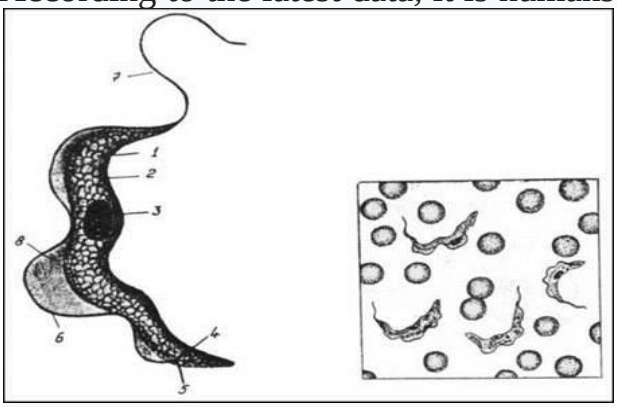


Fig. 17. General plan of the structure of a trypanosome (A) and appearance of a trypanosome in a blood smear (B):

1 - cytoplasm; 2 - periplast; 3 - nucleus; 4 - blepharoplast; 5 - rhizoplast; 6 - free edge of the membrane; 7 - free end of the flagellum; 8 - undulating membrane.

The pathogen develops with a change of hosts. Getting into the midgut of a tsetse fly with the blood of a sick person or animal, trypanosomes (trypanosomal form) begin to multiply intensively. After 15-20 days, trypanosomes penetrate the saliva of the vector's gland, where they gradually transform into the critidial and then metacyclic forms. A person becomes infected when the saliva of an infected tsetse fly enters the wound during bloodsucking.

Invasive stage - metacyclic trypanosomes. After 2-3 weeks, the pathogen spreads to all organs and tissues.

Pathogenic action.

Trypanosomiasis is a transmissible natural focal tropical disease, which is accompanied by fever, muscle weakness, exhaustion, fatigue, drowsiness. In the early stage, there is an increase in lymph nodes (especially cervical).

In the late stage - significant lesions of the central nervous system. The painful condition lasts 7-10 years and in the absence of treatment ends in death. The clinic of Rhodesian trypanosomiasis is characterized by a more acute course. In the absence of treatment, death occurs in about a year.

Parasitism of trypanosomes in mammals and humans is characterized by cyclical increases in the intensity of invasion due to their reproduction, which is accompanied by changes in the structure and antigenic properties of the parasite organisms. The antigens they produce cause the formation of antibodies in the host organism. Under the action of antibodies, most parasites die and the intensity of invasion decreases.

Those trypanosomes that survive shorten (trypanosomal form) and begin to produce other antibodies. Trypanosomal forms of the parasite, which are invasive for the tsetse fly, in its body again acquire an elongated form (metacyclic), which is invasive for humans. The change in body shape and the change in antigenic properties of the shell are repeated many times.

In this way, the parasite population in the host survives and escapes the host's immune response.

The antigenic properties of the surface of the trypanosome depend on only one protein - glycoprotein, which completely covers the entire cell. Glycoprotein consists of 470 amino acid residues. Each wave of parasite reproduction is a new population of trypanosomes, which have a new surface antigen.

These variations in antigenic properties help the parasite to overcome the host's immunological response and make it impossible to vaccinate the population living in natural foci of trypanosomiasis.

The change in antigenic properties is ensured by changes in surface glycoproteins, which are encoded by different genes.

One clone of trypanosomes can produce up to 100 different variable glycoproteins - this is one of the parasite's adaptations to specific living conditions, which increases survival.

Laboratory diagnostics. Material for laboratory diagnostics: blood, lymph node punctates - at an early stage and cerebrospinal fluid - at a late stage; serological studies - RBC and X-ray diffraction with diagnostic agents.

Under the microscope, vegetative forms of trypanosomes are detected.

Prevention. Personal - protection from tsetse fly bites using repellents, nets, taking medications that can prevent infection. Public - destruction of tsetse flies using insecticides, early detection and treatment of patients.

Trypanosoma cruzi is the causative agent of American trypanosomiasis or Chagas disease.

Geographical distribution: Trypanosoma cruzi - South and Central America.

Localization: cells of internal organs.

Morphology. The length of this trypanosome in the blood reaches 20 microns. The kinetoplast is large, rounded. A characteristic feature of the pathogen is the ability to intracellular parasitism. In this case, trypanosomes penetrate first into macrophages of the skin, mucous membranes, and then into myocardial cells, neuroglia and muscles, losing flagella, undulating membranes, and transforming into flagellate, or amastigote, forms.

This is where the parasites reproduce. In the blood, these trypanosomes never divide. As a result, the affected cell becomes filled with amastigote forms of trypanosomes and bursts, and the parasites invade new cells. At the same time, some

of them, turning into a flagellated form, enter the blood, from where they enter the body of the vector.

Life cycle. The vectors are triatomine bugs p.p. Triatoma, Rhodnius, Panstrongylus. In them, trypanosomes multiply and reach a state of invasion, entering the hindgut. After bloodsucking, the bugs defecate on the integument of a person or animal and trypanosomes enter the blood through the wound surface. The definitive hosts, in addition to humans, are armadillos, opossums, rats, monkeys and domestic animals - dogs, cats, pigs.

Invasive stage: metacyclic trypanosomes. Pathogenic action. The disease affects mainly young children, and proceeds acutely in them. In older age, the disease becomes chronic. **Pathogenic action** is expressed in the defeat of organs in the cells of which parasites develop: characteristic myocarditis, hemorrhages in the meninges and meningoencephalitis. Sometimes the disease is mild and ends with self-healing.

Laboratory diagnostics. In the acute form, trypanosomes can be seen in the blood. Also, microscopy of lymph node punctate and cerebrospinal fluid is performed. In the chronic form, the patient's blood is injected into guinea pigs, in which trypanosomes can be seen in large numbers in the blood on the 14th day. Immunodiagnostic methods are also used.

Prevention. Personal - protection from bedbug bites. Public - detection and treatment of patients, destruction of bedbugs with insecticides. Trypanosomes are of interest not only because they can cause serious, fatal diseases in humans.

Leishmania - intracellular parasites, causative agents of leishmaniasis. Several species of Leishmania are pathogenic for humans.

Dermatotropic (cutaneous) leishmaniasis. Pathogens: *Leishmania tropica minor* - causes anthropozoonotic (urban) cutaneous leishmaniasis; *Leishmania tropica major* - causes zoonotic (desert) cutaneous leishmaniasis; *Leishmania brasiliensis* - causes mucocutaneous (American) leishmaniasis; *Leishmania mexicana* - causes cutaneous leishmaniasis.

Geographic distribution: Leishmania tropica minor - Central and Western India; Leishmania tropica major - Central Asia, Northern Afghanistan, Iraq, Iran, Central Africa; Leishmaniabrasiliensis, Leishmania mexicana - South America.

Localization: intracellular (monocytes, macrophages) in skin cells;

Morphology. Very small (2-4 microns, sometimes up to 8 microns) intracellular parasites.

There are two stages in the life cycle: 1) non-flagellate (amastigote, or leishmanial stage) round in shape, 2-6 microns, spherical nucleus, occupies up to 1/3 of the cell, there is a kinetoplast - in the human body and other vertebrates and 2) flagellated (promastigote, or leptomonad stage) of elongated shape, spindle-shaped, up to 10-20 microns long, mobile, flagellum 1520 microns - in the body of insect vectors. Flagellated forms are also formed in culture on a nutrient medium.

Life cycle. Leishmaniasis is a group of transmissible infections. The natural reservoir for L. tropica minor is humans, for L. tropica major - rodents (gerbils, ground squirrels, hamsters, etc.), which are sometimes infected in natural conditions by up to

70%. The source of infection is infected animals, humans. Transmission is carried out by dipteran blood-sucking insects - mosquitoes of the genus Phlebotomus (specific vector).

Mosquitoes become infected by sucking blood from sick people or animals. On the first day, the swallowed non-flagellate parasites transform into motile flagellate forms, begin to multiply and accumulate in the mosquito's pharynx for 6-8 days. Infection occurs through a mosquito bite. When a person or animal is bitten by an infected mosquito, motile leishmania from its pharynx penetrates the wound and then sinks into the skin cells. Here they are transformed into flagellate forms.

Invasive stage: flagellate leptomonad form of Leishmania.

Pathogenic action. At the site of the bite (on exposed parts of the body, mainly on the face) painful ulcers are formed, which do not heal for a long time (about a year), after healing scars remain. A person who has had the disease develops a stable immunity for life.

The disease in animals also manifests itself in the form of skin ulcers. In mucocutaneous (American) leishmaniasis, the causative agent of which is L. brasiliensis, a small ulcer forms at the site of the bite, which heals, leaving a characteristic scar. After a few weeks or months, multiple metastatic ulcers appear on the mucous membranes of the nasal cavity, mouth, pharynx, and larynx. The ulcers enlarge and gradually destroy not only the soft tissues, but also the cartilage (nose). Without treatment, the process lasts for years, and due to the addition of a secondary infection, it ends fatally.

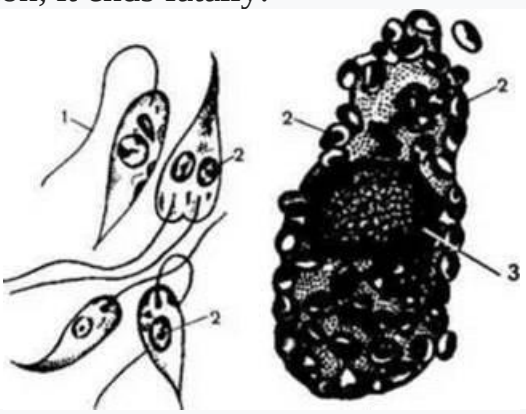


Fig. 18. Leishmania:

a) leptomonad (flagellated) form; b) leishmanial (non-flagellated) form; 1 - flagellum; 2 - nucleus; 3 - nucleus of a tissue cell affected by leishmania.

Laboratory diagnostics. Detection of leishmania under a microscope in smears of secretions from ulcers on the skin. In mucocutaneous leishmaniasis - detection of leishmania in biopsy material or in smears of secretions from ulcers.

Prevention. Personal - protection from mosquito bites, prophylactic vaccinations of cutaneous leishmaniasis strains from animals on closed areas of the skin. Public - control of mosquitoes, destruction of natural reservoirs (rodents) in areas adjacent to settlements.

Visceral leishmaniasis. Pathogens: Leishmania donovani - the causative agent of visceral leishmaniasis (Indian kala-azar); Leishmania infantum - the causative agent of visceral (Mediterranean) leishmaniasis.

Geographical distribution: Leishmania donovani - India, Pakistan, Northeast China, Nepal, Bangladesh; Leishmania infantum - the Mediterranean basin, the Near and Middle East, Central and South America.

Localization: liver cells, spleen, red bone marrow, lymph nodes (Mediterranean leishmaniasis).

Morphology. Morphology and development cycle are almost indistinguishable from dermatotropic leishmania. Exist in leishmanial and leptomonad forms.

Life cycle. The vectors are mosquitoes of the genus Phlebotomus, which are infected by people and dogs with leishmaniasis, and in the wild - by jackals, gerbils, porcupines, other animals from the canine family, and the rodent family. When a person or animal is bitten by an infected mosquito, motile leishmania from its pharynx penetrates the wound and then sinks into the cells of the internal organs.

Invasive stage: leptomonad form of leishmania.

Pathogenic action. Visceral leishmaniasis (Mediterranean) is more common in children because they have a weak immune system. After an incubation period that lasts from several weeks to several months, patients develop a fever, lethargy, weakness, pallor, and loss of appetite. Lymph nodes, spleen, and liver enlarge, causing the abdomen to protrude significantly. Anemia and weight loss develop in the patient. The disease lasts for several months and in the absence of specific treatment ends in death.

Laboratory diagnostics. The final diagnosis of visceral leishmaniasis is established on the basis of the detection of leishmania during microscopy of bone marrow smears. In the preparation, leishmania can be found in groups or singly, inside or outside the cell.

In some cases, the material from the bone marrow is sown on a nutrient medium prepared on agar with the addition of defibrinated rabbit blood. In a positive case, flagellated forms of Leishmania appear in the culture on day 2-10.

Prevention. Personal – individual protection from mosquito bites.

Public – detection and treatment of patients, mosquito control, treatment (or destruction) of sick dogs, sanitary and educational work. In order to prevent the disease of all types of leishmaniasis, the destruction of mosquitoes is carried out, as well as measures to prevent people from mosquito bites.

Giardia. Lamblia intestinalis is the causative agent of giardiasis. The parasite was first described by the Russian scientist D.F. Lambl (1859).

Geographic distribution: widespread.

Localization: duodenum, can penetrate into the bile ducts.

Morphology. Giardia exist in a vegetative form (trophozoite) and are capable of forming cysts.

Vegetative form: active, mobile, resembles half of a pear cut lengthwise; the front end is widened and rounded, the rear narrowed and pointed. A characteristic

feature is the bilateral symmetry of the body. All organelles are paired. There are four pairs of flagella. Two supporting filaments - axostyles - pass through the middle of the body; on the sides of them are two nuclei symmetrically located.

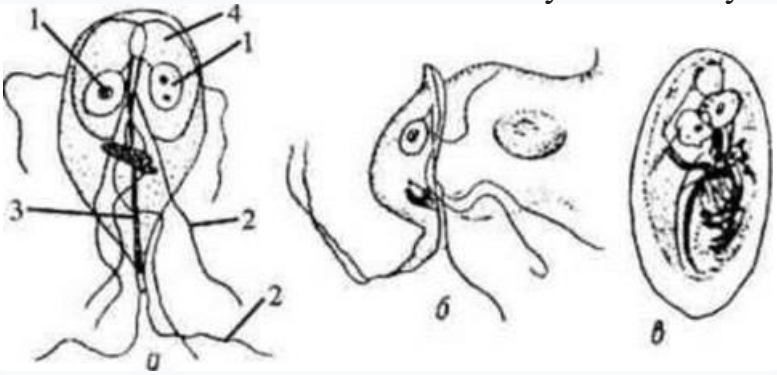


Fig. 19. Lamblia (Lamblia intestinalis): a) view from the ventral side: 1 - two nuclei; 2 - flagella; 3 - two axostyles; 4 - suction disc; b) side view (on the surface of the epithelial cell); c) cyst.

On the ventral surface of the body there is a depression - a suction disc, with which the parasite attaches to the intestinal mucosa. The anterior end of the body is rounded, the posterior end is pointed. Length 9-18 microns. They reproduce by longitudinal division.

It feeds osmotically on substances that accumulate in the zone of parietal digestion. In the lower parts of the intestine it forms cysts - these are immobile forms of Giardia, oval in shape, 4-nucleated. A feature of the cyst is a dense shell, often exfoliated from the cytoplasm. Cysts are resistant to environmental conditions and can remain viable for up to a month.

Life cycle. Infection with giardiasis occurs when cysts are swallowed. The main transmission factors are dirty hands, toys, vegetables, fruits, and water contaminated with cysts. The invasive stage is a tetranucleate cyst. Cysts, entering the intestine, transform into vegetative forms. One cyst forms two vegetative forms.

Giardia parasitizes in the upper parts of the small intestine, attaching to its villi with the help of a suction disk. Giardia do not live in the gallbladder. Giardia are often found during duodenal sounding, this is explained by the fact that they enter the contents of the walls of the duodenum. Vegetative forms are not excreted with feces (sometimes during diarrhea they can be seen in freshly excreted feces).

Giardia, getting into the lower parts of the intestine, turn into cysts and are excreted with feces into the external environment.

Pathogenic action. Parasites disrupt parietal digestion and absorption, especially of fats and fat-soluble vitamins, contribute to the development of vitamin deficiency. The course of giardiasis can be acute, chronic, often asymptomatic. Patients have nausea, regurgitation, pain in the epigastric region, flatulence, diarrhea.

The source of infection is a sick person or a cyst carrier.

Laboratory diagnostics. Cysts are detected in feces or vegetative forms in the contents of the duodenum, which are obtained by probing.

Prevention. Personal - thoroughly wash vegetables and fruits that are eaten raw; heat treatment of food and drinking water; control of flies and cockroaches that carry

cysts; wash hands before eating. Public - identification and treatment of patients, sanitary supervision of water supply sources, public catering establishments, sanitary and educational work.

Trichomonas. There are three types of Trichomonas in the human body: Trichomonas hominis - intestinal Trichomonas, Trichomonas vaginalis - urogenital (vaginal) Trichomonas, Trichomonas tenax - oral Trichomonas.

Urogenital (vaginal) Trichomonas (Trichomonas vaginalis) is the causative agent of urogenital (urogenital) trichomoniasis.

Geographic distribution: everywhere.

Localization: in women - in the vagina, Bartholin glands, ureters, bladder, in men - in the urethra, seminal vesicles, prostate.

Morphology. Parasitic only in the human body, has no free-living stages. The body shape is oval, pear-shaped or spindle-shaped, reaches a length of 15-20 microns. The nucleus is spherical, located at the anterior expanded end of the body. In front of the nucleus, 4 free flagella and an undulating membrane extend. Along the axis of the body of the trichomonad is an axostyle, which protrudes at the posterior end of the body in the form of a spike.

Trichomonas feeds on bacteria and leukocytes. It reproduces by division. It exists only in the vegetative form (trophozoite), it does not form cysts.

Life cycle. The source of invasion is a sick person. Infection increases with the onset of puberty. The pathogen is transmitted sexually, as well as when using shared underwear and personal hygiene items.

Infection is possible during a gynecological examination due to insufficiently sterile gynecological instruments and gloves. Infection occurs from sick people with sufficiently noticeable signs of the disease and from trichomonad carriers.

Invasive stage: trophozoite.

Pathogenic action. Causes inflammatory processes in the genital tract. In women, in the acute course, excessive liquid serous-purulent discharge, itching and burning in the area of the external genitalia and in the vagina are characteristic. In men, the disease is mainly asymptomatic.

Laboratory diagnostics. Detection of vegetative forms in native and stained smears from the vagina and urethra, cervix, less often - in urine sediment. Trichomonas carriers, both men and women, have no complaints. There are no inflammatory phenomena in the genitourinary system. However, vaginal trichomonads are found during laboratory examination.

Prevention. Personal: refusal of promiscuous sexual relations, use of condoms. Public – treatment of patients, sterilization of gynecological and urological instruments.

Intestinal trichomonas (Trichomonas hominis) is the causative agent of intestinal trichomoniasis.

Geographic distribution: ubiquitous.

Localization: large intestine.

Morphology. Size 5-15 microns, oval in shape, with a pointed outgrowth at the posterior end. From the anterior end depart 3-4 free flagella, which are directed forward, and one, which is directed backward and connected to the undulating membrane. In the middle of the body passes a supporting rod (axostyle), the end of which protrudes at the posterior end of the body. The nucleus is one. It feeds on bacteria, which it swallows with its cellular mouth, and also osmotically - liquid substances. It reproduces by longitudinal division. The formation of cysts has not been established. Infection occurs through food and water contaminated with vegetative forms of Trichomonas.

Pathogenic action. Pathogenic action has not been established. It occurs both in healthy people and in people with intestinal diseases.

Laboratory diagnostics. Material for research - feces. In smears of feces under a microscope, vegetative forms are detected. Prevention is the same as for amebiasis.

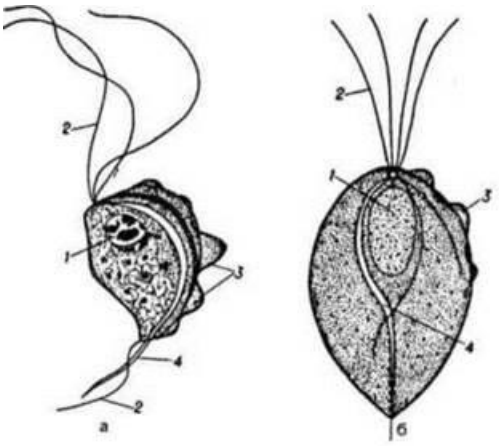


Fig. 20. Trichomonas: a) Trichomonas hominis; b) T.vaginalis:1 - nucleus; 2 - flagellum; 3 - undulating membrane; 4 - axostyle.

Oral Trichomonas (Trichomonas tenax) - similar in structure to intestinal. Does not form cysts. Pathogenic significance has not been proven. They can be seen in the sputum of people with pulmonary diseases, as well as with diseases of the oral cavity (gingivitis, periodontitis, dental caries).

Topic 23. Sporozoa. Infusoria. Methods for diagnosing protozoa. Flatworms. Liver flukes, cat flukes, Chinese flukes and lanceolate flukes; metagonism.

Type Apicomplexa. Class Sporozoa (Sporozoa)

The class Sporozoa includes exclusively parasitic protozoa that have adapted to life in body cavities or inside the cells of humans and animals.

Due to the parasitic lifestyle, the organization of sporozoites is extremely simplified: there are no organoids of movement, respiration, excretion, nutrition (digestive, pulsating vacuoles). These processes are carried out osmotically. When

reproducing, in most cases they form spores (embryos with a dense shell) - hence the name of the class.

The life cycle is characterized by a change of hosts, alternation of asexual (schizogony, endogony), sexual reproduction and sporogony (formation of spores and sporozoites).

Individuals of the asexual generation are called trophozoites or schizonts. They reproduce by schizogony, which gives rise to small uninucleate bodies - merozoites.

The sexual generation, gamonts, produces gametes. The sexual process ends with the fusion of gametes and the formation of a zygote, an oocyst. Mature oocysts have a dense membrane and contain one or more small sporozoite embryos. The host becomes infected by ingesting an oocyst containing sporozoites.

In blood sporozoites, the zygote never enters the external environment, and the transmission of parasites is carried out by a vector.

Human parasites belong to the order Blood sporozoites and the order Coccidia.

The Haemosporidia (Haemosporidia)

series lives at a certain stage of development in the erythrocytes of vertebrates and humans.

There is no spore stage, since Haemosporidia are transmitted from one host to another without entering the external environment. Human parasites are malarial plasmodia.

Malaria plasmodia. Malaria plasmodia are the causative agents of malaria.

There are over 100 species of malaria plasmodia - parasites of reptiles, birds, mammals. 4 species parasitize humans:

Plasmodium vivax - the causative agent of three-day malaria.

Plasmodium falciparum - the causative agent of tropical malaria.

Plasmodium malariae - the causative agent of four-day malaria.

Plasmodium ovale - the causative agent of oval malaria (of the three-day type).

Geographic distribution: in all countries of Africa and the Middle East, Southeast Asia, on the islands of the Pacific Ocean, Central and South America (between 400 south latitude and 600 north latitude).

Localization: intracellular parasites, in humans - in liver cells and erythrocytes.

Morphology: malarial plasmodium undergoes a complex life cycle with several stages of development. The following stages are found in the human body:

• *sporozoite* - spindle-shaped, 1x15 μm in size;

• *tissue (pre-erythrocytic) schizont* - round, 50-70 μm in size;

• *tissue merozoite* - round or oval, with an eccentrically located nucleus, diameter about 0.7 μm.

The erythrocyte trophozoite goes through the following stages of development:

- *ring-shaped trophozoite* - occupies no more than 1/3-1/5 of the diameter of the erythrocyte; when stained by the Romanovsky-Giemza method, a colorless vacuole is located in the center of the trophozoite, the cytoplasm is located in the form of a blue rim, the nucleus is dark red;

- *amoeba-like trophozoite* - occupies more than half of the erythrocyte, has an irregular shape due to the appearance of pseudopods, is mobile; the vacuole is reduced,

the cytoplasm contains grains of dark brown pigment formed as a result of the breakdown of hemoglobin;

- *mature trophozoite* occupies almost the entire erythrocyte, is round in shape; the vacuole is small or absent; the nucleus is large, the number of pigment grains increases;

- *schizont* is characterized by a divided nucleus; around each daughter nucleus, cytoplasm separates to form merozoites. Pigment is pushed out of the cytoplasm and gathers in a cluster on the side of the center of the erythrocyte. This stage is called morula;

- *erythrocyte merozoite* - resembles a tissue merozoite in structure, about 1.5 microns in size;

- female and male *gametocytes* (macro- and microgametocytes) - immature germ cells of a rounded shape (Pl. falciparum - crescent-shaped). Female gametocytes resemble mature trophozoites in appearance, but are larger than them, acquire a blue color. Male gametocytes are usually smaller in size than female ones, grayish-blue, with a large, loose pale pink nucleus located in the center of the cell.

The life cycle of malarial plasmodia is typical for sporozoites, and includes the stages of asexual reproduction in the form of schizogony, sexual process and sporogony. The definitive host of the parasites is the female mosquito of the genus Anopheles, and only humans are intermediate. The mosquito also acts as a vector. Therefore, malaria is a typical anthroponotic transmissible disease.

During a bite, a mosquito injects the malaria pathogen into the human blood at the sporozoite stage with its saliva. The sporozoite is the invasive stage for humans. The development of parasites in the human body occurs synchronously. With the bloodstream, sporozoites are carried into liver cells, where they undergo exoerythrocytic (tissue) schizogony. Each schizont produces a large number (from 1000 to 5000) of tissue merozoites.

The exoerythrocytic cycle is carried out once. In PI. falciparum it lasts 6, PI. vivax - 8, PI. ovale - 9, in PI. malariae - 15 days. It has been proven that in the case of four-day and tropical malaria, after the end of tissue schizogony, merozoites completely exit the liver into the blood. In three-day malaria, due to the heterogeneity of sporozoites (there are tachy- and bradysporozoites), tissue schizogony can occur both immediately after a mosquito bite (tachysporozoite entry) and 1.5-2 years after it (bradysporozoite entry), which is the cause of a long incubation period and distant relapses of the disease, caused by the so-called "dormant" stages of the parasite.

The incubation period is the period from the moment the pathogen enters the human body to the appearance of clinical manifestations of the disease.

Tissue merozoites enter the blood and penetrate erythrocytes. The erythrocyte part of the life cycle of malarial plasmodium (*erythrocyte schizogony*) begins.

Due to the difference in potentials, the erythrocyte is infected negatively, and the merozoite is positive.

They are mutually attracted to each other, the cytoplasm of the erythrocyte bends and the merozoite penetrates the cell. Other authors note that there are specific

receptors on erythrocytes. If they are present, tissue merozoites penetrate the erythrocytes. For Plasmodium vivax, such receptors are the Duffy blood group isoantigens. Duffy negative, often found in the Negroid race of Africa and they do not suffer from three-day malaria in 90% of cases, in the Negroid race of America Duffy is negative in 70%.

Merozoites that have penetrated the erythrocytes increase, a vacuole forms near the nucleus of the merozoite, which displaces the nucleus to the periphery, and the parasite resembles a ring in shape (ring stage).

Then the vacuole decreases, pseudopodia are formed (*the stage of the amoeba-like trophozoite*). Gradually, the plasmodium fills the entire erythrocyte, acquires a spherical shape, the nucleus is located in the center (*the stage of the mature trophozoite*). At the stage of schizogony, the nucleus divides, and the trophozoite contains from 6 to 24 nuclei. Around the nuclei, clumps of cytoplasm are separated - *erythrocyte merozoites* are formed.

Then the erythrocyte membrane ruptures, merozoites and toxic products of plasmodia enter the blood. This process coincides with attacks of malaria. Merozoites that have entered the plasma penetrate new erythrocytes and the cycle repeats, forming a new generation of merozoites. This process is repeated many times. The cycle of erythrocytic schizogony in Plasmodium vivax, PLfalciparum and PI. ovale lasts 48 hours, in PI. malariae - 72 hours. That's how long the intervals between malaria attacks last.

After a series of erythrocytic schizogonies, some of the merozoites that have penetrated the erythrocytes develop not into schizonts, but into immature sexual forms (gametocytes) - *macrogametocytes* (immature female sexual forms) and *microgametocytes* (immature male sexual forms).

For further development, gametocytes must enter the stomach of the final host - a female mosquito of the genus Anopheles, where the process of sexual reproduction and sporogony occurs. Gametocytes are the *invasive stage* of malarial plasmodium for the malarial mosquito. They enter the stomach of a female malarial mosquito during its feeding on the blood of a sick person (males do not feed on blood).

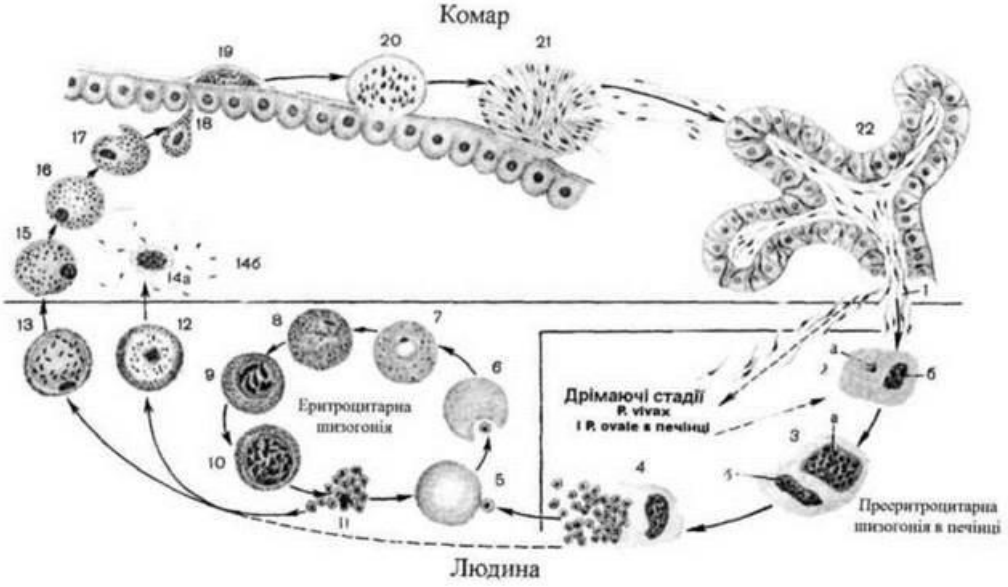


Fig. 21. Life cycle of Plasmodium vivax and P. ovale:

1 - exit of the sporozoite from the salivary gland duct and its penetration into the liver cell; 2 - trophozoite in the liver cell: a - trophozoite; b - nucleus of the liver cell; 3 - schizont in the liver cell: a - schizont; b - nucleus of the cell; 4 - exit of tissue merozoites from the liver cell into the blood plasma; 5 - attachment of the merozoite to the erythrocyte; 6 - penetration of the merozoite into the erythrocyte; 7 - trophozoite at the ring stage; 8 - young trophozoite in erythrocyte 9 - immature erythrocyte schizont; 10 - mature erythrocyte schizont; 11 - erythrocyte merozoites; 12 - male gametocyte (microgametocyte); 13 - female gametocyte (macrogametocyte); 14a - formation of male gametes; 14b - male gamete; 15 - female gamete; 16-17 - fertilization; 18 - ookinete; 19-20 - formation of oocyst and development of sporozoites; 21 - exit of sporozoites from oocyst into the body cavity of the mosquito; 22 - sporozoites in the salivary gland of a mosquito.

Sexual reproduction and sporogony occur in the stomach of the female malaria mosquito. Mature female gametes are formed from *macrogametocytes*. *Microgametocytes* divide several times during maturation and form mature male gametes. Micro- and macrogametes fuse (fertilization) and a zygote is formed. It is motile, hence its name - *ookinete*.

The ookinete penetrates the epithelium of the mosquito's stomach, greatly increases in size and turns into an oocyst. Inside the oocyst, multiple divisions of the nucleus and cytoplasm (sporogony) occur. This produces a large number (up to 10,000) of sporozoites. The oocyst shell breaks down and the sporozoites are released into the hemolymph, from where they enter the mosquito's salivary glands. When bitten, sporozoites enter the human bloodstream along with the mosquito's saliva, which then penetrates the liver cells.

All types of malarial plasmodia can infect humans through hematrfusion (blood transfusion). In this case, none of the parasites forms an exoerythrocytic stage. Therefore, there are no late relapses in this case.

The blood transfusion route of infection is most common in four-day malaria due to the fact that in this form of the disease, schizonts in erythrocytes are contained in small quantities and may not be seen when examining the donor's blood.

Sometimes a person can be infected with two or three types of plasmodia simultaneously. In this case, malaria attacks do not have a clear periodicity and clinical diagnosis is difficult to establish.

Pathogenic action. Malaria is a severe disease, which is accompanied by periodic attacks of fever, associated with the simultaneous release of a large number of merozoites and toxic products of their vital activity from erythrocytes. Each attack includes stages of fever and an increase in temperature to 40° C and lasts up to 6-12 hours. Characteristic is an increase in the liver and spleen, anemia. Fatalities are possible.

In tropical malaria, attacks initially develop at different intervals, and later after 24 hours. The patient may die from complications of the central nervous system or kidneys. Schizonts are not preserved in liver cells, and the disease can last up to 18 months.

Laboratory diagnostics. Material - blood. Research methods - microscopy of a smear and a thick drop of blood. Blood is taken during an attack or immediately after it, before the start of specific treatment. Schizonts and gametocytes are detected.

Prevention. Personal - protection from mosquito bites, taking preventive medications. Public - identifying and treating patients and parasite carriers, destroying adult mosquitoes and their larvae with insecticides and breeding biological enemies of mosquitoes, improving the area through land reclamation measures.

Differential diagnosis of human malaria parasites in a smear (by: Sh.D. Moshkovsky, N.A. Demina)

	P. vivax	P. malariae	P. falciparum	P. ovale
Clinical form of invasion	Malaria tertiana	Malaria quartana	Malaria tropica	Three-day malaria
Duration of schizogony	48 h	72 h	48 h	48 h
Stages of parasite development	All stages of schizogony and gamont development	All stages of schizogony and gamont development	Mostly only rings and mature gamonts	All stages
Young schizonts (rings)	Regular ring-shaped, with a diameter of 1/3-1/4 of the size of the erythrocyte.	Similar to P. vivax.	Small rings occupy 1/8 of the diameter of the erythrocyte, large ones up to 1/3 of the diameter, sometimes with an additional body.	The same size and shape as in P. vivax, but with a larger nucleus.
Amoeboid schizonts	Pseudopodia are well expressed. Schizonts, depending on age, occupy less than half, half and more than half of the affected erythrocyte, respectively. The pigment is located evenly	Pseudopodia are not sharply expressed, wide. In the process of maturation of the schizont, the pigment accumulates more and more. Some schizonts acquire a ribbon-like	Pseudopodia are not sharply defined, wide. They are similar to the amoeba-like schizonts of P. malariae, differing from them in the color of the pigment and the nature of its distribution.	Pseudopodia are not sharply defined, similar to the amoeba-like schizonts of P. malariae. They differ from them in their larger nucleus and size.

	in young schizonts, and accumulates more and more as the parasite matures.	shape, the parasite is elongated in the form of a wide ribbon. The nucleus is elongated along one edge	The pigment is dark brown, almost black, collected in one compact bunch	
Schizonts preparing for division	Round or oval in shape without pseudopodia or vacuoles, with a single, somewhat elongated nucleus. Occupies almost the entire erythrocyte. Pigment clusters are located on the periphery of the cytoplasm	Similar to P.vivax, but smaller, no larger than a normal red blood cell	Similar to P. malariae, differing in pigment (dark brown, almost black) collected in one compact cluster	Similar to P. malariae, but larger and with a large nucleus
Dividing Schizonts	Similar to the previous ones, have 2 or more cores.	Similar to the previous ones, have 2 or more cores.	Similar to the previous ones, have 2 or more cores.	Similar to the previous ones, have 2 or more cores.
Morula	12-18 merozoites arranged randomly around a compact pigment cluster	6-12, mostly 8 merozoites arranged in a regular rosette along the periphery of the pigment cluster	12-24, mostly about 16 merozoites, smaller than in other forms, arranged randomly around the pigment cluster	4-12 large merozoites arranged randomly around the pigment cluster, with larger nuclei
Gamonts	Round or oval cell without	Similar to P.vivax, but	Crescent-shaped.	Same as P.vivax

	pseudopodia or vacuoles. With age, it increases in size, filling almost the entire erythrocyte. The pigment is more intense than in schizonts, distributed evenly.	smaller, no larger than a normal erythrocyte. Female and male gamonts are distinguished by the same features as in P.vivax	Female gamonts with slightly pointed ends and cytoplasm that becomes dark blue. The nucleus is compact, surrounded by a pigment ring in the central part of the parasite.	

Order Coccidia (Coccidia).

The greatest medical importance is toxoplasma.

Toxoplasma (Toxoplasma gondii) is the causative agent of toxoplasmosis.

Toxoplasmosis is an anthropozoonotic invasion. Toxoplasma is an obligate intracellular parasite.

Geographic distribution: ubiquitous.

Localization: lymph nodes, liver, spleen, lungs, brain, uterus, eyes, skeletal muscles, myocardium.

Morphology. Toxoplasmas that are localized inside the host cell are called endozooids. The endozooid has the shape of a crescent, one end is pointed, the other is rounded (4-7 x 2-4 microns). At the pointed end of the toxoplasma there is an apparatus for penetrating the host cell (apical complex) - a conoid (for fixing the parasite on the cell surface) and rhoptria containing enzymes for dissolving the cell membrane.

In the center or at the posterior pole of the cell is the nucleus. The accumulation of toxoplasma under the cell membrane is called a pseudocyst. True (tissue) cysts - spherical or oval formations, 50-200 microns in size, are an accumulation of several hundred endozoites surrounded by a dense protective membrane.

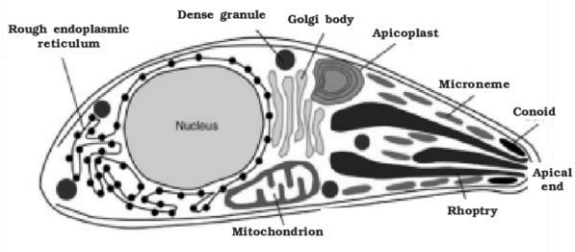


Fig. 22. Ultrastructure of Toxoplasma.

The life cycle is associated with a change of hosts and the alternation of asexual and sexual reproduction. Definitive hosts are domestic cats and other members of the

feline family; intermediate hosts are birds and mammals (about 350 species in total), as well as humans, and less often reptiles. In the body of the intermediate host, asexual reproduction occurs by longitudinal division and endogony (internal budding).

As a result of multiple divisions, a large number of toxoplasmas accumulate in the cell (12-32 daughter cells). The accumulation of toxoplasmas under the cell membrane is called a *pseudocyst.* The cell membrane ruptures, the endozooids come out and penetrate into neighboring cells. During this period, toxoplasma is excreted with the body's excreta (saliva, milk, tears, etc.).

As the body's immune response increases, toxoplasma begin to form true cysts. They persist throughout the life of the host and, with a decrease in immunity, can cause an exacerbation of the disease. In chronic toxoplasmosis, in addition to pseudocysts, true cysts are formed. The parasites enter the body of the definitive host (cat) with the meat of intermediate hosts, which contains pseudocysts with endozooids.

In the internal organs of the cat, asexual reproduction of the parasite occurs, and in the epithelium of the small intestine - sexual reproduction (i.e. the cat is the definitive and intermediate host of Toxoplasma). In the epithelial cells of the small intestine, *macrogametocytes* are first formed from some endozooids, and then *macrogametes*, and from others - *microgametocytes*, and then *microgametes*; after copulation, a zygote is formed, which is covered with a dense membrane.

This form is called an oocyst. It is excreted with the cat's feces into the external environment. At temperatures above +20 °C, sporogony occurs inside the oocyst and two spores with four sporozoites are formed in each.

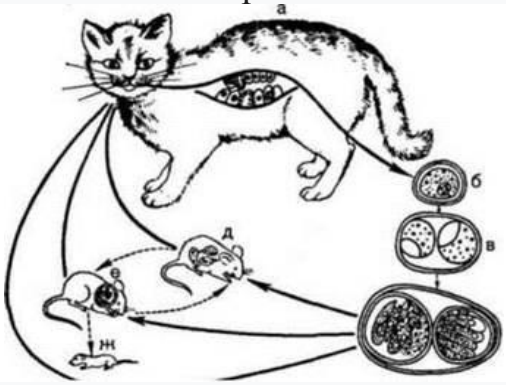


Fig. 23. Life cycle of Toxoplasma: a - cat (definitive host); b, c, d - stages of oocyst development in the external environment (a mature oocyst contains two spores with four sporozoites in each); d, e - mouse (intermediate host); g - newborn mouse, transplacentally infected with the toxoplasmosis pathogen.

A feature of the development cycle of toxoplasma is that intermediate hosts can become infected not only from the main host, but also by eating each other. So, pigs can become infected by eating the corpses of rodents that died of toxoplasmosis, rodents can become infected by cannibalism. Intrauterine infection of the fetus from a sick pregnant female is also possible, in which case the parasites penetrate through the placenta.

Mechanisms of transmission of the toxoplasmosis pathogen: 1) through the mouth - alimentary (transmission factors - thermally unprocessed meat, dairy products, eggs containing endozoites and true cysts, hands contaminated with oocysts); 2)

percutaneous - through the skin and mucous membranes (in workers of meat processing plants, obstetricians, laboratory assistants when conducting laboratory and clinical research); 3) transplacental (intrauterine infection of the fetus through the placenta).

When the parasite enters the mouth from dirty hands, unwashed vegetables and fruits, cat hair, the invasive stage is an *oocyst*, in other cases - *endozooids* and true cysts.

Pathogenic action. Acquired toxoplasmosis is manifested by fever, enlarged lymph nodes, damage to the central nervous system, eyes, myocardium, skeletal muscles. Diagnosis is difficult due to the variety of clinical manifestations.

Congenital toxoplasmosis, which is a consequence of transplacental transmission of the pathogen when a woman is infected during pregnancy, is characterized by fetal malformations, CNS damage, fever, jaundice, rash. Miscarriages or stillbirths are possible.

Laboratory diagnostics. Material - pieces of tissue during biopsy, punctures of organs and lymph nodes, cerebrospinal fluid, blood. In the acute stage of the disease, the pathogen can be found both in the organs and in the blood.

Laboratory diagnostic methods: 1) serological reactions (detection of antibodies to toxoplasma); 2) microscopy of blood smears, cerebrospinal fluid, lymph node punctate, amniotic fluid, fetal membranes; 3) biological test (intraperitoneal infection of white mice with an emulsion of the studied organs); 4) intradermal test with toxoplasmin (ether extract of peritoneal exudate of white mice infected with toxoplasma). The final diagnosis is made on the basis of a complex of clinical and laboratory studies.

Prevention. Personal - eat only cooked meat, boil milk, wash hands before eating. Public - sanitary and educational work, especially among pregnant women.

Type Ciliates, or Infusoria (Ciliophora, Infusoria). Class Litostomatea.

Organoids of movement of ciliates - cilia. Another feature is the presence of two different nuclei: large (macronucleus) and small (micronucleus). The macronucleus (vegetative nucleus) regulates vital processes, the micronucleus (generative nucleus) plays an important role in sexual reproduction. Most ciliates live in the aquatic environment. There are also parasitic species. Balantidium intestinalis is of medical importance.

Balantidium coli - the causative agent of balantidiasis.

Geographical distribution: widespread.

Localization: large intestine.

Morphology. The only parasitic ciliate of humans. It exists in the form of trophozoites and cysts. The trophozoite has relatively large dimensions - 30-200 x 20-70 microns, the body shape is oval or ovoid.

The organelles of movement are cilia, there are two pulsating vacuoles, two nuclei (micronucleus and bean-shaped macronucleus), at the anterior end there is a peristome (preoral cavity), which passes into a cytostome (cellular mouth) and cytopharynx (cellular pharynx). It feeds on undigested food residues, erythrocytes.

Undigested residues are expelled through the anal pore at the posterior end of the body. It reproduces asexually (transverse division) and sexually (conjugation) methods.

The cyst is oval or spherical, 50-60 microns in diameter, covered with a two-layer membrane. Macro- and micronucleus are found in the cytoplasm. Posterior contractile vacuole.

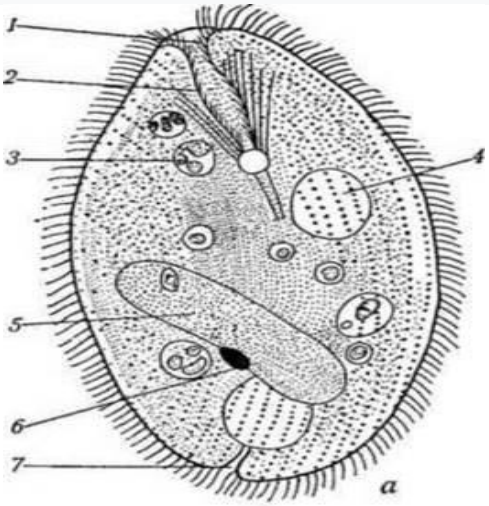


Fig. 24. Balantidium coli:

a - vegetative form; 1 - cytostome; 2 - cytopharynx; 3 - digestive vacuole; 4 - secretory (contractile) vacuole; 5 - macronucleus; 6 - micronucleus; 7 - anal pore.

Life cycle. The invasive stage for humans is a cyst. Infection occurs when cysts are swallowed with water, food, or dirty hands contaminated with cysts. Cysts are spread by flies and cockroaches. Vegetative forms form from cysts in the digestive tract. The main source of infection is pigs, in which balantidia easily encyst. A person with balanitis or a parasite carrier is rarely the source of infection, because cysts rarely form in the human body. People who work on pig farms and meat processing plants are mostly infected.

Pathogenic action. Parasitic in the colon and especially often in the cecum. Sometimes they live for a long time without showing pathogenic action. But in some cases they penetrate the walls of the intestines, where they cause bleeding ulcers. In the acute form, severe abdominal pain, nausea, vomiting, frequent loose stools with mucus and blood. Without treatment, death is possible.

Laboratory diagnostics. Material for diagnostics – fresh feces. Under a microscope, cysts and vegetative forms are detected.

Prevention. Personal - wash hands before eating and after visiting the toilet, thoroughly wash vegetables and fruits that are consumed raw, use boiled water for drinking. Public - combating soil contamination by pig feces, as well as humans, appropriate organization of working conditions on pig farms, identification and treatment of patients, and sanitary and educational work.

Medical helminthology is a branch of medical parasitology that studies parasitic worms (helminths) of humans, the diseases they cause, and measures to combat them. Diseases caused by helminths are called helminthiasis.

The division of helminths into bio- and geohelminths was proposed by K.I. Skryabin and R.S. Schultz (1931). Helminths, the development of which occurs with a mandatory change of host (intermediate and definitive), are called biohelminths (cat fluke, unarmed tapeworm). Geohelminths develop without intermediate hosts (ascaris, hairworm). The most favorable environment for the development of their eggs is the soil, which is where the name "geohelminths" (Greek geo - earth) comes from. Accordingly, helminthiasis is divided into biohelminthiasis and geohelminthiasis. A person who is invaded, that is, infected with bio- or geohelminths, is not directly contagious to others.

In 1952, E.S. Shulman proposed to allocate an additional group - contact helminthiasis, to which he included two invasions - enterobiasis and hymenolepidosis. The peculiarity of their epidemiology does not allow them to be attributed to either bio- or geohelminthiasis. The eggs of these helminths can be infected directly from a sick person, mainly through hands contaminated with eggs.

Human parasitic worms belong to two phyla: 1) the phylum Plathelminthes and 2) the phylum

Nemathelminthes. Phylum Plathelminthes.

The type Flatworms unites about 7300 species. In the process of evolution, flatworms arose from intestinal coelenterates and in turn gave rise to round and annelid worms.

Animals of this type are characterized by:

1) three-layeredness (development of ecto-, ento- and mesoderm in embryos);

2) the presence of a skin-muscular sac (the body covers fuse with the muscles);

3) the absence of a body cavity (the space between the organs is filled with parenchyma);

4) bilateral (two-sided) symmetry of the body;

5) the shape of the body is flattened in the dorsal-ventral (dorso-ventral) direction;

6) the presence of developed organ systems: muscular, digestive, excretory, nervous and reproductive;

7) the circulatory and respiratory systems are absent.

Parasitic flatworms of humans are of medical importance, which belong to two classes:

1) the class Trematoda and

2) the class Cestoidea.

Class Trematoda

The class includes about 3 thousand species. All trematodes are parasitic organisms. The body is unjointed, mostly leaf-shaped, flattened in the dorsal-ventral direction. A characteristic feature is the presence of suckers, of which there are mainly two: oral and abdominal (hence the name of the class). Suckers are the organs of fixation of the parasite to the host's body.

The body is covered with a skin-muscular sac, which consists of the tegument (outer cover) and the muscles that have grown together with it. The muscles are represented by three layers - circular, diagonal and longitudinal. The cuticle is covered with epithelium, often has spines.

The digestive system has an ectodermal foregut (mouth, pharynx, esophagus) and two branches (branched or unbranched) of the endodermal midgut, which end blindly. There is no anus. Undigested food remains are expelled through the mouth.

Protonephridial excretory system. Represented by numerous terminal stellate cells. They have tubules with a bundle of cilia (flashing flame). Products from the parenchyma enter the lumen of the tubule of the terminal cell, and from there, with the help of cilia, they move into one or two secretory ducts that open outwards through an excretory pore.

The nervous system has a typical structure for flatworms (orthogon). It consists of a peripharyngeal nerve ring, from which three pairs of nerve trunks depart, of which the lateral ones are the most developed. The nerve trunks are interconnected by jumpers. The nervous system as a whole resembles a lattice (ganglionic-granular type of nervous system).

Almost all suckers are hermaphrodites. The male reproductive system consists of two testes, two vas deferens, which merge into the seminal duct, and a copulatory organ (cirus). The cirrus is located in a cirrus bag, which is located above the abdominal sucker. The female reproductive system is complex. The ovary, yolk sac, and seminal receptacle open into the ootype, where fertilization and the final formation of eggs take place.

Here, nutrient material for eggs and secretions from special glands (Melissa's corpuscle) also come from the vitelline. From the ootype, eggs move into the uterus and are expelled through the genital opening, which is located next to the male's. In some mammals, fertilization occurs in the seminal receptacle. Fertilization is usually cross-fertilization. Self-fertilization is less common.

Life cycle: with a change of hosts and several generations of larvae. The final hosts are vertebrates and humans, the intermediate one is necessarily a mollusk. Some trematodes, in addition, have a second intermediate host. A characteristic feature of the life cycle is the reproduction of larval stages by parthenogenesis (without fertilization). The sexually mature form of tapeworms is called a *marita*.

Medical significance. Several species of flukes parasitize humans. Diseases caused by flukes (trematodes) are called trematodes.

Liver fluke (Fasciola hepatica) is the causative agent of fascioliasis.

Geographic distribution: ubiquitous.

Localization: intrahepatic bile ducts, gallbladder, pancreas.

Morphology. Marita Size 3-5 cm, the anterior end is elongated in the shape of a cone. The abdominal sucker is located not far from the oral one. Immediately behind the abdominal sucker is a multilobed uterus, behind the uterus lies the ovary, the entire middle part of the body is occupied by the testes. The two intestinal canals have

numerous branches. The ovary and testes are also branched. Numerous vitellines are located on the sides of the body.

Eggs are yellow-brown, oval, with a cap at one pole; dimensions 135x80 microns.

Life cycle. Liver fluke - biohelminth. Development - with a change of hosts. *Definitive hosts* - herbivorous mammals, cattle and small cattle, horses, pigs, rabbits, occasionally humans.

There is only one *intermediate host* - the small pond snail Limnea (Galba) truncatula. The eggs are released into the external environment by the feces of the definitive host and must fall into the water. Here, a larva - a *miracidium*, covered with cilia, develops in the egg. The miracidium has protonephridia, a nerve ganglion, an eye and special germ cells.

The front end of the body has an apical gland - it produces enzymes that are able to dissolve living tissue when penetrating the intermediate host. The egg lid opens in the light and the miracidia leaves the egg shells. It actively swims, feeds on the nutrients of the egg, then actively dives into the body of the mollusk, penetrates the liver and turns into a *sporocyst*.

Sporocysts are sac-shaped, immobile, and lack excretory and nervous systems. In the sporocyst, new larvae—redia—develop from germ cells parthenogenetically, that is, without fertilization. *Redia* have a mouth, pharynx, and a blind-ending intestine, and germ cells from which the next larval stage—*cercariae*—also develops in the redia body.

The cercariae have a long muscular tail that provides translational movement. The cercariae leave the mollusk, swim actively in the water, then attach to aquatic plants or other objects, shed their tail, become covered with a shell, and transform into an *adolescaria.*

Cattle eat plants and ingest the adolescariae. Humans become infected by drinking raw water from open, especially stagnant, bodies of water or by consuming unwashed vegetables and greens (most often lettuce) that have been watered with water from a river or lake where the adolescariae are found.

In the human intestine, the shell of the adolescariae dissolves and fasciolae emerge, which penetrate the host's liver. Thus, in the life cycle of fasciolae, the *invasive stage* for the intermediate host (mollusk) is the miracidia, and for the definitive hosts, the adolescariae.

Pathogenic action. Fasciolosis - biohelminthiasis, a natural focal disease, zoonosis. Fasciolae cause toxic-allergic reactions, mechanical damage to the bile ducts and liver tissues, leading to the development of mechanical jaundice as a result of obstruction of the bile ducts. With prolonged invasion - inflammation of the bile ducts with the growth of fibrous tissue, cirrhosis of the liver.

Laboratory diagnostics. Detection of eggs in the feces of a sick person. Eggs can also be detected in a healthy person if he or she has eaten the liver of animals infected with fasciola (transit eggs). To avoid errors, liver should be excluded from the patient's diet and the analysis repeated.

Prevention. Personal: do not drink raw water from open bodies of water, especially stagnant ones, thoroughly wash vegetables that are eaten raw. Public: veterinary measures: treatment of sick animals (deworming), change of pastures, sanitary and educational work.

Dicrocoelium lanceatum: the causative agent of dicrocoeliosis.

Geographical distribution: widespread.

Localization: bile ducts of the liver, gallbladder, pancreas.

Morphology. The body is lanceolate in shape, size - 8-10 mm. There are two suckers - oral and abdominal. Two unbranched branches of the intestine extend along the sides of the body to the posterior end, where they end blindly. Two round testes are located behind the abdominal sucker.

The female reproductive system consists of a small round ovary located behind the testes, paired yolk sacs lying on the sides of the body, and a highly developed uterus occupying the posterior part of the body. The eggs are elongated, asymmetrical, with a cap at the narrowed end, yellowish to dark brown in color, and 38-45 microns in size.

Life cycle. The lanceolate sisun is a biohelminth. Life cycle - with a change of hosts. Definitive hosts - small and large cattle, other herbivorous mammals, occasionally humans. There are two intermediate hosts: the first - terrestrial mollusks of the genera **Helicella, Zebrina,** the second - ants.

Eggs with the excreta of the definitive host are released into the external environment and must be swallowed by the mollusk. The egg already contains miracidia. In the mollusk, the miracidia is released from the egg shells, penetrates the liver and turns into a first-order sporocyst, in which second-order sporocysts develop, and in them - *cercariae.*

There is no redia stage. Cercariae emerge from sporocysts and penetrate the lungs of the mollusk, where they encyst, several stick together, forming collective cysts. The latter are released with mucus and fall on plants. If they are eaten by a second intermediate host (ants of the genus Formica), then in its body each cercaria, having left the shell, turns into the next larval stage - *metacercaria.*

Definitive hosts are infected by swallowing ants with metacercariae. Humans are infected accidentally, but also by swallowing ants infested with metacercariae. Invasive stages: for the first intermediate host (mollusk) - egg with miracidia, for the second intermediate (ant) - cercariae, for definitive hosts - metacercariae.

Pathogenic action. Dicroceliosis is a biohelminthiasis, a natural focal disease, a zoonosis. It is accompanied by liver dysfunction, inflammatory processes, after which cirrhosis may occur. The liver is painful and enlarged. Blockage of the bile ducts can cause *jaundice.*

Laboratory diagnostics. Detection of eggs in the feces of a sick person. Transit eggs are possible.

Prevention. The main measures are veterinary: treatment of sick animals (deworming), changing pastures, sanitary and educational work. Personal: washing vegetables and fruits before consumption.

The cat fluke, or Siberian fluke (Opisthorchis felineus) is the causative agent of opisthorchiasis. The disease was first described in 1891 by K.N. Vinogradov in Siberia.

Geographical distribution: along the banks of the rivers of Western Siberia, especially the Ob-Irtysh basin. Separate foci have been registered in the Baltic States, in the basins of the Kama, Volga, Dnieper, and Southern Bug.

Localization: bile ducts of the liver, gallbladder, pancreas, its ducts.

Morphology. The anterior end of the body is narrower than the posterior. Size - 8-13 mm. The branches of the intestine are not branched, ending before reaching the posterior end of the body. The uterus occupies the middle part of the body. Behind it is a round ovary and a bean-shaped oviduct.

In the back of the body are two rosette-shaped testes, between which an S-shaped duct of the excretory system is visible. The yolk sacs are located between the intestinal ducts and the edge of the body. The eggs are very small (23-34 x 10-19 microns), oval in shape, somewhat asymmetrical, narrowed at the anterior pole, yellow in color. At the narrowed pole there is a lid, at the opposite pole there is a clearly visible tubercle, the shell is thick, double-contoured, the contents are fine-grained, there are miracidia.

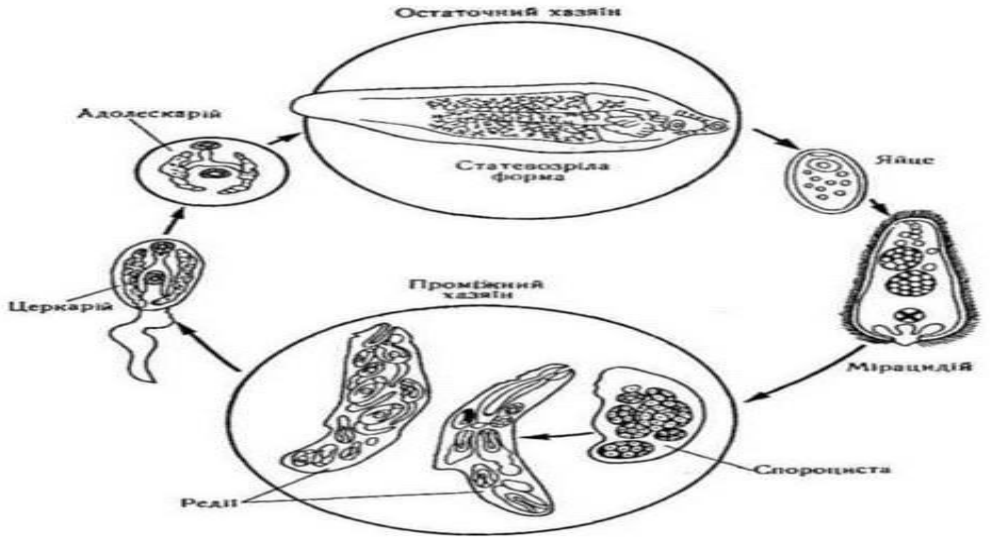


Fig. 25. Life cycle of the liver fluke (Fasciola hepatica).

Life cycle. The cat fluke is a biohelminth, developing with a change of hosts. Definitive hosts are humans, cats, dogs, foxes, otters, muskrats and other mammals that feed on fish. There are *two intermediate hosts:* the first is the freshwater mollusk Bithynia leachi, the second is cyprinid fish (ide, roach, carp, roach, etc.).

The parasite eggs are excreted in the feces of the definitive host, must enter the water and be ingested by the mollusk. In the mollusk, the miracidia emerges from the egg, penetrates the liver and turns into a sporocyst. In the sporocyst, rediae develop parthenogenetically, from which cercariae develop. The latter leave the mollusk into the water, swim freely, and then are swallowed by the fish or attach to its body and actively penetrate the subcutaneous tissue and muscles. Here they encyst and turn into

metacercariae. Two shells are observed around the parasite: a hyaline shell, which is formed by the parasite, and a connective tissue shell, formed by the host. Metacercariae become invasive after 6 weeks.

Humans become infected by eating undercooked, raw or dried fish with metacercariae. In the body of the definitive host, the larvae enter the digestive canal, are released from their shells by the action of digestive juices, and penetrate the gallbladder and liver, where they become sexually mature.

Invasive stages: for the first intermediate host (mollusk) - egg with miracidia, for the second intermediate host (carp fish) - cercaria, for the definitive host (human, cat, etc.) - metacercaria.

Pathogenic action. Opisthorchiasis - biohelminthiasis, natural focal disease, zoonosis. The causative agent of the disease is especially common in those areas where there is a custom to eat raw fresh-frozen fish (Siberia). In the early phase of opisthorchiasis - allergy, fever, pain in the liver, eosinophilia. With the accumulation of parasites - bile stasis, cirrhosis of the liver. Complications of opisthorchiasis - biliary peritonitis, primary cancer of the liver or pancreas. In severe cases, death is possible.

Laboratory diagnostics. Detection of eggs in the feces or contents of the duodenum of a sick person. *Prevention.* Personal: do not eat raw, undercooked or underfried river fish. Public: control over the technology of cooking fish dishes, identification and treatment (deworming) of patients, protection of water bodies from fecal pollution, do not feed raw fish to domestic dogs and cats, sanitary and educational work.

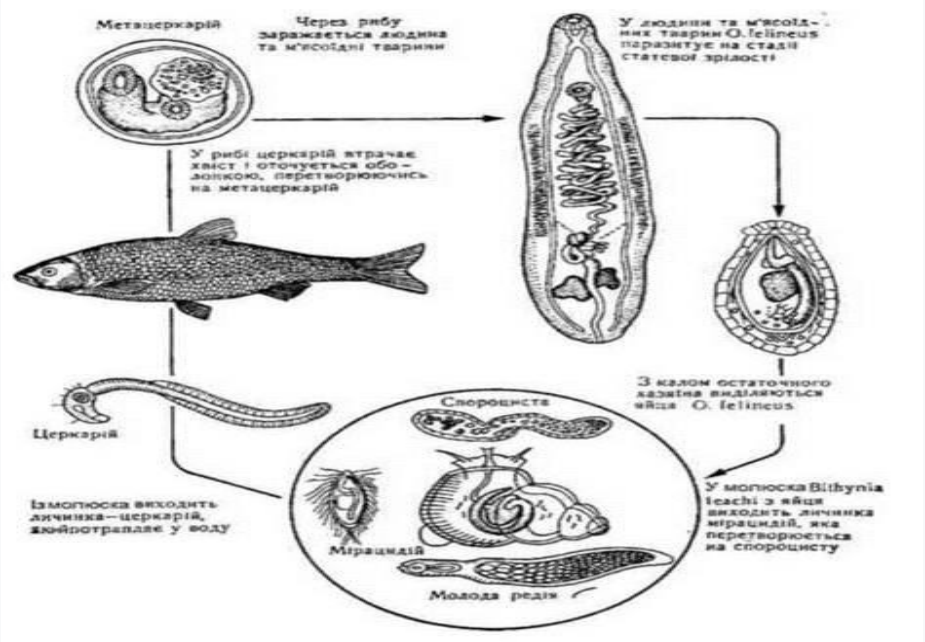


Fig. 26. Life cycle of the cat fluke.

Clonorchis sinensis - the causative agent of clonorchiasis.

Geographic distribution: Far East, China, Japan, Korea.

Localization: bile ducts of the liver, gallbladder, pancreatic ducts.

Morphology. Size 10-25mm. The anterior end is narrowed, the posterior end is rounded. The oral sucker is larger than the abdominal one. The uterus and yolk sacs

occupy the middle part of the body. Two branched testes are located in the posterior part of the body. Eggs are yellow-brown in color, small 26-30 X 15 microns.

Pathogenic effect. Clonorchiasis - biohelminthiasis, natural focal disease, zoonosis. Accumulations of parasites cause bile stasis, cirrhosis of the liver. Life expectancy in the human body - up to 25-40 years.

Laboratory diagnostics. Detection of eggs in the feces of a sick person. The eggs are practically indistinguishable from the eggs of a cat's puss.

Prevention. Personal - do not eat insufficiently cooked fish, freshwater crayfish. Public - identification and treatment of patients, protection of water bodies from fecal pollution, control over the technology of preparing culinary products from fish, not feeding domestic dogs and cats raw fish, sanitary and educational work.

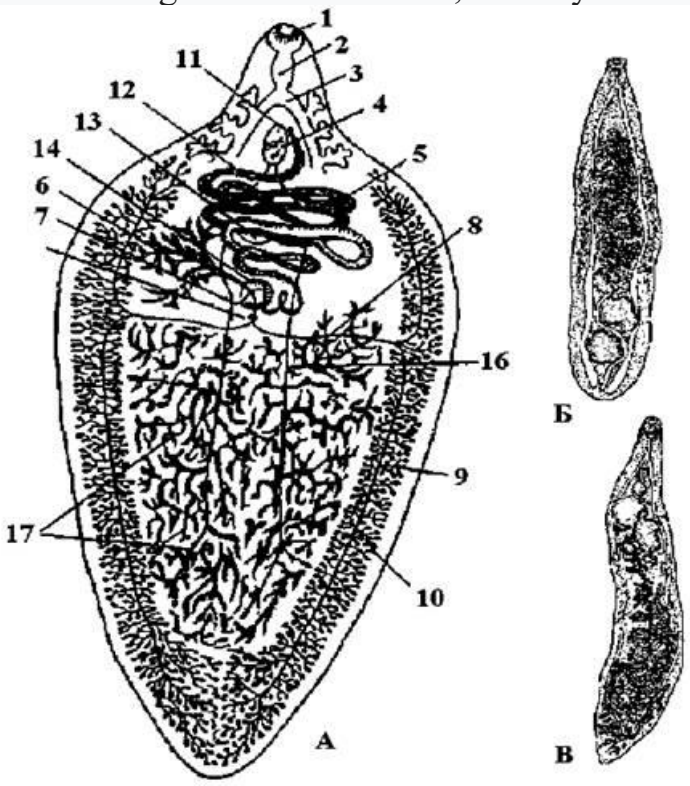


Fig. 27. A - hepatic sucker: 1 - oral sucker; 2 - pharynx; 3 - anterior part of the intestine; 4 - sac of the copulatory organ; 5 - uterus; 6 - ovaries; 7 - Laurer's canal; 8 - transverse vitelline duct; 9 - longitudinal vitelline duct; 10 - vitelline glands; 11 - terminal part of the uterus; 12 - vas deferens; 13 - abdominal sucker; 14 - Melissa's body; 15 - vitelline reservoir; 16 - vas deferens; 17 - testis. B - cat sucker; C - lanceolate sucker.

Metagonimus yokogawai: causative agent of metagonimus.

Geographical distribution: Japan, China, South Korea, Indonesia, Amur region. In Ukraine, it is found in the basins of the Dnieper, Dniester, and Danube rivers.

Localization: small intestine.

Morphology. Length - 1-2.5 mm, width - 0.4-0.7 mm. The body is covered with small spines. The oral sucker is much smaller than the abdominal one. The intestinal branches reach the posterior end of the body, where there are two round testes. The yolk sacs are located on the sides of the body in the posterior third of the sucker. The eggs are light brown, lemon-shaped, with a cap at one pole and a tubercle at the opposite, size - 26-28 x 15-17 microns.

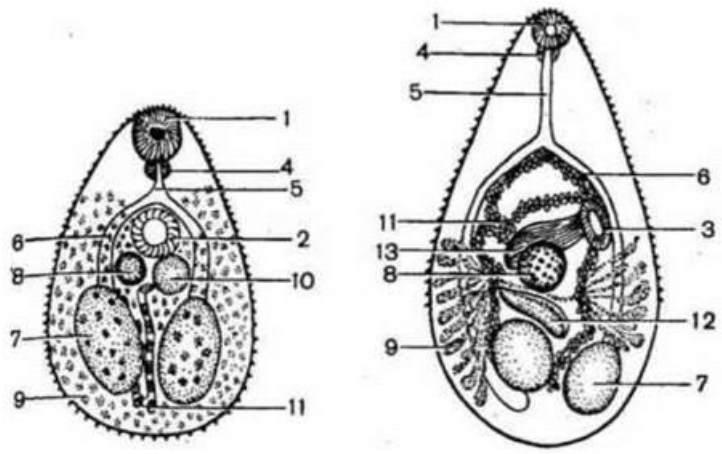


Fig. 28. Nanophyetus salmincola schikhobalowi, Metagonimus yokogawai: a) Nanophyetus salmincola schikhobalowi; 6) Metagonimus yokogawai: 1 - oral sucker; 2 - abdominal sucker; 3 - genital sucker; 4 - pharynx; 5 - esophagus; 6 - intestine; 7 - testes; 8 - ovary; 9 - yolk sac; 10 - sex sac; 11 - uterus with eggs; 12 - seminal receptacle; 13 - seminal vesicle.

Life cycle. Metagonimus is a biohelminth. Definitive hosts are humans, dogs, cats, foxes, pelicans, cormorants, etc. There are two intermediate hosts: the first is a mollusk, the second is various species of carp and salmonid fish. With the feces of the definitive host, the egg is released into the environment and must enter the water.

It produces a miracidium, which passively penetrates the body of the first intermediate host - a mollusk, where it develops to the cercariae stage. The cercariae enter the water and actively penetrate the body of the second intermediate host - a fish, where they transform into metacercariae in the muscles, as well as on the scales and fins.

Humans become infected by eating undercooked or undercooked, as well as raw and dried fish infected with metacercariae of Metagonimus. Invasive stages: for mollusks - miracidia, for fish - cercariae, for humans and other definitive hosts - *metacercariae.*

Pathogenic action. Metagonimosis - biohelminthiasis, natural focal disease, zoonosis. Accompanied by intestinal disorders. Larvae make passages in the intestinal mucosa, causing inflammatory processes.

Laboratory diagnostics. Detection of eggs in the feces of a sick person.

Prevention. Personal - do not consume raw, dried, and insufficiently cooked fish. Public - protect water bodies from fecal pollution, sanitary and educational work.

Topic 24. Suckers: lung and blood suckers, nanophiet. Tapeworms: broad tapeworm.

Lung fluke (Paragonimus ringeri, syn. P. westermani) - the causative agent of paragonimiasis.

Geographic distribution: East Asia, Far East, South America, Africa.

Localization: small bronchi, lungs; extrapulmonary localization - liver, spleen, brain, muscles.

Morphology. The body is ovoid, reddish-brown, covered with spines, up to 10 mm in size. The testes are located in the posterior third of the body, the ovary and uterus are located above the testes. The eggs are wide and oval, with a lid, golden-brown in color, up to 100 microns in size.

Life cycle. Lungworm - biohelminth. Development with a change of hosts. Definitive hosts - animals from the canine, feline, raccoon, pig families, less often humans. There are two intermediate hosts: the first - freshwater mollusks, the second - freshwater crayfish and crabs. The parasite's eggs are excreted with the sputum and feces of the definitive host into the external environment.

For further development, they must enter the water. The egg produces a miracidium that actively penetrates the mollusk, where the larval stages of sporocysts, redia, and cercariae develop sequentially. The cercariae leave the mollusk's body and actively penetrate the body of the second intermediate host (freshwater crayfish, crabs), where they transform into metacercariae. A person becomes infected by eating insufficiently cooked freshwater crayfish and crabs infected with metacercariae or through water (after the crayfish dies, the metacercariae remain alive in the water for up to 25 days).

Invasive stages: for the first intermediate host (mollusk) - miracidia, for the second intermediate (freshwater crayfish and crabs) - cercariae, for the definitive hosts - metacercariae.

Pathogenic action. Paragonimiasis - biohelminthiasis, natural focal disease, zoonosis. In the lungs, paragonimiasis causes inflammation, hemorrhages, and the formation of cystic cavities. There is a cough with sputum and blood impurities, which may resemble tuberculosis. There are cases of extrapulmonary localization of the parasite. With cerebral paragonimiasis, blindness, paralysis, seizures, mental disorders often develop.

Laboratory diagnostics. Detection of eggs in sputum or feces.

Prevention. Personal - do not eat raw freshwater crayfish and crabs. Public - protect water bodies from fecal pollution, sanitary and educational work.

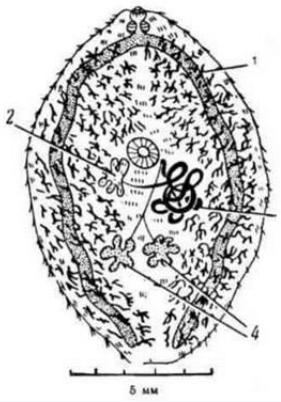


Fig. 29. Lungworm (Paragonimu ringed):
1 - yolk sac; 2 - ovary; 3 - uterus; 4 - testes.

Nanophyetus salmincola schikhobalowi - the causative agent of nanophytosis.

Geographical distribution: Far East (Amur basin), northern part of Sakhalin Island, North America.

Localization: small intestine.

Morphology. The smallest human trematode, size 0.6 x 0.4 mm, almost round in shape, yellowish-gray in color, armed with spines. Elongated-oval large testes are located symmetrically in the posterior half of the body. The ovary is located in the right body cavity in front of the testes. Small ovules are scattered throughout the body. Eggs are oval, gray or yellowish in color, have a lid, very similar to eggs of a broad tapeworm, measuring 0.07X0.04 microns.

Life cycle. Definitive hosts are humans, cats, dogs, various wild mammals. Eggs are excreted with the feces of the definitive host. There are two intermediate hosts. The first is gastropod mollusks, the second is freshwater fish. A person becomes infected by eating undercooked fish infected with nanophyte larvae.

Pathogenic effect. Nanophytosis is one of the most common helminthiasis in the Far East. The disease is manifested by digestive disorders (damage to the mucous membrane of the small intestine).

Laboratory diagnostics. Detection of eggs in the feces of a sick person.

Prevention. As with opisthorchiasis.

Blood flukes, or schistosomes - the causative agents of schistosomiasis, belong to the family

Shistomatidae: the only family of dioecious trematodes.

Geographic distribution: countries with tropical and subtropical climates.

Localization: the lumen of blood vessels, usually veins.

Morphophysiological characteristics. Schistosomes, unlike other trematodes, are dioecious. The body is narrow, cylindrical in shape. The male is much shorter and wider than the female, 10-15 mm long. On its abdominal part there is a groove - the gynophore canal, in which a long, thin female, about 20 mm in size, is placed during fertilization. Two intestinal canals in the middle of the body are connected into one unpaired one, which ends blindly near the posterior end of the parasite.

Life cycle. The definitive host is a person and various mammals, the intermediate one is freshwater mollusks. There are two generations of sporocysts in the life cycle (I and II order), redia are absent. The invasive stage for the definitive hosts is *cercariae*.

Infection occurs through active penetration of cercariae through the skin or mucous membranes upon contact with water. The eggs have a spike. The following species parasitize humans: ***Schistosoma haematobium, Schistosoma mansoni, Schistosoma japonicum.***

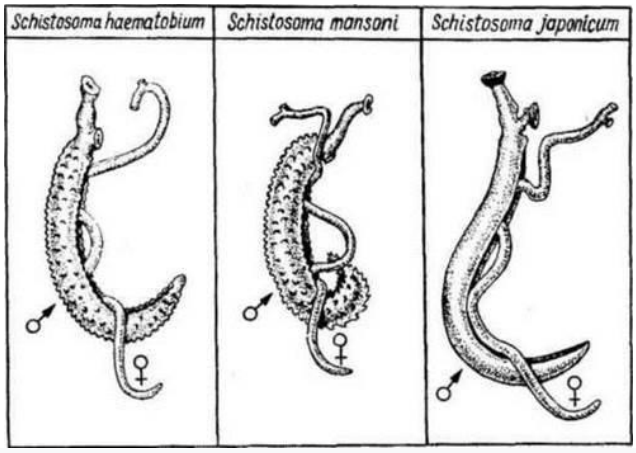


Fig. 30. Schistosome.

Urogenital schistosomiasis is a parasitic disease characteristic of a number of tropical countries in Africa, America, and the Middle East.

Etiology and pathogenesis. The causative agents of the disease are trematodes of the family Schistosomatidae. The intermediate hosts of these trematodes are gastropods, the final host is humans, mammals and birds. When schistosomatide eggs enter the water, they release miracidia, which penetrate the mollusk tissues, where their further development occurs. Human infection occurs when swimming in water bodies where there are cercariae.

Schistosomiasis, as a result of active movement and tissue lysis, penetrates the vascular bed and migrates to the venous plexuses of the gastrointestinal tract or urinary bladder, where females begin to lay eggs, which, through the vascular wall, move into the submucosa of the urinary bladder and genitals. Thus, a schistosomiasis infiltrate is formed - *bilharzioma.*

As a result of the contraction of the bladder, the eggs perforate its mucous membrane and are excreted with the urine.

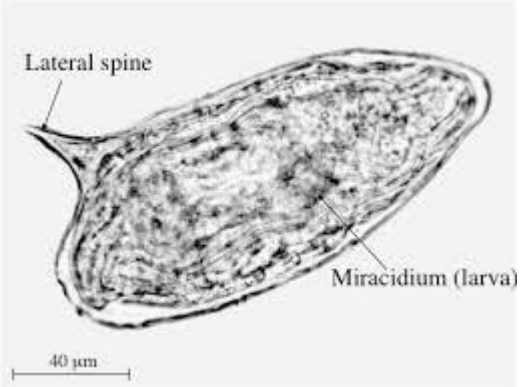


Fig. 31. Egg Schistosoma mansoni.

Violation of the trophic mucosa leads to the formation of ulcers, which, when scarring, involve the ureters and develop bilateral ureterohydronephrosis and chronic renal failure. In addition to the bladder, migrating parasites can penetrate the anastomoses of the venous plexuses into the prostate gland, seminal vesicles, epididymis, and vas deferens.

Clinical picture. After 10-15 minutes, urticaria appears at the site of cercariae penetration into the skin, and within 24 hours a transient spotted rash with severe itching appears, which persists for up to 5 days. 1-2 months after infection with schistosome, acute schistosomiasis, or *Katayama fever*, develops. The disease is characterized by sudden onset, fever for 2 weeks or more, dry cough, the appearance of urticarial rash, hepatomegaly, splenomegaly, hematuria, dysuria, leukocytosis, eosinophilia, and an increase in erythrocyte sedimentation rate.

Diagnosis. The absolute sign of the disease is the detection of schistosome eggs in the urine. Cystoscopy plays an important role, during which schistosomiasis tubercles are detected, which have the appearance of hemispherical transparent formations of yellow color without signs of inflammation of the surrounding mucous membrane.

In later stages of the disease, schistosomiasis infiltrates (hyperemic irregularly shaped formations in the mucous membrane of the bladder) and bladder ulcers are detected. In chronic invasion, the mucous membrane of the bladder is pale yellow, with a poor vascular pattern and the presence of "sandy" spots: this is due to calcified helminth eggs shining through the thin mucous membrane. The diagnosis is confirmed by indirect immunofluorescence with schistosome antigens.

Prevention consists in a complete ban on swimming in natural bodies of water in tropical countries, boiling drinking water.

Schistosoma mansoni is the causative agent of intestinal schistosomiasis.

Geographical distribution: Africa and South America (especially Brazil).

Localization: mesenteric veins, intestines and hemorrhoidal veins.

Morphophysiological characteristics. In structure similar to Sch. haematobium. In size somewhat smaller: male up to 10 mm in length, female - up to 15 mm. The body is covered with somewhat larger spines. The egg has a large spine, which is located not at the pole, but on the side, measuring 140x61 microns.

Life cycle. Definitive host - humans, monkeys; intermediate hosts - mollusks of the genera Planorbis and Bullinus. Eggs are laid by fertilized females in small venules close to the intestinal lumen. They pass into the intestinal cavity and are excreted with feces.

Pathogenic action. Eggs with their spikes destroy the intestinal wall, ulcers and polypous growths are formed. A severe complication of the late period of the disease is liver damage by introduced schistosome eggs.

Laboratory diagnostics. Detection of eggs in feces.

Prevention. The same as in urogenital schistosomiasis.

Schistosoma japonicum: the causative agent of Japanese schistosomiasis.

Geographic distribution: China, Southern Japan, Indonesia, Philippine Islands.

Localization: intestinal veins, mesentery, portal vein system.

Morphology. It differs from other schistosomes by a smooth body surface devoid of spines. The size of the male is up to 20 mm, the female - up to 26 mm. The

eggs are rounded, the rudimentary spine in the form of a tubercle is located laterally, measuring 85x60 microns.

Life cycle. Japanese schistosomiasis is a naturally occurring focal disease with a wide range of hosts. Definitive hosts are humans, as well as domestic and wild animals (cattle, horses, pigs, dogs, rats, etc.). However, the main source of infection is humans. The intermediate host is a mollusk of the genus Oncomelania. Development does not differ significantly from other schistosome.

Pathogenicity. Compared to other schistosomiasis, Japanese schistosomiasis is characterized by a malignant course and high mortality (Katayama disease).

Laboratory diagnostics. Detection of eggs in feces.

Prevention. The same as for other schistosomiasis.

Class Tapeworms (Cestoidea).

Tapeworms are obligate endoparasites, in the mature stage they parasitize in the intestines of humans and vertebrates, causing diseases called *cestodes*. The body is flattened in the dorsal-ventral direction and has the shape of a ribbon. At the front end is the head (*scolex*), then the neck, then the strobila, which consists of segments (*proglottids*). On the head are the fixation organs: suckers (usually 4) or suction slits (bothria). In many, in addition to suckers, there is also a hobbit with cuticular hooks at the top of the scolex. The neck is the growth zone of the helminth. It is here that new segments are formed.

The body is covered externally by a skin-muscular sac, the surface layer of which is the *tegument*, which contains a number of digestive enzymes and an antiproteolytic enzyme that prevents the parasite from being digested in the host's intestines. Under the tegument lie three layers of muscles – the outer (circular), the inner (longitudinal) and between them – the diagonal.

The digestive system is absent. Nutrients that are in the host's intestines are absorbed osmotically by the entire body surface. The tegument cells secrete digestive enzymes, which helps digest and assimilate food.

Excretory organs are protonephridia. There are two main excretory ducts; they are located on the sides of the strobila along its entire length and open into excretory pores in the posterior segment. In each proglottid, the longitudinal channels are connected by a transverse one.

The nervous system is of the ganglionic-ladder type. It consists of the anterior nerve node - the ganglion, which is located in the scolex, and two main lateral trunks, which extend along the entire body.

The sense organs, except for the organs of touch, are absent.

The circulatory and respiratory *systems are absent.*

The reproductive system, in comparison with other organ systems, is extremely developed and very complex. Cestodes are hermaphrodites. In each segment, the complexes of male and female genital organs are repeated. Due to this, tapeworms are characterized by enormous fertility. In the youngest segments, which lie directly behind the neck, the reproductive system is still absent, then the organs of the male reproductive system appear, and as these proglottids move even further back, female

reproductive organs also develop in them, after which the segment becomes hermaphroditic, or immature. Later, in many species, part of the reproductive organs in the segments is reduced, leaving only the uterus, which contains eggs with oncospheres.

Such a segment is called mature. It can break away from the strobila and be released to the outside. The male reproductive system is represented by numerous testes, vas deferens, which are connected into a common vas deferens, which opens with the male genital opening in the genital cloaca. The distal end of the vas deferens performs the function of a copulatory organ - the *cirrus.*

Female reproductive system: ovary, yolk sac, vagina, ootype and uterus. The vagina is a special organ for the receipt of male gametes. At one end it is connected to the ootype, at the other it opens into the genital cloaca next to the male genital opening. The uterus in many species of cestodes does not have an external opening (closed type). In these cases, as the eggs arrive, it increases in size, gradually filling the entire segment, other parts of the hermaphroditic reproductive system partially atrophy. In some cysts, the uterus has an exit hole (open type) and through it the eggs with oncospheres are released to the outside. The type of cestodes is determined by the structure of the uterus (a systematic feature). Fertilization in cestodes occurs, as a rule, between different segments of the same individual (self-fertilization) or between different individuals (cross-fertilization).

The life cycle is characterized by a change of hosts and the presence of several larval stages. The final (definitive) host is vertebrates and humans, the intermediate - mainly vertebrates, but can also be invertebrates.

In the development cycle of all cestodes, there are necessarily two larval stages - the oncosphere and the fin. The oncosphere, or the first larval stage, develops in the egg when it is still in the segment, has a spherical shape and six hooks. In the intestine of the intermediate host, the oncosphere is released from the egg, with the help of hooks penetrates the blood vessels and is passively carried with the blood to various organs, where it turns into the second larval stage - the fin.

The following fins are distinguished:

cysticercus - a small fluid-filled vesicle the size of a pea, inside which one scolex is wrapped;

tsenur - a vesicle, inside which several scolexes are wrapped;

cysticercoid - a double-walled vesicle with a scolex and a tail appendage wrapped in the middle;

echinococcal cyst - a cyst that reaches large sizes, inside which there is a toxic liquid, many scolexes, daughter and grandchild vesicles;

alveococcal cyst - a conglomerate of small vesicles with colloidal contents, inside which there is a small number of scolexes;

plerocercoid - a worm-like larva with suction slits (bothria) at the anterior end.

The development of the fins into the sexually mature stage occurs in the intestine of the definitive host, where the head, under the influence of digestive juices, turns out and attaches to its wall, and the bladder collapses.

Medical significance. Several species of tapeworms are causative agents of human cestodes.

The broad tapeworm (Diphyllobothrium latum) is the causative agent of diphyllobothriasis.

Geographical distribution: The causative agent of diphyllobothriasis is found among the population engaged in fishing, in particular in Karelia, the Baltic States, along the banks of the Volga and Dniester rivers.

Localization: the small intestine.

Morphology. The largest human helminth (length 8-10 m, individual specimens - up to 20 m). The scolex is elongated, instead of suckers it bears two longitudinal suction slits - *bothria.*

Proglottids have a characteristic shape, their width is several times greater than their length. There are differences in the structure and arrangement of the reproductive system compared to tapeworms, which is of diagnostic importance. The genital cloaca is not located laterally, but on the ventral side of the segment near its anterior edge.

The yolk sacs are located in the lateral parts of the segment ventral to the testes. The uterus is coiled in a loop in the form of a rosette, has its own exit opening through which the eggs are released as they arrive, and does not form lateral branches.

The definitive hosts are humans and carnivorous mammals (cat, fox, arctic fox, dog, bear).

There are two *intermediate hosts*: the first is the Cyclops crustacean, the second is freshwater fish (pike, burbot, pike perch, etc.). Definitive hosts secrete eggs with feces, which must enter the water. The egg hatches into a larva - a coracidium - a six-hooked oncosphere, spherical in shape, covered with cilia and floating freely in the water for some time (3-4 days) until it is swallowed by the Cyclops. In the body, the cyclops from the coracidia penetrates through the intestinal wall into the body cavity with the help of hooks and turns into a fin procercoid. The cyclops is eaten by fish. In the stomach of the second intermediate host, the cyclops is digested, and the procercoid penetrates the muscles and turns into a plerocercoid.

Plerocercoid is a worm-like white larva, about 6 mm long, with two sucking slits at the anterior end. If an infected fish is eaten by another predatory fish, the plerocercoid retains its viability. Therefore, predatory fish are reservoir hosts: a large number of plerocercoids can be concentrated in their body. A person becomes infected by eating raw, dried or undercooked fish with plerocercoids. In the body of the definitive host, the plerocercoid attaches to the intestinal walls with bothria and turns into a sexually mature individual. The tapeworm lives in the human body for up to 28 years. Invasive stages: for cyclops – *coracidium*, for fish – *procercoid*, for the definitive host (human, etc.) – *plerocercoid.*

Life cycle. The broad tapeworm is a biohelminth. Development with a change of hosts.

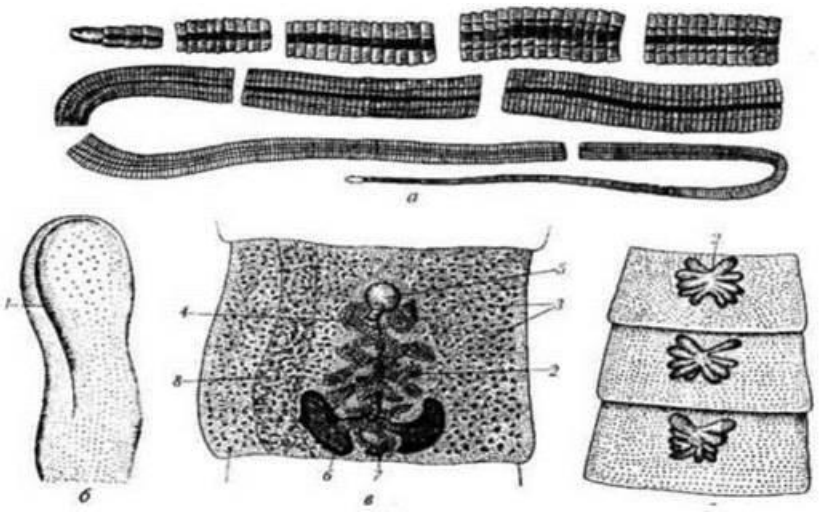


Fig. 33. Diphyllobothrium latum: a - body; b - head (bothria visible - 1); c - hermaphroditic segment; d - mature segments; 2 - uterus; 3 - yolk sac; 4 - uterine loops; 5 - cirrus sac; 6 - ovary; 7 - Melissa's body; 8 - testes.

Pathogenic action. Diphyllobothriasis is a biohelminthiasis, a naturally focal disease. The parasite damages the intestinal mucosa with sucking cracks, which leads to tissue death. The accumulation of parasites can cause intestinal obstruction. The patient often develops severe anemia associated with a deficiency of cyanocobalamin (vitamin B12), which the parasite selectively adsorbs on its surface from the contents of the intestines.

Laboratory diagnostics. Detection of eggs in the feces of a sick person. The eggs are wide, oval, with a smooth transparent double-contour shell, yellowish or gray in color, there is a cap, size up to 70 microns. Often the diagnosis is confirmed when fragments of strobiles of various lengths are found in the feces. Wide strobiles with short segments and a centrally located rosette-shaped uterus indicate diphyllobothriasis.

Prevention. *Personal* – do not eat raw and semi-raw fish or caviar. *Public* – identification and deworming of patients; sanitary improvement of ships, settlements; protection of water bodies from pollution by human feces; sanitary control over compliance with the rules for processing fish products; sanitary and educational work.

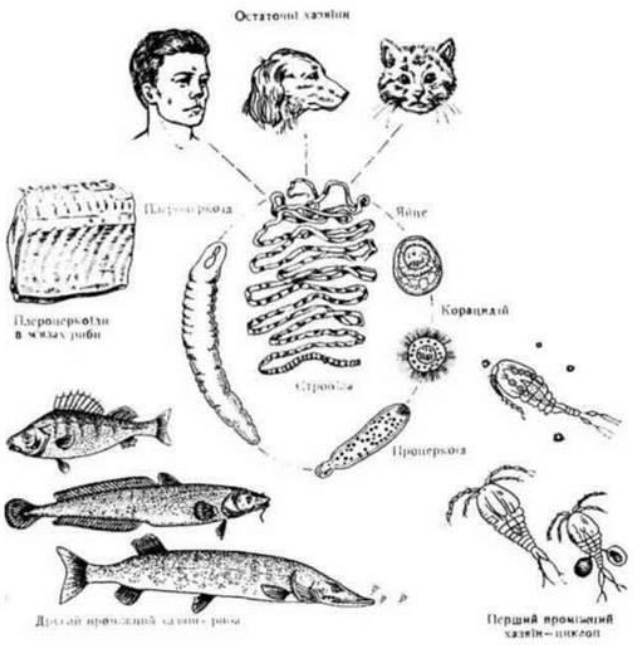


Fig. 34. The development cycle of the broad-leaved tapeworm.

Topic 25. Tapeworms: bovine tapeworm, pork tapeworm

Armed or pork tapeworm (Taenia solium) - in the mature stage, the causative agent of teniosis, in the larval stage (fin - cysticercus) - cysticercosis.

Geographical distribution: everywhere, where pig farming is developed.

Localization: the mature form parasitizes in the small intestine, fins - in various organs, most often in the muscles, the central nervous system.

Morphology. The body is ribbon-shaped, white, 2-3 m long. The head is microscopic (2-3 mm), bears 4 suckers and a double corolla of hooks (hence the name - armed tapeworm). Behind the head is an unjointed neck. The strobilus has up to 1000 or more segments. Hermaphroditic segments are square in shape. The ovary has three lobes - two large and a third small (additional), which is a specific feature. The yolk sac is located under the ovary. The testes are located in the lateral parts of the proglottid. The genital cloaca is located in one segment on the left side, in the next - on the right. The uterus is blindly closed. In mature segments, the uterus forms 7-12 branches on each side (diagnostic sign).

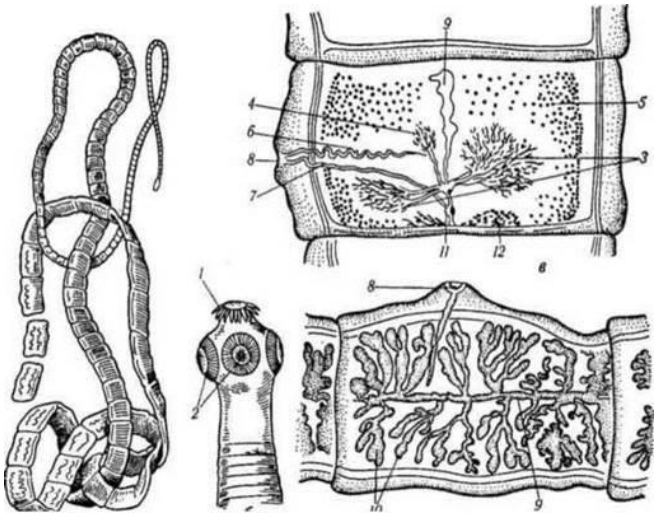


Fig. 35. Armed tapeworm (Taenia solium): a - strobila; b - scolex; c - hermaphroditic proglottid; d - mature proglottid; 1 - hooks on the scolex; 2 - suckers; 3 - ovary; 4 - third (additional) lobe of the ovary; 5 - testes; 6 - vas deferens; 7 - vagina; 8 - cirrus sac; 9 - main trunk of the uterus; 10 - lateral branches of the uterus; 11 - Melissa's body; 12 - yolk sac.

Life cycle. Armed tapeworm - biohelminth. Development with a change of hosts. The definitive host is only a person, the intermediate host is a pig, occasionally a person. A person with teniasis excretes mature segments with feces, which contain eggs with *oncospheres.* Pigs rummage in feces and can swallow segments or individual eggs. In the stomach of a pig, a six-hooked larva – an oncosphere - emerges from the egg.

With the help of hooks, oncospheres penetrate blood vessels and are carried with blood to various internal organs (liver, muscles, brain), where after 2 months they turn into a *cysticercus.*

The cysticercus can be seen with the naked eye. It has a diameter of up to 10 mm. A person becomes infected when eating raw or undercooked pork infested with cysticercus. Under the influence of digestive juices, a scolex is turned out of the cysticercus, which attaches to the wall of the small intestine, then proglottids begin to grow from the neck and after 2-3 months the helminth reaches sexual maturity. The life span in the human body is 10 years or more. Thus, the invasive stage for the intermediate host is eggs with oncospheres, for the definitive one - the fin (cysticercus).

Pathogenic effect. Taeniasis is a biohelminthiasis, zoonosis. The pathogenic effect is due to mechanical action, the use of digested food by the host and the toxic effect of the waste products of the causative agent of taeniasis. Digestive disorders, anemia, and general weakness are observed.

The armed tapeworm is also dangerous because humans can be intermediate hosts if eggs are accidentally swallowed or as a result of autoinvasion (when proglottids can enter the stomach in patients with teniasis during vomiting). In the stomach, oncospheres are released from the eggs, which are carried with the blood to various organs, where they turn into cysticerci. The localization of cysticerci in the brain is dangerous, which can sometimes cause death, as well as in the organ of vision, which can lead to blindness. Treatment of cysticercosis is only surgical.

Laboratory diagnostics of teniasis. Detection of mature segments in the feces of a sick person. The presence of 7-12 lateral branches of the uterus indicates teniasis. The uterus does not have an exit opening, so eggs in feces are rare.

Laboratory diagnostics of cysticercosis. X-ray studies, immunological reactions.

Prevention of taeniasis. *Personal* – do not consume pork that has not passed veterinary examination. *Public* – identification and treatment of patients, especially those working in livestock farming; veterinary examination of pig meat; protection of soil from contamination by human feces; closed housing of pigs.

Prevention of cysticercosis. *Personal* – follow the rules of personal hygiene. *Public* – sanitary and educational work.

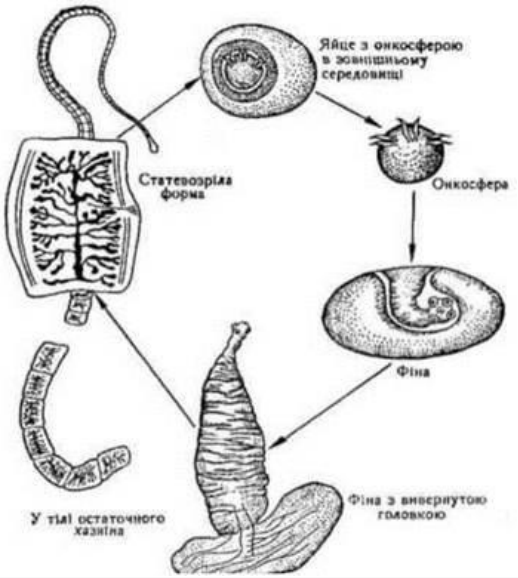


Fig. 36. The development cycle of the armed tapeworm.

The unarmed, or bovine, tapeworm (Taeniarhynchus saginatus) is the causative agent of taeniarhynchosis.

Geographical distribution: everywhere.

Localization: the small intestine.

Morphology. One of the largest human helminths, 4-7 m long (individual specimens up to 10 and even 18 m). Structurally similar to the pork tapeworm. It differs from it in the absence of hooks on the scolex (hence the name unarmed) and the third (additional) lobe of the ovary in the hermaphroditic segment (the ovary has only two lobes). In addition, in the mature segment, the uterus has 17-35 lateral branches. Mature segments, breaking away from the strobila, can independently crawl out of the anus and move around the patient's body and underwear. Mature segments of the armed tapeworm do not have this ability.

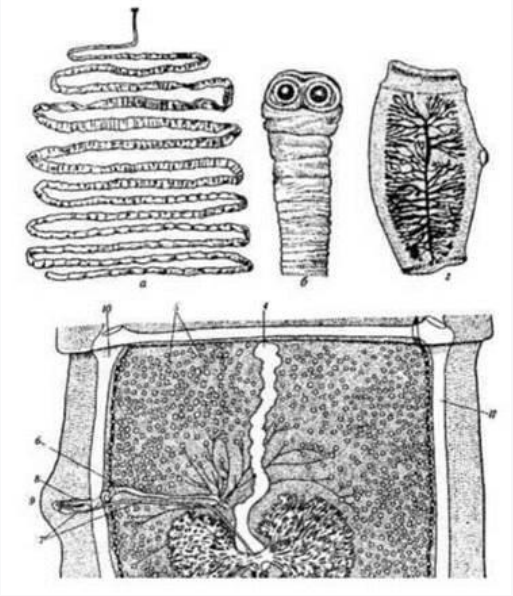


Fig. 37. Unarmed tapeworm (Taeniarhynchus saginatus):
a - general view; b - head; c - hermaphroditic segment; d - mature segment; 1 - ovary; 2 - yolk sac; 3 - Melissa's body; 4 - uterus; 5 - testis; 6 - vas deferens; 7 - vagina; 8 - cirrus sac; 9 - genital cloaca; 10 - excretory system canal; 11 - nerve trunk.

Life cycle. Unarmed tapeworm – biohelminth. Development with a change of hosts. The definitive host is only humans, the intermediate host is cattle. A person suffering from teniarrhythmia excretes mature segments with feces, which contain eggs with *oncospheres.*

If the segments or eggs enter the digestive tract of cattle, the egg shell is digested, and the six-hooked oncosphere penetrates the intestinal wall into the blood vessels and is carried with the blood to various organs of the host. Here the oncosphere loses its hooks and turns into a nymph – *cysticercus.* In the muscles, cysticerci can live for years, but do not develop. Further development is possible only in the intestines of the final host – humans. Humans become infected by eating undercooked meat of cattle infected with cysticerci. In the human intestine, the head of the cysticercus turns out, attaches to the wall of the small intestine, after which the growth of strobila begins from the neck. Thus, the invasive stage for the intermediate host (cattle) is an egg with an oncosphere, for the definitive (human) - a fin (cysticercus). Life expectancy is about 10 years.

Pathogenic action. The course of teniarrhinosis is similar to teniasis.

Laboratory diagnostics. Detection of mature segments in the feces of a sick person. The uterus in a mature segment has 17-35 branches on each side. The uterus in an unarmed tapeworm is also closed, so eggs are often not found in the feces of a patient. If they are found (in scrapings from the perianal folds), they are morphologically indistinguishable from the eggs of the pork tapeworm.

Prevention. *Personal* - do not consume meat that has not passed veterinary examination. *Public* - identification and treatment of patients; veterinary examination of cattle meat; protection of soil from contamination by human feces; sanitary and educational work.

Dwarf tapeworm (Hymenolepis nana) - the causative agent of hymenolepidosis.

Geographical distribution: ubiquitous.

Localization: the small intestine of a person. *Morphology*. The dimensions, compared to other cestodes, are small: length - 1.5-2 cm, rarely up to 5 cm (hence the name - dwarf). The scolex is pear-shaped, bears four suckers and a retractable proboscis with hooks. The neck is long and thin.

There are 100-200 segments in the strobilus. The genital openings of all segments are located on one side. The posterior segments with a sac-like uterus are very delicate. When detached from the strobilus, they quickly collapse, and the eggs with oncospheres enter the lumen of the small intestine.

Life cycle. In the life cycle of the dwarf tapeworm, humans are the definitive and intermediate hosts, the only source of infection. From humans, the parasite's eggs, along with feces, enter the external environment. They are already invasive.

Infection occurs through the mouth. The main factor in the transmission of the causative agent of hymenolepidosis is dirty hands. In the intestine, oncospheres are released from the eggs, which penetrate the villi of the small intestine and turn into a cysticercoid. The cysticercoid grows, destroys the villi and falls into the lumen of the intestine.

Under the influence of digestive juices, the head of the cysticercoid turns out, attaches to the wall of the small intestine and the growth of segments begins. After 14-15 days, a sexually mature individual is formed. It is believed that autoinvasion (development of parasite eggs in the intestine without exit to the external environment) is possible in hymenolepiasis. Under such conditions, the invasion lasts a long time. A person suffering from hymenolepidosis, if he does not follow the rules of personal hygiene, can bring eggs of his own parasites into his mouth (autoreinvasion). The definitive host of the parasite and the source of invasion for humans can be rats and mice, and the intermediate host is the flour beetle and its larvae.

Pathogenic action. Hymenolepidosis - contact biohelminthiasis, anthroponosis. The source of infection is a sick person. The mechanism of transmission is fecal-oral, carried out through the ingestion of eggs. Preschool children are mainly infected.

The parasite is found in large numbers (up to 1500 specimens), which causes a significant pathogenic effect on the host's body, which consists in the destruction of intestinal villi and the toxic effect of helminth waste products. With hymenolepidosis, headaches, abdominal pain, disorders of the digestive and nervous systems, general weakness and fatigue are observed. Children become capricious and irritable.

Laboratory diagnostics. Detection of eggs in the feces of a sick person.

Prevention. *Personal* - the strictest observance of personal hygiene rules, instilling hygiene skills in children, washing hands before eating and after visiting the toilet. *Public* - identification and deworming of patients; in children's groups it is necessary to isolate the sick from the healthy; sanitary and educational work among parents and employees of children's institutions; control of rodents.

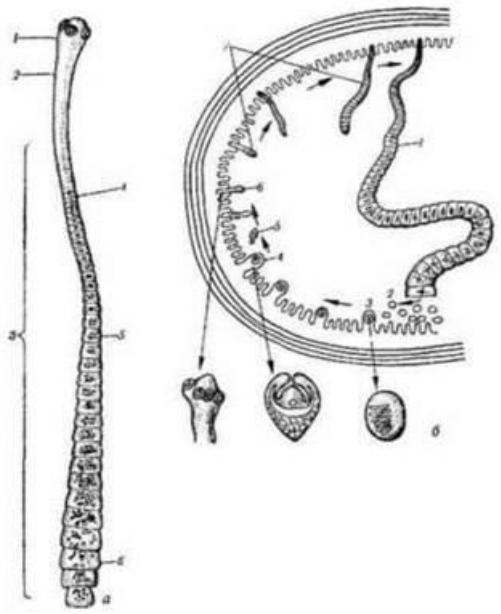


Fig. 38. Dwarf tapeworm (Hymenolepis nana):
a - general view; 1 - head; 2 - neck; 3 - body; 4 - immature segment; 5 - hermaphroditic segment; 6 - mature segment; b - development cycle in the human intestines: 1 - body of a sexually mature worm; 2 - eggs; 3 - oncospheres that have emerged from the eggs, in the villi of the mucous membrane; 4 - cysticercoid; 5 - exit of the cysticercoid with an inverted head from the villi into the intestinal cavity; 7 - growth of the worm's body.

Echinococcus (Echinococcus granulosus) - the causative agent of echinococcosis.

Geographic distribution: widespread, especially in areas where sheep are bred. In Ukraine, it is found mainly in the southern regions.

Localization: in humans, unlike other cestodes, it parasitizes in the fin stage, affects the liver, lungs, brain, tubular bones, but can occur in any organ.

Morphology. The body of a sexually mature parasite is 3-6 mm long. The scolex has 4 suckers and a proboscis with a double corolla of hooks. The neck is short. The strobila consists of 3-4 segments. The penultimate of them is hermaphroditic, the last is mature, contains a uterus, which has lateral outgrowths and is filled with eggs with oncospheres (500-800 eggs).

Life cycle. Echinococcus is a biohelminth. Development - with a change of hosts. Mature individuals parasitize in the small intestine of dogs, wolves, jackals, which are the definitive hosts. Intermediate hosts - humans, cattle and small cattle, pigs, camels, rabbits and many other herbivorous mammals. The last segment breaks off from the strobila and is excreted with feces or independently crawls out of the anus of the final host, mainly a dog, and actively crawls through the fur, releasing eggs. The segments that are excreted with feces crawl onto grass. Domestic herbivorous animals eat grass and simultaneously swallow echinococcus eggs.

In the intestines of intermediate hosts, an oncosphere emerges from the egg and penetrates the blood vessels. Through the portal vein, it enters the liver (the first place in terms of frequency of damage). Oncospheres that have not settled in the liver enter

the lungs through the right heart. Often, oncospheres are carried by the blood to the brain and other organs. Here, the oncosphere turns into a fin - an echinococcal bladder. The pinworm grows slowly and can reach large sizes - in animals, a pinworm weighing 64 kg has been described, and in humans, the size of a newborn baby's head. Pinworms live in the body of an intermediate host for years. For further development, they must enter the intestines of the definitive host.

Infection of dogs and other definitive hosts occurs when eating the organs of intermediate hosts affected by echinococcus. In the intestines of the definitive host, a large number of tapeworms are formed from the fin.

Invasive stages: for definitive hosts - the fin, for intermediate - eggs with oncospheres.

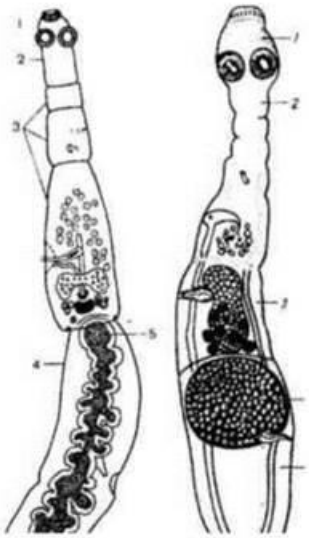


Fig. 39. Echinococcus and alveococcus:
a - echinococcus; b - alveococcus; 1 - head; 2 - neck; 3 - hermaphroditic segments; 4 - mature segment; 5 - uterus filled with eggs.

A person is most often infected with the causative agent of echinococcosis when personal hygiene rules are not followed from sick dogs, on whose fur there are eggs. Through unwashed hands, eggs enter the mouth.

Infection is possible from sheep, to whose wool echinococcus eggs stick from sick guard dogs. The causative agent of echinococcosis is also transmitted through unwashed vegetables, greens, contaminated with feces of sick dogs. Man is a biological dead end (blind branch) in the life cycle of echinococcus, because after the death of a person, the tapeworm is usually not transmitted to animals, but dies.

Pathogenic action. Echinococcosis is a biohelminthiasis, a natural focal invasion. The first signs of the disease appear after a considerable period of time after infection, when the echinococcous cysts reach a certain size. The manifestations of the disease depend on the localization of the cyst and the phase of development of the parasite.

The pathogenic effect is due to the toxicity of the fluid of the bladder and its mechanical effect on the tissues (tissue compression), which disrupts the function of the organ. Treatment is only surgical. Rupture of the echinococcal bladder is very

dangerous: the toxic fluid contained in it can cause anaphylactic shock and instant death.

In addition, rupture can result in seeding of the abdominal cavity with daughter scolexes and the development of multiple echinococcosis. Sometimes seeding occurs as a result of fluid from the fin with scolexes during surgical treatment of echinococcosis.

Laboratory diagnostics. The diagnosis is made on the basis of immunological reactions. X-ray examinations are also used. To identify sick dogs, their feces are examined, which contain echinococcus eggs.

Prevention. *Personal* - follow the rules of personal hygiene, wash hands after contact with dogs, wash vegetables, boil water, prophylactic deworming of domestic dogs twice a year. *Public* – fight against stray dogs; identification and deworming of sick service dogs; destruction of internal organs affected by echinococcosis, sanitary and educational work.

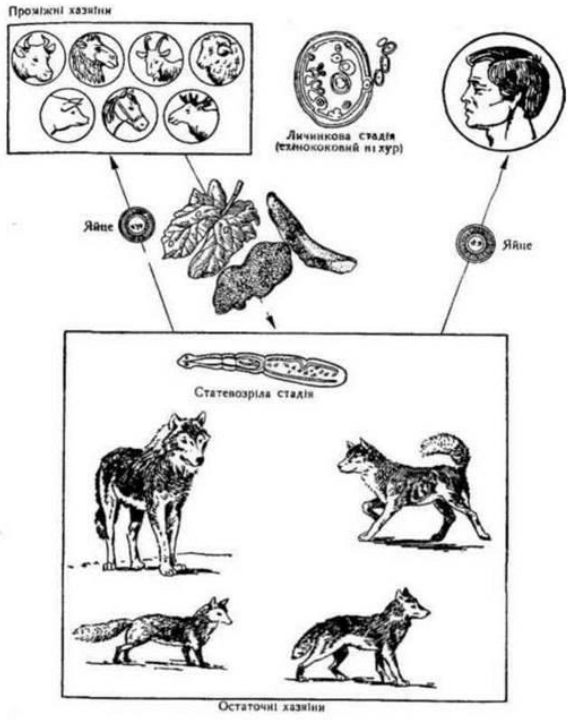


Fig. 40. The development cycle of echinococcus.

Alveococcus (Alveococcus multilocularis) is the causative agent of alveococcosis.

Geographical distribution: occurs less frequently than echinococcosis - Ukraine, Siberia, Alaska, Northern Canada, Southern France, Germany, Northern Kazakhstan, Northern Vietnam.

Localization: basically the same as in echinococcosis, but the liver is primarily affected, it is rare in other organs.

Morphology. The filamentous form of alveococcus is similar to the filiform echinococcus. It differs in smaller dimensions (1,2 – 3,7 mm), the number of hooks on the scolex, the shape of the uterus (in alveococcus it is spherical, there are no lateral protrusions), the genital opening in alveococcus is located in the anterior part of the

lateral edge of the segment, in echinococcus - in the posterior. The alveococcus fin is a collection of small vesicles. The bubbles do not contain liquid, bud outward and gradually grow into the tissues like malignant tumors, forming metastases.

Life cycle. Alveococcus is a biohelminth. Development with a change of hosts. Definitive hosts are foxes, arctic foxes, wolves, dogs, sometimes cats; intermediate hosts are mouse-like rodents, occasionally humans. The life cycle is similar to echinococcus.

Eggs with oncospheres are excreted with the feces of the definitive hosts. A person becomes infected by consuming forest berries contaminated with alveococcus eggs; by handling the skins of sick foxes, arctic foxes, and dogs; by contact with sick dogs or objects contaminated with dog feces containing alveococcus eggs. A person is the biological final link in the alveococcus life cycle.

Pathogenic action. Alveococcosis is a biohelminthiasis, a naturally occurring disease. The primary localization of the parasite in humans occurs mainly in the liver. Alveococcosis of the liver is asymptomatic for a long time (sometimes for years). Pain occurs in later stages. The disease is characterized by a malignant course. Metastatic nodes can form in the lungs, brain. Treatment is only surgical. The bladder has to be removed with part of the affected organ, because it does not have a pronounced capsule.

Laboratory diagnostics. Immunological reactions are used to establish the diagnosis. The diagnosis is usually made in the late stages, when surgery is difficult or impossible.

Prevention. *Personal* – compliance with personal hygiene rules when in contact with dogs, when handling fox, arctic fox, dog skins, washing berries, boiling water. *Public* – organization of a special room for removing skins; sanitary and educational work.

Topic 26. Oviparous nematodes. Viviparous nematodes. Laboratory diagnostics of helminthiasis. Ringworms: medical leech. Type Roundworms (Nemathelminthes).

Main characteristics of the type:

1) the body is unsegmented, cylindrical or fusiform, round in cross section; 2) they have a primary body cavity, which is filled with liquid under pressure (the liquid performs the function of a hydrostatic skeleton and transport of organic substances;

3) unlike flatworms, most roundworms are hermaphroditic; 4) circulatory and respiratory systems are absent; 5) the excretory system is either protonephridial type or represented by modified skin glands; 6) in the digestive system, unlike flatworms, a third (posterior) section appears, which ends with an anus.

All roundworms that parasitize humans belong to the class Nematoda.

Class Nematoda (Nematoda)

Body coverings and locomotor apparatus. The skin-muscular sac is formed by the cuticle, hypodermis and muscles. The cuticle has a complex ten-layer structure and performs the function of an external skeleton to which muscles are attached, protects

against mechanical and chemical factors; it is not sensitive to the action of digestive juices.

Under the cuticle is the hypodermis, which forms four ridges that extend deep into the body cavity. Behind the hypodermis lies a single layer of longitudinal muscles, separated by ridges of the hypodermis. The movements of nematodes are limited, carried out only in the dorsal plane. Inside the skin-muscular sac is the primary body cavity (pseudocoel), which contains the cavity fluid and internal organs.

The peculiarity of this cavity is that it is not lined with mesodermal epithelium. The cavity fluid is under high pressure, which creates support for the muscle bag (hydroskeleton). In some nematodes, it is toxic.

The digestive system is a tube that begins at the mouth and ends at the anus. The mouth is located at the anterior end of the body and is surrounded by several cuticular outgrowths - lips (2-6), or has the appearance of a mouth capsule with cuticular teeth or plates. The anterior, middle and posterior sections of the digestive tube are distinguished.

The anterior and posterior sections are of ectodermal origin, the middle section is of endodermal origin. The posterior section ends with an anal opening, which opens at the posterior end of the body on the ventral side.

The circulatory and respiratory systems are absent.

The excretory system is represented by 1 - 2 unicellular skin glands. Outgrowths in the form of two lateral channels depart from the gland, which lie in the lateral ridges of the hypodermis. Behind the channels end blindly, and in the front part they connect into one unpaired channel, which opens outwards through the excretory pore behind the lips. The function of excretion is also inherent in special phagocytic cells, which are located along the excretory channels.

The nervous system consists of a peripharyngeal ring, from which the nerve trunks - dorsal, ventral and 4 lateral - depart. The trunks are interconnected by commissures. The sense organs are poorly developed.

Reproductive system. Reproduction is sexual only. Nematodes are usually hermaphroditic. Reproductive organs are tubular in structure. In males, the reproductive system is unpaired: testis, vas deferens, seminal duct (opens into the hindgut), copulatory organ (spicules).

The female reproductive system is paired: ovaries (eggs are formed), oviducts, uterus, which are connected to each other and form an unpaired vagina (opens outward at the front end of the body). In some species, the female has only one sex tube. Nematodes are characterized by sexual dimorphism - males and females differ in external signs. Males are smaller, the posterior end of the body in some of them is twisted to the ventral side.

The life cycle is simpler than that of flatworms: the transformation of one larval form into another is usually absent. Most nematodes belong to the geohelminths, development is direct, without a change of hosts. Fertilized eggs begin to develop in the uterus, but the final formation of the larva occurs only in the external environment without the participation of an intermediate host.

For the development of the larva, certain conditions are required - the presence of heat, humidity, free oxygen. The development of other types of nematodes (biohelminths) occurs with the participation of an intermediate host. The larvae of many nematodes are characterized by migration in the body of the host. Some types of nematodes are viviparous, that is, the egg develops to the larval stage in the female's genital tract and live larvae emerge from the female's body.

Medical significance. Many members of the class Nematodes are parasites of humans. Diseases caused by nematodes are called nematodosis.

Human roundworm (Ascaris lumbricoides) - the causative agent of ascariasis.

Geographical distribution: everywhere.

Localization: small intestine.

Morphology. Ascarids are yellow with a pink tint. The spindle-shaped elongated body is covered with a strong shiny cuticle, narrowed to both ends. The length of females is up to 40 cm, males - 15-25 cm.

The posterior end of the female is conically pointed, on the anterior third of the body there is a ring-shaped constriction, on which the external genital opening opens from the ventral side. The posterior end of the male is bent to the ventral side. The mouth is surrounded by three cuticular lips - a dorsal and two ventral, on which there are a pair of sensitive papillae. On the lateral surfaces, longitudinal lateral lines are visible, in which the channels of the excretory system pass.

Eggs can be fertilized and unfertilized. Fertilized eggs are round or oval, 60-70x40-50 microns in size, yellow-brown in color. The outer albumen shell is tuberculate, the middle one is glossy, the inner one is fibrous, thick, smooth, colorless.

Inside the egg is a dark-colored germ cell. The albumen shell may be absent. Unfertilized eggs are oval or irregular in shape, 80x55 microns in size. The entire egg cavity is filled with yolk cells.

Life cycle. Ascaris is a geohelminth, parasitizes in the small intestine of humans. It does not have special fixation organs, it is held in the lumen of the intestine due to constant movement against the flow of food. It feeds on food gruel. The female lays up to 240 thousand eggs per day. They are not invasive.

Together with the feces of a sick person, the eggs are released into the external environment, where under favorable conditions (free oxygen, heat, humidity) their development occurs. In the soil at optimal humidity and temperature +24-25°C, a motile larva develops in the egg after about 24 days and it becomes invasive.

A person becomes infected by swallowing invasive eggs. The eggs are brought into the mouth with unwashed vegetables, fruits, and dirty hands. In the intestines, a larva hatches from the egg, which penetrates the intestinal mucosa, blood vessels, and migrates through the human body with the blood.

Migration path: intestine - liver - right heart - lungs. Ascaris larvae need free oxygen to develop. They destroy blood capillaries and successively penetrate the alveoli, where they grow and molt twice.

Then they enter the bronchioles, bronchi, trachea, larynx and oral cavity. With saliva, the larvae are re-swallowed, enter the small intestine again and turn into

sexually mature forms. Migration lasts about two weeks. The total duration of development of ascaris from the moment of infection to sexual maturity is 70-75 days. The life span of adult ascaris in the human intestine is about a year.

Ascaris eggs are resistant to adverse environmental conditions and can remain viable for up to 6 years or more. They are resistant to various chemicals, but quickly die under the influence of high temperature. A temperature of +60 ° C kills them within 1-2 minutes, at +70 ° C - in a few seconds. Flies and cockroaches (mechanical carriers) play a certain role in the spread of eggs.

Pathogenic action. Ascariasis - geohelminthiasis, anthroponosis. The only source of infection is a sick person. The mechanism of transmission of the pathogen is fecal-oral.

The pulmonary stage of ascariasis is characterized by cough, chest pain, fever, often in combination with urticaria, lasts up to 2 weeks.

The intestinal stage of ascariasis is manifested by headaches, abdominal pain, dyspeptic disorders, mechanical damage to the intestinal wall, the formation of pathological intestinal reflexes due to constant irritation of the intestinal walls, ascarids absorb nutrients, contribute to hypovitaminosis, and exhaustion of the body.

Ascariasis can cause complications - intestinal obstruction. Cases of extraintestinal (atypical) localization of ascarids, which is associated with their high mobility, have been described. Most often, ascarids penetrate the liver, causing abscesses and mechanical jaundice as a result of obstruction of the bile ducts. Cases of detection of ascarids in the frontal sinuses, middle ear cavity, larynx, etc. have been described.

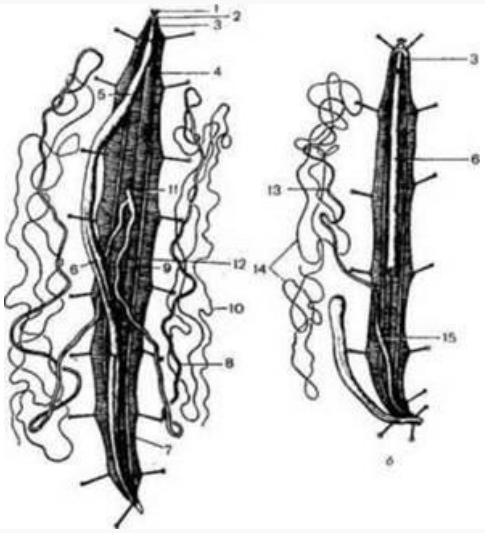


Fig. 41. Internal structure of ascaris:

a - female: b - male; 1 - lips; 2 - nerve ring; 3 - pharynx; 4 - phagocytic cells; 5 - esophagus; 6 - midgut; 7 - lateral hypodermic roller with excretory duct; 8 - oviduct; 9 - uterus; 10 - ovary; 11 - vagina; 12 - abdominal hypodermic roller; 13 - vas deferens; 14 - testis; 15 - seminal duct.

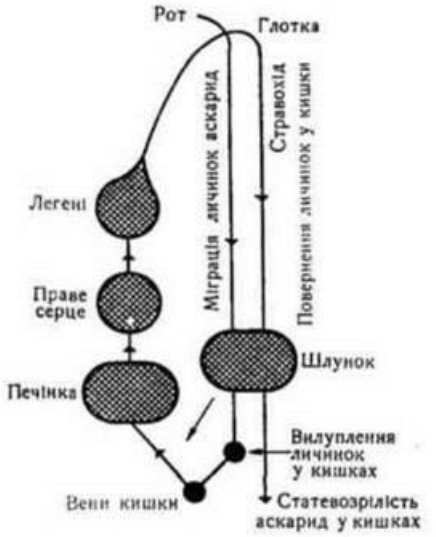


Fig. 42. Scheme of migration of ascarid larvae in the human body.

Laboratory diagnostics. Detection of larvae in sputum (larvoscopy) in the pulmonary stage of the disease; ovoscopy of feces (eggs in feces may be absent if only males or young ascarids parasitize in the intestine), serological reactions

Prevention. Personal - wash your hands before eating. Vegetables and berries that are consumed raw are recommended to be subjected to heat treatment. In this case, it is necessary to wash the vegetable products well first with clean cold water, then lower them for 2-3 seconds in boiling water or for 8-10 seconds in hot water (70-76° C) and then rinse with cold water. Then vegetables, berries, fruits and other greens will be completely disinfected from eggs of ascarids, pinworms and other geohelminths. Public - sanitary improvement of populated areas, protection of soil from fecal contamination, control of flies and cockroaches. Vegetable gardens and berry bushes should not be fertilized with fresh human feces and pig droppings.

Fertilizing gardens with feces is permissible only after they have been composted for one year (at least). Although pork ascaris does not parasitize in the human intestines, the migration of larvae can occur in the human body and cause a painful condition.

Human hair head (Trichocephalus trichiurus) is the causative agent of trichocephalosis.

Geographical distribution: everywhere.

Localization: cecum, upper parts of the colon.

Morphology. The hairy head is 3-5 cm long. The front part of the body is narrowed and looks like a thread or hair (hence the name), a long esophagus passes through it. All other organs are located in the posterior, expanded part of the body. In males, the posterior end of the body is spirally twisted.

The eggs are yellowish-brown in color, 50-54 x 22-23 microns in size, with fine-grained contents. They resemble a lemon or a barrel in shape with light crust-like formations at the poles.

Fig. 43. Trichocephalus trichiurus:
a - female; b - male; 1 - anterior end; 2 - posterior end.

Life cycle. Trichocephalus is a geohelminth, a parasite of humans only. The source of infection is a person suffering from trichocephalosis. The mechanism of transmission is fecal-oral. Trichocephalus eggs are excreted into the external environment with the patient's feces.

The larva develops in the egg, which reaches invasive maturity at a temperature of 25-30° C in about 25-30 days. Infection occurs when infective eggs are swallowed with unwashed vegetables, berries, fruits, and water. Under the influence of gastric juice, the egg shells dissolve, and larvae emerge from the eggs, which, unlike roundworm larvae, do not migrate.

They penetrate the villi of the small intestine and develop there for three to ten days. The villi are destroyed, and the larvae again enter the lumen of the intestine, descend and fix on the wall of the cecum or colon. The parasite penetrates deeply into the intestinal wall with its anterior filamentous end, as if lacing it, and feeds on blood (hematophagy) and cells of the intestinal wall. 1 - 1.5 months after infection, the female begins to lay eggs. The life span of the hairy head is 5-6 years, the female releases about 60 thousand eggs per day.

Pathogenic action. Trichocephalosis is a geohelminthiasis, anthroponosis, which is accompanied by paroxysmal pain in the lower abdomen, especially on the right, loss of appetite, digestive disorders, dizziness, epileptimorphic seizures in children.

In the blood picture - eosinophilia. Trichocephalus can cause inflammation of the appendix. When treating trichocephalosis, it is necessary to keep in mind that drugs that are injected into the intestinal lumen do not act on the trichocephalus, since it is a hematophagous and does not feed on intestinal contents.

Laboratory diagnostics. Detection of eggs in the feces of a sick person.

Prevention. Personal - do not eat unwashed vegetables, berries, fruits; wash hands after using the toilet; protect products from flies and cockroaches, which are mechanical carriers of helminth eggs. Public - sanitary and educational work; do not

fertilize vegetable gardens with uncomposted human feces; build toilets according to sanitary and hygienic standards; fight against flies and cockroaches.

The hookworm (Ancylostoma duodenale) is the causative agent of hookworm disease.

Geographic distribution: mainly in countries with subtropical and tropical climates, found in Transcaucasia, Central Asia. In temperate, and even cold, climates, foci of hookworm disease can occur in mines, where relatively high temperatures and humidity are constantly maintained.

Localization: duodenum.

Morphology. Small parasites of reddish color. The head end is bent ventrally (hence the name - kryvogolovka). The length of the female is 10-18 mm, the male - 8-10 mm. In males, the posterior end is expanded in the form of a bell (genital bursa).

At the head end is a mouth capsule with 4 teeth, into which the ducts of two glands open. The secretion of the glands prevents blood clotting. The roundworm captures a section of the intestinal mucosa with its capsule and, attaching to it, feeds on blood (hematophagous). The egg is similar in shape to the egg of Ascaris, but the shell is smooth, thin and transparent, measuring 66 x 38 microns. It is at the stage of 4-8 spherical blastomeres.

Life cycle. The roundworm is a geohelminth, a parasite of only humans. Fertilized eggs with the feces of a sick person are excreted into the external environment. At a favorable temperature (25-27 ° C), rhabdit larvae emerge from the eggs after a day. They are non-invasive. They are characterized by the presence of two expansions (bulbous) of the esophagus. The larvae molt twice. During the second molt, the cuticle peels off but is not shed, the larva remains as if in a sheath. At the same time, the esophagus is restructured, which acquires a cylindrical shape. The rhabdit larva turns into a filarial larva.

Filarial larvae are invasive. They are concentrated mainly in the surface layers of the soil and can also climb up moist plant stems. Infection occurs in two ways:

1) through the skin when exposed areas of the body come into contact with soil contaminated with invasive hookworm larvae (when a person walks without shoes or lies on the ground; in mines) and 2) through the mouth with vegetables or water contaminated with hookworm larvae.

Larvae that have entered the human body through the skin migrate, sequentially entering the right side of the heart, pulmonary arteries, alveoli, bronchioles, bronchi, trachea, pharynx, are swallowed with saliva and enter the esophagus, stomach, and duodenum, where they become sexually mature.

They live in the intestines for 5-6 years. If the larva enters the human body through the mouth, migration usually does not occur. It is believed that infection through the mouth is less common. The main route of infection is the active penetration of larvae through the skin. The source of infection is a person with hookworm. People who are constantly in contact with the ground are most often affected: tea plantation workers, gardeners, diggers, and miners.

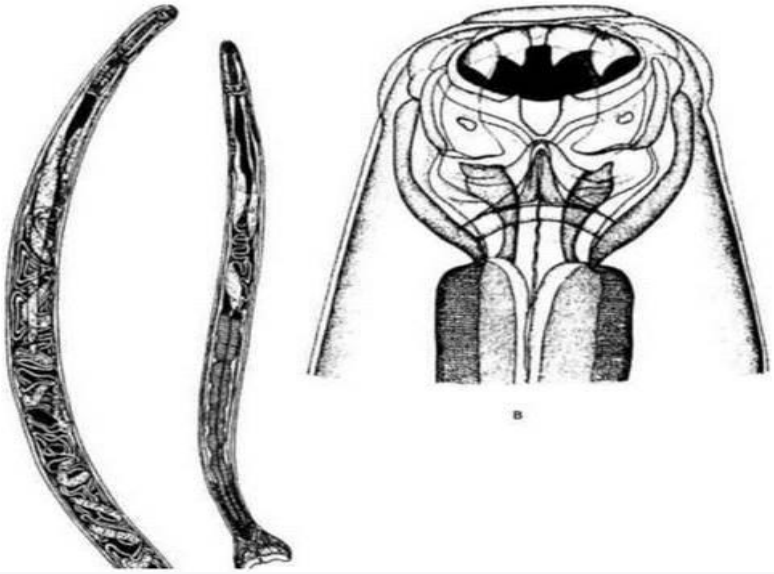


Fig. 44. Hookworm (Ancylostoma duodenale):
a - female; b - male; c - head end (cuticular teeth are visible in the oral capsule).

Pathogenic action. Hookworm is a geohelminthiasis, an anthroponosis, which is characterized by a chronic course, progressive weakness, headache, weight loss, iron deficiency chloranemia, edema.

The pathogenic effect of hookworms is due to the loss of blood, which they feed on, and intoxication with the products of the parasite's vital activity.

Laboratory diagnostics. Detection of eggs in feces and duodenal contents.

Prevention. Personal - in areas of hookworm infection, do not walk without shoes, do not lie naked on the ground. Do not eat unwashed vegetables, observe personal hygiene rules.

Public - detection and treatment of patients; in order to prevent the introduction of hookworms into mines, a coprological examination for helminth eggs is carried out on all persons accepted for underground work; detected patients are left in above-ground work until they are completely freed from hookworms; if larvae are detected in mines, the rock is treated with table salt. There are no foci of hookworm infection in the mines of Ukraine.

Necator (Necator americanus) is the causative agent of necatorosis, which is clinically indistinguishable from hookworm. In this regard, they are combined into one group of diseases - ankylostomiasis. Necator is widespread in tropical and subtropical climates, mainly in Asia and South America. Morphologically and biologically it is very similar to ankylostoma, but its size is somewhat smaller, the length of the female is 8-13 mm, the male is 5-10 mm. In the oral cavity instead of teeth there are 2 sharp plates.

Eggs morphologically do not differ from those of hookworm. Diagnosis is made as in hookworm. **Prevention** as in hookworm.

Pinworm (Enterobius vermicularis) - the causative agent of enterobiasis.

Geographical distribution: widespread.

Localization: lower part of the small intestine and the initial part of the large intestine.

Morphology. The roundworm is a small white worm. The length of females is about 10 mm, males - 2-5 mm. The posterior end of the male's body is twisted to the ventral side, in females - pointed like an awl. At the anterior end of the body there is a swelling of the cuticle - a vesicle that surrounds the mouth opening and participates in the fixation of the helminth to the intestinal walls.

In the back of the esophagus there is a spherical swelling - bulbus. The intestine is in the form of a straight tube. The reproductive system has a typical structure for nematodes.

Pinworm eggs are colorless, asymmetrical (one side is convex, the other is flat), the shell is smooth, transparent. Size - 50-60 x 20-30 microns. Inside the egg you can see the larva

Life cycle. Pinworms are parasites of humans only. Pinworms attach to the intestinal wall using a bulb and vesicle. Males die after fertilization of females. The female does not lay eggs in the intestine. The fertilized female descends to the anus, mainly at night, when the sphincter tone weakens, comes out and lays from 10 to 15 thousand eggs on the skin of the perianal area of a person.

The optimal conditions for egg development are a temperature of 34-36°C and high humidity of 70-90%. Pinworm eggs become invasive after 4-6 hours. Females, crawling, cause skin irritation. A person experiences severe itching. Patients with enterobiasis scratch itchy areas during sleep. Eggs get on the fingers, especially accumulating under the nails, and are also scattered on underwear.

They can be brought from the hands into the mouth by the patient himself (especially if he has a habit of biting his nails, which is often found in children). This is how repeated self-infection occurs (autoreinvasion). The egg is the invasive stage. Larvae hatch from swallowed eggs, which turn into sexually mature forms in the intestines. Larvae do not migrate.

The life span of pinworm is about 1 month. If during this period there is no new infection, self-healing is possible. Pinworm is a contact helminth. The only source of infection is a person suffering from enterobiasis. Unlike other helminthiasis, a patient with enterobiasis poses a direct epidemic danger.

Pathogenic action. Enterobiasis is a contact helminthiasis, anthroponosis, which is accompanied by itching at night in the anus. There are disorders of the gastrointestinal tract and nervous system: nausea, loss of appetite, abdominal pain, sometimes headache, lack of sleep, convulsions in children.

In case of penetration into the appendix, pinworms can cause its inflammation. Pinworms can contribute to the appearance of cracks, dermatitis, eczema in the perineum, and also crawl into the vagina, causing vulvovaginitis.

Laboratory diagnostics. Detection of eggs in scrapings from the perianal skin folds. Sometimes, pinworms that have come out are visible in the feces.

Prevention. Careful observance of personal hygiene rules, keeping the living space clean. It is especially important to instill hygiene skills in children, monitor the cleanliness of their hands and nails, and cut their nails short. Sick children are

recommended to wear panties at night, which must be washed in the morning and ironed with a hot iron while wet. Public prevention consists of conducting mass examinations of children, especially in children's groups, followed by deworming. The premises should be wet cleaned. Toys should be periodically treated with boiling water. Of great importance is the implementation of sanitary and educational work, increasing the medical literacy of the population.

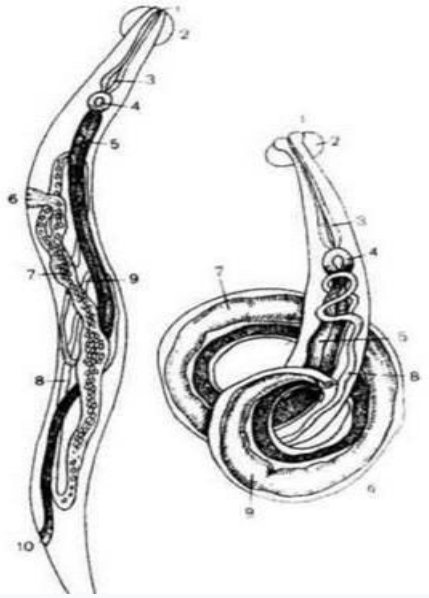


Fig. 45. Pinworm (Enterobius vermicularis):
a-female; b-male; 1-mouth; 2-vesicle; 3 - esophagus; 4 - bulbus; 5 - midgut; 6 - vaginal opening; 7-9 - parts of the reproductive system; 10 - anus.

Intestinal pinworm (Strongyloides stercoralis) - the causative agent of strongyloidiasis.

Geographical distribution: mainly in tropical and subtropical countries, but also found in the temperate zone.

Localization: small intestine.

Morphology. Mature individuals are colorless, translucent, the length of the female is 2-3 mm, the male is 0.7 mm. The anterior end of the body is evenly narrowed, the posterior end is pointed. The oral capsule is short, with four weakly expressed lips.

Life cycle. The intestinal tapeworm is a geohelminth that parasitizes only humans. The life cycle is associated with the existence of free-living and parasitic generations. In the human intestine, eggs hatch into rhabdit larvae, which are excreted into the external environment with feces.

Further development of rhabditic larvae can occur in two ways: 1) if the rhabditic (non-invasive) larva enters unfavorable conditions in the soil, it molts and quickly turns into a filarial (invasive) larva, which actively penetrates the human skin and migrates through the right heart, lungs, respiratory tract, pharynx, then is swallowed and enters the intestines.

During migration (lasting 17-21 days), the larvae transform into sexually mature forms. Fertilization can occur in the lungs and intestines; 2) if the rhabdit larvae in the external environment fall into favorable conditions (warmth, humidity, oxygen), they

transform into males and females of the free-living generation, which live in the soil, feeding on decomposing organic matter. The eggs laid by the female give rise to rhabdit larvae, which, under favorable conditions, transform into sexually mature individuals.

Under unfavorable conditions, the rhabdit larvae of the free-living generation transform into filarial larvae, which are capable of infecting humans and giving rise to a parasitic generation; 3) there is a third path of development - autoinvasion, or intraintestinal infection (development of parasites in the human intestine without exiting to the external environment). Rhabdit larvae that remain in the intestine transform into filarial worms, penetrate the intestinal wall, then into the lumen of blood vessels and begin a new cycle of development.

The source of invasion is a person with strongyloidiasis. The routes of infection are the same as for hookworm. People who work with the earth are most often infected. Epidemics of strongyloidiasis in mines have been described.

Pathogenic effect. Strongyloidiasis is a geohelminthiasis, an anthroponosis, which is accompanied by a violation of the digestive system, a pronounced toxic-allergic effect, mechanical damage to tissues during the period of larval migration, damage to the mucous membrane of the small intestine, which leads to the accession of a secondary infection. As a result of the penetration of larvae through the skin, inflammatory processes may occur on it.

Laboratory diagnostics. Detection of larvae (larvoscopy) in feces, which should be fresh, still warm.

Prevention. The same as for hookworms. Trichinella (Trichinella spiralis) - the causative agent of trichinosis.

Trichinella larvae were first discovered in 1835 by the English medical student J. Paget (later a famous English surgeon) in the muscles of a human corpse.

Geographic distribution: on all continents, except Australia and Antarctica.

Localization: mature individuals - in the wall of the small intestine, larvae - in the striated muscles.

Morphology. Small filamentous worms. The length of the female is 3-4 mm, the male – 1,4-1,6 mm. The stylet is located in the oral capsule. Female trichinella are viviparous.

Life cycle. Trichinella is a biohelminth. It parasitizes in the human body and many mammals. The host organism is both definitive and intermediate. Infection occurs alimentarily when eating meat with Trichinella larvae. Under the action of gastric juice, the meat and the wall of the capsule surrounding the larvae are digested. The larvae are released from the capsules, penetrate the mucous membrane of the small intestine and turn into sexually mature forms. The latter penetrate under the epithelium with their anterior ends, and their posterior ends lie between the villi. In the intestines of humans and animals, sexually mature trichinella parasitize for a short time (in humans no more than 42-56 days).

During this time, the female reproduces (starting from the 4th day after infection) up to 2000 larvae (0.1 mm). Young trichinella with the flow of lymph and blood are introduced into all organs and tissues (migrate), but settle only in skeletal muscles. The

diaphragm, intercostal, masticatory, deltoid, and calf muscles are most often affected. The larvae penetrate under the sarcolemma of the muscle fiber, grow, and spirally twist.

On the 20th-23rd day after infection, a thin connective tissue capsule appears around the spirally coiled larva and the sarcoplasmic area. In the encapsulated state, the larvae remain alive and invasive for a very long time (almost until the end of the host's life). Sometimes several larvae are contained in the capsule. Gradually, the capsule wall thickens and becomes impregnated with calcium salts (calcifies).

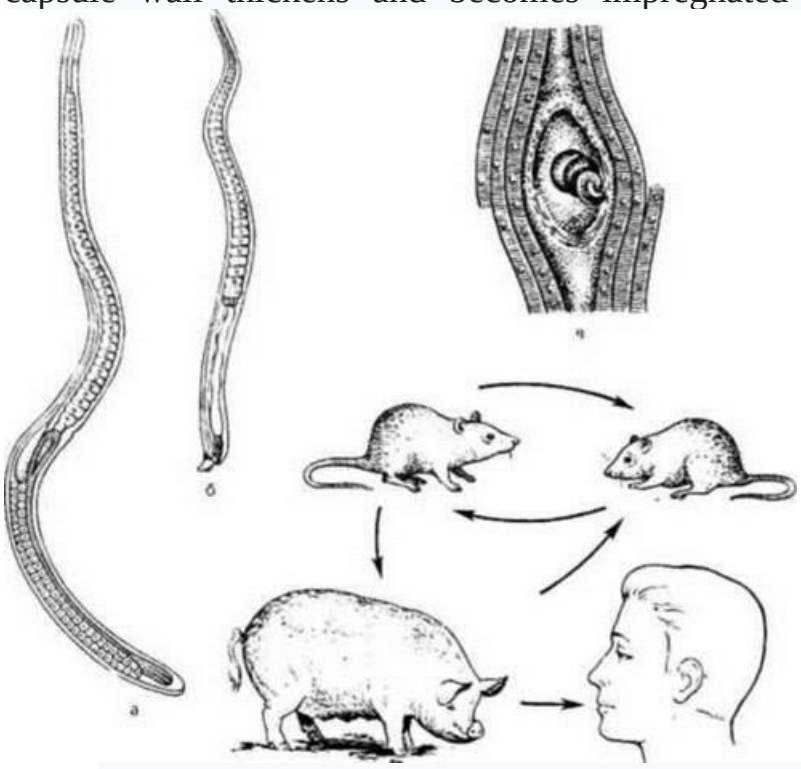


Fig. 46. Trichinella (Trichinella spiralis): a - female; b - male; c - encapsulated larva in muscle fiber; d - the main route of circulation of Trichinella in synanthropic foci.

To transform the larvae into a sexually mature form, they must enter the gastrointestinal tract of another host. This occurs if the meat of an infected animal is eaten by an animal of the same or another species. For example, a rat will be eaten by another rat or a pig. In the life cycle of Trichinella, a person is a biological dead end, since after its death the parasites are not transmitted to other hosts and die. A person becomes infected by eating infested pig meat, products made from it (sausage, ham, lard with veins of meat), meat of wild animals (wild boar, bear, badger, nutria, etc.).

Trichinosis is a naturally occurring disease. The circulation of Trichinella in natural foci is supported by food links between many species of mammals, mainly predators (wolf, fox, etc.), because they feed on meat. Synanthropic foci of trichinosis can form in populated areas if anti-trichinosis measures are violated. In synanthropic foci, the circulation of Trichinella occurs between domestic animals (pigs, dogs, cats) and synanthropic rodents (rats, mice). The spread of Trichinella is facilitated by free grazing of pigs, feeding of raw offal to domestic animals, and carcasses of animals shot while hunting.

Pathogenic action. Human diseases are group and family in nature, which is associated with the presence of a common source of infection. The period of intestinal

invasion corresponds to the incubation period of the disease, but with a large invasion it is accompanied by abdominal pain and digestive disorders.

During the migration period, the main clinical symptoms are observed: swelling of the eyelids and face; muscle pain; fever and high (up to 40%) eosinophilia. With intensive invasion, complications are observed: damage to the myocardium, lungs, and brain. Trichinosis with complications can result in death.

Laboratory diagnostics. The diagnosis is made based on the clinical signs listed above and is confirmed by: 1) the detection of Trichinella larvae in the meat that could have caused the infection; 2) immunological reactions. In rare cases, a biopsy of the patient's muscle is performed to confirm the diagnosis (the surgeon cuts out a piece of muscle measuring 3 x 1.5 cm).

Prevention. *Personal* – do not eat meat that has not passed veterinary examination. Heat treatment of trichinella-infected meat is ineffective because the trichinella inside the pieces of meat remain viable and can cause invasion. *Public* – veterinary examination of meat of pigs and wild animals susceptible to trichinosis (wild boar, badger, bear, nutria), destruction of trichinosis meat, keeping pigs in well-maintained pig pens, sanitary and educational work.

The tapeworm (Dracunculus medinensis) is the causative agent of dracunculosis.

Geographic distribution: Iraq, India, tropical Africa and a number of other countries. The focus of dracunculosis existed in Central Asia in Bukhara, but during 1923-1932 pp. it was eliminated thanks to the research and practical activities of L. M. Isayev (1886-1964).

Localization: subcutaneous tissue, near the joints, mainly of the lower extremities.

Morphology. One of the largest human nematodes. The body shape is filamentous. The female reaches a length of 30 to 150 cm with a thickness of 1-1.7 mm. Males are smaller, 12-29 mm long, 0.4 mm thick. Viviparous. The external genital opening is closed, so the larvae exit through a tear in the uterus and cuticle at the head end.

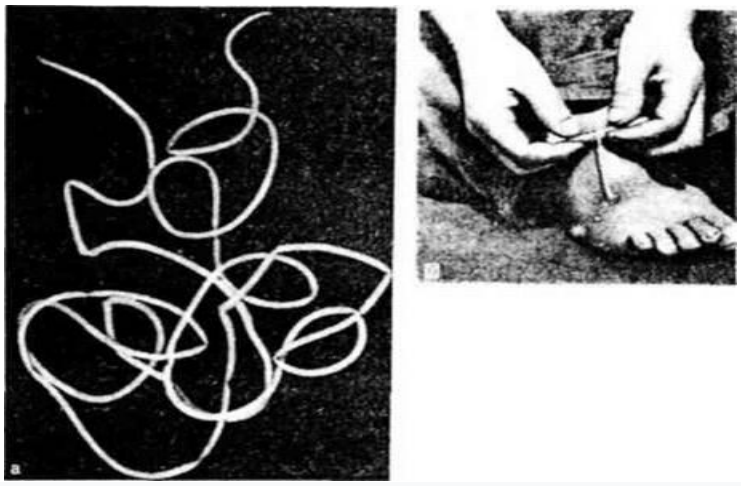


Fig. 47. Tapeworm (Dracunculus medinensis).

Life cycle. Tapeworm is a biohelminth. The life cycle is associated with a change of hosts. The definitive host is a person, there can be domestic and wild animals (horse, dog, monkey, etc.), the intermediate one is the freshwater crustacean Cyclops.

Only fertilized females are found in the subcutaneous tissue (copulation occurs at earlier stages of parasite development). Being in the subcutaneous tissue of the definitive host, the mite forms a cord-like roller, at the end of which a blister forms. After the blister ruptures, the head end of the mite protrudes through the resulting wound.

When the blister is washed with water, the uterus of the worm bursts and the released larvae (microfilariae) are released into the water. Further development of the larvae occurs when they fall into a reservoir and are swallowed by a cyclops. A person becomes infected by swallowing cyclops with microfilariae when drinking raw unfiltered water.

Invasive stage - larvae - microfilariae. In the human stomach, the cyclops is digested, and the microfilariae of the hookworm penetrate the intestinal wall and migrate into the subcutaneous tissue.

Pathogenic action and diagnosis. Dracunculiasis manifests itself in the form of itching and hardening in the places of localization of the parasite. When localized near the joints, the patient cannot walk.

The ulcers are painful; in addition, they may be accompanied by secondary infection. In the late phase of the disease, before the appearance of ulcers, the diagnosis can be established by the presence of clearly visible tortuous ridges under the skin at the sites of parasite localization.

Prevention. *Personal* – do not drink raw, unfiltered water in foci of dracunculosis. *Public* – identify and treat patients; drain reservoirs where cyclops may be infected; destroy cyclops in open reservoirs; sanitary and educational work.

Filariae (Filaria) - causative agents of filariasis. This name unites nematodes of a filamentous form (Greek filus - thread), which are common in tropical and subtropical countries. Females give birth to live larvae - microfilariae.

The mechanism of infection is transmissive. Carriers are blood-sucking dipteran insects.

Filariae include ***Wuchereria Bancrofti, Brugia malaji, Onchocerca volvulus, Loa loa.***

Wuchereria Bancrofti - the causative agent of wuchereriosis.

Geographic distribution: Asia (China, Japan, countries of the Indochina Peninsula, India, Ceylon, Philippines, Indonesia), some countries of Africa and South America.

Localization: adult nematodes parasitize in the lymphatic system, connective tissue, larvae - in the bloodstream.

Morphology. Mature individuals are filamentous, milky white. The size of the female is about 80-100 mm, the male is about 40 mm. The female is viviparous.

Life cycle. The definitive host is only humans, the intermediate host and vector are mosquitoes of the genera Anopheles, Culex, Aedes, Mansonia. In the lymphatic vessels and nodes of the definitive host, males and females usually intertwine with each other, forming a ball.

Females give birth to microfilariae, which migrate from the lymphatic system to the bloodstream. During the day, the larvae are in large blood vessels (aorta, carotid artery) and vessels of internal organs or muscles, and at night they enter peripheral blood vessels. Therefore, the larvae are called nocturnal microfilariae (Microfilaria nocturna). The daily migration is explained by the synchronization of the parasite and vector cycles.

Vectors (mosquitoes) attack humans mainly at night. With the blood of an infected person, the larvae enter the mosquito's stomach. From the digestive tract, they migrate to the pectoral muscles and then to the proboscis. The duration of the development cycle in a mosquito, depending on temperature conditions, ranges from 8 to 35 days. At the moment of a mosquito bite on a person, the microfilariae rupture the proboscis membrane, get on the skin and actively penetrate it.

Then they are introduced into one or another department of the lymphatic system and there develop into sexually mature forms. Life expectancy in the human body is about 17 years.

Pathogenic action. Wuchereriosis - transmissible biohelminthiasis, anthroponosis. Gathering in balls, wuchereria can clog the lumen of lymphatic vessels, which disrupts the normal movement of lymph. As a result, the volume of the affected organ increases sharply, sometimes reaching enormous sizes. In this regard, wuchereriosis is known as "elephant disease", or elephantiasis. The lower limbs, genitals, and mammary glands are most often affected. Sometimes the disease is complicated by the addition of a secondary infection.

Laboratory diagnostics. The material for the study is blood, which is taken at night. Microfilariae are detected under a microscope. Immunological reactions are also used.

Prevention. *Personal* – protection from mosquito bites. *Public* – detection and treatment of patients, destruction of mosquitoes at all stages of development using insecticides, agrotechnical measures for the improvement of the area, sanitary and educational work.

Fig. 48. Elephantiasis caused by Wuchereria bancrofti.

Brugia malaji - the causative agent of brugia. In structure and life cycle, it is similar to W. bancrofti. It differs in a slightly smaller size: females - up to 55 mm, males - 20-23 mm. Viviparous.

Geographical distribution: more limited, found only in Asian countries (Indonesia, India, Vietnam, etc.).

Localization: adult nematodes parasitize in the lymphatic system, connective tissue, larvae - in the bloodstream.

Life cycle. The final host is a person, but there may also be cats, dogs, monkeys. Intermediate - the same species of mosquitoes as in wuhireria, but most often mosquitoes of the genus Mansonia. Larvae are also found in the peripheral blood at night, but at different hours.

Laboratory diagnostics. Detection of microfilariae in peripheral blood. Blood is collected in the evening and at night. Immunological reactions.

Prevention. The same as for wuchereriosis.

Onchocerca volvulus - causative agents of onchocerciasis. Onchocerciasis is an important medical and socio-economic problem for many countries of the world. In Africa alone, about 20 million people suffer from onchocerciasis, of which 1-2% become blind as a result of the invasion.

Geographic distribution: Widespread in Africa, Central America (Mexico, Guatemala).

Localization: skin, subcutaneous tissue, lymph nodes, organs of vision.

Morphophysiological characteristics. The body is filamentous, white, pointed on both sides. The size of females is up to 50 cm, males are much smaller - 2.5-4 cm. Females reproduce small larvae (microfilariae) up to 0.03 mm in length.

Life cycle. Definitive host - man, intermediate - midges of the genus Simulium. Attacking a sick person, midges absorb microfilariae into the stomach. Under favorable conditions, microfilariae become invasive in 6 days. When midges attack a person, invasive larvae burrow into the skin, migrate into the lymphatic system, then into the subcutaneous tissue and under the aponeuroses of muscles, where they develop into sexually mature individuals. Parasitizing in the human body, the female gives birth to microfilariae, which accumulate in the skin. The source of invasion is a person with onchocerciasis. *The invasive stage* is microfilariae.

Pathogenic action. Onchocerciasis is a transmissible biohelminthiasis. Symptoms of the disease depend on the location of the nodes with parasites and the intensity of the invasion. One patient can have 1-3 nodes (onchocerciasis), but there can be more (up to 50). Size from a pea to a pigeon egg. A serious complication is damage to the organs of vision by onchocerciasis larvae, which often leads to complete blindness. American onchocerciasis is characterized by a more malignant course compared to African: blindness occurs more often, due to the location of the nodes in the periosteum, perforation of the skull bones and dysfunction of the nervous system are possible.

Parasitism of microfilariae leads to lymph stagnation, the formation of ulcers. The metabolic products of hookworms cause allergization of the body. Treatment is surgical.

Laboratory diagnostics. If the diagnosis by external examination is difficult, dissection and histological examination of the node are performed.

Prevention. *Personal* – protection from midge bites. *Public* – identification and treatment of patients, destruction of midges in places of their breeding. Most often these are rapid mountain streams with a fast flow. Sanitary and educational work.

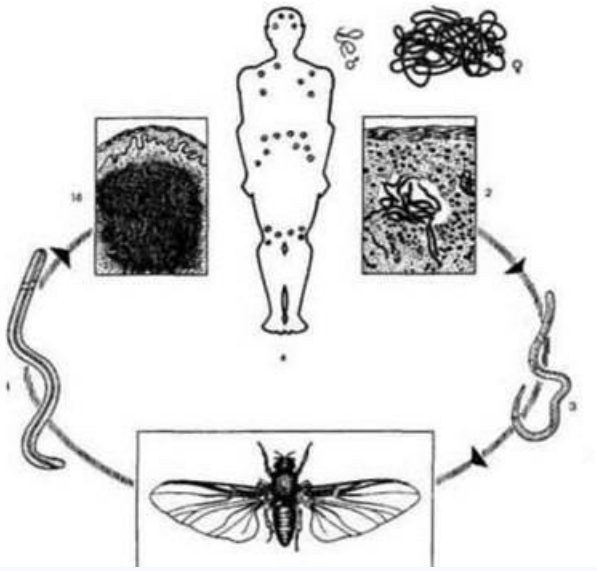


Fig. 49. Life cycle of Onchocerca volvulus:

a - definitive host (human): top right - male and female parasite; b - section of subcutaneous node with onchocerca; 2 - microfilariae from subcutaneous connective tissue; 3 - microfilariae in the blood; b - intermediate host (midge Simulium damnosum); 4 - invasive larvae from the proboscis of the intermediate host.

Loa loa - causative agent of loiasis.

Geographic distribution: equatorial Africa, zone of humid tropical forests.

Localization: adult filarial parasites parasitize in the subcutaneous connective tissue and under the serous membranes, where they migrate at a speed of 12.5 mm per minute and are especially often found under the conjunctiva of the eye. From here they move into the vitreous body, into the depths of the orbit and return to the anterior chamber of the eye. The parasite in the eye is clearly visible to the naked eye, its movements are rapid.

Morphology. The body is filamentous, translucent, white or yellowish in color, covered with numerous rounded tubercles. The male is 30 mm long, 0.43 mm thick, the female reaches a length of 50-70 mm and a thickness of 0.50 mm.

Life cycle. The final host is humans, monkeys. Intermediate - gadflies of the genus Chrysops. Fertilized females reproduce microfilariae, which reach the capillaries of the lungs through the lymphatic and blood vessels and after a few weeks systematically migrate into the peripheral blood vessels. Microfilariae of this species are characterized by a daily periodicity, therefore they are called Microfilaria diurna

(daytime). This is due to the biological characteristics of gadflies, which are characterized by daytime activity.

Geckos become infected by biting a sick person. In the gecko's body, the larvae penetrate the gecko's head after 7-10 days. When attacking a healthy person, the microfilariae pass to the skin and quickly penetrate its thickness.

Pathogenic action. Loaosis is a transmissible biohelminthiasis. The effect of the parasite on the human body is toxic, mechanical. An early and constant symptom of loaosis is a suddenly occurring, dense swelling of the skin and subcutaneous tissue (the so-called Calabar edema).

Laboratory diagnostics. Microscopic examination of blood, immunological reactions.

Prevention. Personal - protection from bedbug bites. Public - identification and treatment of patients, destruction of bedbugs, sanitary and educational work.

Larvae of animal ascarids are the causative agents of the cutaneous and visceral forms of larva migrans. Larvae of some animal ascarids, which migrate in the body of obligate hosts, are able to migrate in the human body similarly to human ascaris, but in an unusual host, they are unable to complete a full development cycle. The clinical syndrome of this phenomenon is called larva migrans. There are cutaneous and visceral forms of this syndrome.

In humans, the most common larval toxocariasis is caused by larvae of the ascarids of the genus Toxosaga: ***Toxosaga canis and T. mystax. T. canis*** parasitizes in the intestines of the canid family (dog, wolf, fox, arctic fox), ***T. mystax*** – In the intestines of the feline family (domestic cat, wild cats), which are obligate hosts.

Humans are facultative hosts in which these helminths parasitize in the larval stage. Infection occurs when invasive eggs enter the gastrointestinal tract. Eggs are brought into the mouth mainly with dirty hands, which most often happens in children during games on the ground, as well as with unwashed vegetables and fruits. The larvae that have emerged from the eggs migrate to various organs and tissues, settle in them, without losing their viability for several years.

Gradually they are surrounded by granulomas, then fibrous tissue and die. Migration can take up to 10 years (experiments on primates). Toxocariasis is observed mainly in children aged 1.5 to 4 years. Its main symptoms: allergy, urticaria, pulmonary edema, liver enlargement, eosinophilia. Rashes of various nature, small nodules may appear on the skin. Many infected children have a distorted appetite, try to eat earth, lime, chalk. Often there are signs of damage to the central nervous system - irritability, sleep disorders, behavior, as well as encephalitis and meningitis. One of the variants of toxocariasis is ocular toxocariasis, in which the retina, lens, and iris are affected.

Ocular toxocariasis can lead to vision loss. The final diagnosis of toxocariasis is made when larvae are detected in tissue biopsies.

Prevention. Protection of vegetable gardens, playgrounds, and parks from contamination with animal feces, examination and treatment of cats and dogs, and adherence to personal hygiene rules.

Laboratory diagnostics of helminthiasis.

Mature helminths, which are inside the host's body, constantly lay eggs or larvae, which, depending on the localization of the helminths, are either released into the external environment or accumulate in the blood, lymph, and other tissues. The detection of certain helminths, their eggs or larvae is the essence of laboratory diagnostics of helminthiasis.

In the external environment, eggs or larvae of helminths are most often excreted with feces. Therefore, feces or coprological analysis (Greek kopros - feces) is most often performed. The following methods are used for this - helminthoscopy, helminth ovoscopy and helmintholarvoscopy.

Helminthoscopy. Helminthoscopy is a method of laboratory diagnosis of helminthiasis based on the detection of whole specimens of helminths or their fragments. This method is macroscopic, it is performed without a microscope and only if necessary a magnifying glass is used.

Macroscopic examination of feces is used either to detect helminths that are shed after deworming, or to detect segments or fragments of tapeworms that periodically break away from the helminth's body and are excreted into the external environment with feces.

The technique of helminthoscopy is as follows. Small portions of feces are mixed with water and, viewing them under good lighting in glass trays with black paper placed under them, helminths and all suspicious white formations are removed with tweezers or a pipette for further study. More often, in helminthoscopy, the method of sequential settling of feces is used.

To do this, the entire portion of feces is mixed with water in glass cylinders, allowed to stand (for several minutes), the liquid is drained, and the sediment is again filled with water and stirred. This is repeated several times. When the liquid becomes transparent, it is drained, and the sediment is examined in small portions in a glass bath or Petri dish on a dark background.

Helminth ovoscopy is a method of laboratory diagnosis of helminthiasis based on the detection of helminth eggs in feces.

The method of a patch smear. A pea-sized piece of feces is placed on a glass slide (6 x 9 cm) in a 50% aqueous solution of glycerin, stirred with a wooden stick, insoluble particles are removed and examined without a coverslip under a microscope.

In a native smear, it is possible to detect eggs of all types of helminths. However, this method is not effective enough because with a small number of eggs, they are not always possible to find. More accurate are methods that are based on the concentration of eggs contained in the sample in a small volume (the so-called enrichment methods). These include the Fulleborn method, the Kalantaryan method, etc.

Fulleborn method. This method is based on the floating of helminth eggs in a saturated solution of sodium chloride (specific gravity 1.2). 2.5-5 g of feces are placed in a porcelain or glass tall glass (50-100 ml) and, gradually adding a saturated solution of sodium chloride, the feces are thoroughly stirred. The solution is poured almost to the top. For stirring, it is most convenient to use wooden sticks, new each time. Large

particles that have floated to the surface of the solution are removed and the solution is left to stand for 45 minutes. During this time, due to the difference in specific gravity, eggs, as lighter, float and are in the surface film, and large insoluble particles of feces are precipitated. Using a wire loop bent at a right angle, the film is removed and shaken onto a glass slide, covered with a coverslip and viewed under a microscope.

Prepare at least four preparations. The loop is calcined in an alcohol lamp. The method is effective, but eggs of trematodes, teniids, broad tapeworms (as they are heavier), unfertilized eggs of ascaris (the shell is permeable to salts) do not float in this solution. Therefore, it is necessary to examine, in addition to the surface film, also the sediment, which complicates the method.

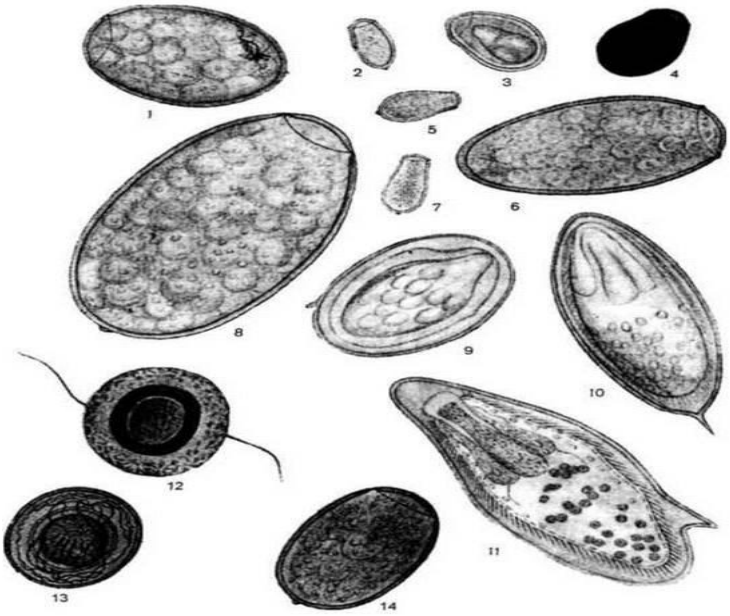


Fig. 50. Trematode and cestode eggs:

1 - nanophyte; 2 - cat fluke; 3,4 - lanceolate fluke (immature and mature); 5 - Chinese fluke; 6 - lung fluke; 7 - metagony; 8 - fasciola; 9 - Japanese schistosome; 10 - urogenital schistosome; 11 - Munson's schistosome; 12 - taeniids; 13 - dwarf tapeworm; 14 - broad tapeworm.

The Kalantaryan method is a slightly modified Fulleborn method. Instead of a saturated solution of table salt, a saturated solution of sodium nitrate (specific gravity 1.38) is prepared. The study also reveals eggs of the tapeworm and unfertilized eggs of Ascaris. The disadvantage of the method is the higher cost of sodium nitrate than the cost of table salt.

There are methods of helminth ovoscopy based on the principle of sedimentation of eggs in a solution whose specific gravity is less than the specific gravity of the eggs.

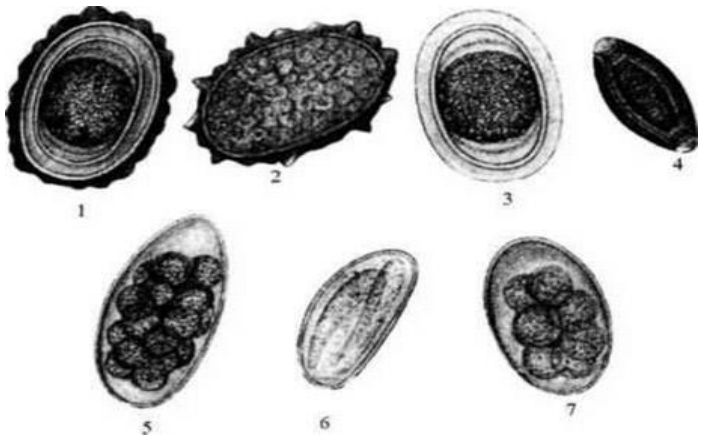


Fig. 51. Nematode eggs: ascarid: 1 - fertilized, with a protein shell; 2 - unfertilized, with a protein shell; 3 - fertilized, without a protein shell; 4 - hairball; 5,6 - pinworm: freshly released and with a larva; 7 - hookworms.

Pinworms lay their eggs in the perianal area, so a specific method is used for laboratory diagnostics of enterobiasis - the perianal scraping method. A cotton swab, tightly wound on a wooden stick and moistened with a 50% aqueous solution of glycerin, is carefully scraped from the perianal folds. The stick with the swab is placed in a dry test tube and delivered to the laboratory.

Here, the eggs are washed off the swab with 1-2 drops of 50% aqueous glycerin solution and 4 preparations are prepared on two glass slides. Instead of a cotton swab, you can use a wooden spatula (smoothed match) moistened with 50% aqueous glycerin solution or sticky polyethylene film. In addition to pinworm eggs, this method also detects bovine tapeworm eggs.

Helmintholarroscopy is a method for detecting helminth larvae. In some helminthiasis (strongyloidosis), not eggs but larvae are excreted in the feces, for the detection of which the Berman method is used. The method is based on the ability of helminth larvae to migrate towards heat. A glass funnel, on the narrow end of which a rubber tube with a clamp is put on, is placed in a tripod. 5-10 g of feces are placed on a strainer with gauze folded in two layers. The strainer is lowered into a funnel, which is filled with heated water (40-45° C) so that the lower part of the strainer is immersed in water. Larvae from the feces actively migrate into warm water and concentrate in a rubber tube. After 4 hours. water from the tube is released into a centrifuge tube and centrifuged. The supernatant is drained, and the precipitate is examined under a microscope.

Topic 27. Arthropods. Arachnids. Ticks
Type Arthropoda (Arthropoda)

Type Arthropoda (Arthropoda) is the most numerous type of animal world, which unites more than 1 million species. In the process of evolution, arthropods arose from annelids.

Characteristic features of the type: 1) bilateral symmetry; 2) three-layeredness, i.e. the development of three germ layers in the embryo; 3) heteronomous body

segmentation, which is manifested in the fact that body segments have a different structure and perform different functions; 4) fusion of segments into body sections (head, thorax, abdomen, but variability is observed in different taxa: cephalothorax and abdomen - in crustaceans and arachnids, in ticks - fusion of all sections); 5) the appearance of jointed limbs, which represent a multi-jointed lever; 6) muscle differentiation and the appearance of striated muscles; 7) external chitinized skeleton, which protects against the effects of the external environment and is intended for muscle attachment; 8) mixed body cavity - mixocoel, which is formed during embryonic development as a result of the fusion of the primary and secondary body cavities; 9) the presence of organ systems: digestive, respiratory, excretory, circulatory, nervous, endocrine, reproductive.

Classification of the Type Arthropoda:

1. Class Crustacea:
    - higher crustaceans
    - lower crustaceans
2. Class Arachnoids:
    - Order Phalanxes or Solpugae
    - Order Scorpiones
    - Order Spiders (Aranei)
    - Order Mites (Acarina)
3. Class Insects:
    - Order Cockroaches (Blattodea)
    - Order Bedbugs (Heteroptera)
    - Order Lice (Anoplura)
    - Order Fleas (Aphaniptera)
    - Order Diptera

The digestive system consists of three sections: anterior, middle and posterior, which ends with the anus. The middle section has digestive glands.

Respiratory organs. Their structure depends on the living conditions: in aquatic forms - gills, which are able to use oxygen dissolved in water, in terrestrial - lungs and trachea.

Excretory organs - in representatives of different classes are constructed differently. In some, these are highly modified metanephridia (excretory glands of crustaceans), in others, excretory organs of a new type - Malpighian tubules (in arachnids and insects).

Circulatory system. Progressive due to the presence of a pulsating organ - the heart, which is located on the dorsal side of the body. However, unlike annelids, arthropods have an open circulatory system.

The nervous system is of the nodal type (ventral nerve chain). It is represented by the main ganglion, parapharyngeal commissures, and ventral nerve chain. But in arthropods, the nerve ganglia have merged, especially in the head and thoracic regions.

In addition to the nervous system, the endocrine glands perform the regulatory function, which determine metamorphosis and adaptation to environmental conditions.

Reproductive system. Arthropods have only sexual reproduction, they are dioecious, and most have pronounced external sexual dimorphism.

The similarity of arthropods to annelids indicates their phylogenetic relationship. Progressive features (aromorphoses) compared to annelids in arthropods are: heteronomous metamerism, the appearance of limbs, the development of the muscular system, a more complex structure of the nervous system, the appearance of the heart, and an external chitinized skeleton that protects the body and to which muscles are attached.

Arthropods are characterized by numerous adaptations to different environmental conditions, a diverse structure of the respiratory, feeding and locomotor organs.

Classification. The type Arthropoda is divided into several classes, of which the following are of medical importance: the class Crustacea, the class Arachnoidea and the class Insecta.

Class Arachnids (Arachnoidea)

The class includes about 35 thousand species adapted to life on land. The body consists of two sections - the cephalothorax and the abdomen. The degree of segmentation of the sections is not the same. The most segmented body is the phalanges. In scorpions, only the abdomen is segmented, in spiders, the abdomen is no longer segmented, and in most mites, the body is continuous.

Body integuments and locomotion. The body is covered with a chitinized cuticle with a hypodermis beneath it. Derivatives of the hypodermis are glands - spider and poisonous. A characteristic feature is six pairs of limbs: the first two pairs (chelicerae and pedipalps) are adapted for capturing and grinding food, the other four pairs are walking limbs. During embryonic development, several pairs of limbs are laid on the abdomen, but later they turn into webbed warts.

The digestive system is adapted to feeding on semi-liquid food, digestive enzymes are introduced into the body of the victim and, after its tissues are digested, are absorbed by the predator. The pharynx of arachnids performs the function of a sucking apparatus.

The respiratory system is represented either by lamellar lungs or by tracheae, which open outward through openings called stigmata. In the pulmonary sacs are numerous leaf-shaped folds, in which there are blood capillaries (homologous to the gills of crustaceans). The tracheae are a system of branched tubes that go directly to all organs, where tissue gas exchange takes place.

Excretory system. Some arachnids have modified metanephridia, others have Malpighian vessels, which are outgrowths of the intestinal tube (on the border of the midgut and hindgut), located in the body cavity. From them, waste products enter the hindgut.

Circulatory system. It is most complex in scorpions and spiders, which have pulmonary respiration and is similar to that of crustaceans. The circulatory system is simpler in arachnids, which breathe through tracheae; in ticks it may be absent altogether or consist of a sac-shaped heart and a pair of ostia (openings).

The nervous system is characterized by the concentration of its components. In some forms, the abdominal nerve chain merges into a single cephalothorax ganglion.

All arachnids are dioecious. Sexual dimorphism is well expressed.

The most important orders of arachnids. which are of medical importance are the order of the Phalanges (Solifugae), the order of the Scorpions (Scorpiones), the order of the Spiders (Araneae) and the order of the Ticks (Acari).

Order Scorpions (Scorpiones). More than 1,500 species are known. They live in hot and warm regions of the globe. In Ukraine, in the south of Crimea, there is one endemic species - the Crimean scorpion (Euscorpiustauricus); size - 5-10 cm. The body consists of an unsegmented cephalothorax and a long segmented abdomen. Pedipalps are pincer-shaped. The abdomen has a wide anteroabdomen and a narrow hind abdomen, which is incorrectly called a «tail». The last segment of the abdomen ends in a swollen telson, which contains two venom glands and bears a sharp claw-like spike - the sting.

The ducts of the venom glands open at the tip of the sting. The venomous apparatus serves to kill prey and to protect against enemies. Predators.

During the day they hide under stones, in cracks in houses, under the bark of trees, and at night they go out in search of prey, which they kill with a sting, while bending the hind abdomen over the back to the victim, which they hold with pedipalps. They feed mainly on arthropods. Most species are viviparous, with the female carrying the young for some time.

Medical significance. Scorpions are poisonous animals. The bites of scorpions that live in Ukraine are usually not fatal to humans, but they cause severe pain and swelling that can spread over a considerable distance. In severe poisoning, intoxication develops - it is difficult to breathe, swallow, nausea and even convulsions appear. All these phenomena last for several days. Bites of large tropical species (17 cm) can lead to death.

For therapeutic purposes, a specific anti-scorpion serum is used.

Prevention. When spending the night in tents, it is necessary to carefully inspect the bedding, shoes, and shake out clothes.

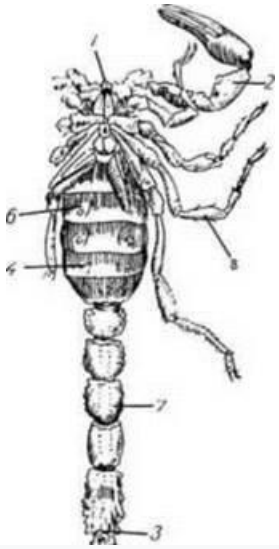


Fig. 52. Scorpion (Buthus eupeus); ventral view:

1 - chelicerae; 2 - pedipalp; 3 - anal opening; 4 - stigma; 5 - telson; 6 - one of the segments of the anterior abdomen; 7 - one of the segments of the posterior abdomen; 8 - leg; 9 - stinger.

Order Spiders (Araneae). More than 20,000 species are known. Sizes range from 0.8 to 11 cm. Males are mostly smaller than females. The body consists of an unsegmented cephalothorax and abdomen, connected by a narrow stalk. There are six pairs of limbs: chelicerae, pedipalps and four pairs of walking legs. The chelicerae end in a movable claw-like segment, near the apex of which is the opening of the duct of the venom gland.

Pedipalps in males serve as copulatory organs. At the posterior end of the abdomen are three pairs of web warts, where the web glands open. The digestive organs are adapted for feeding on semi-liquid food. Development is direct. After mating, the female often eats the male if he does not have time to escape. Spiders are predators, feeding on arthropods. Prey is killed with poison. Karakurt and tarantula are of medical importance.

Order Ticks (Asari). Ticks are a large group of the class of arachnids. There are about 10,000 species of ticks. Among this group, a significant place is occupied by blood-sucking ticks that parasitize animals and humans. Ticks are small, sometimes microscopic in size. The body is divided into two sections: a small head - gnathosome and the body itself - idiosoma. In some species, the body is not divided into sections and is not segmented. They have six pairs of limbs.

The first two pairs (chelicerae and pedipalps) have transformed into a proboscis (mouth apparatus), adapted for capturing and grinding food. The mouth apparatus is of the pricking-sucking or gnawing-sucking type. The other four pairs are walking legs, which are connected to the ventral surface of the body by immobile coxae. They breathe with the help of tracheae, in some species the respiratory organs are reduced.

The digestive system of blood-sucking species is highly branched, especially in females: the midgut is represented by a stomach with appendages (diverticula). Development occurs with metamorphosis (transformation). The fertilized female lays eggs, from which larvae with three pairs of legs hatch. The larva molts and turns into a nymph, which, like the adult form, has four pairs of legs, but does not have a genital

opening. There may be several nymphal stages. After the last molt, the nymph transforms into a sexually mature form (imago). Ticks are oviparous, and there are also viviparous species.

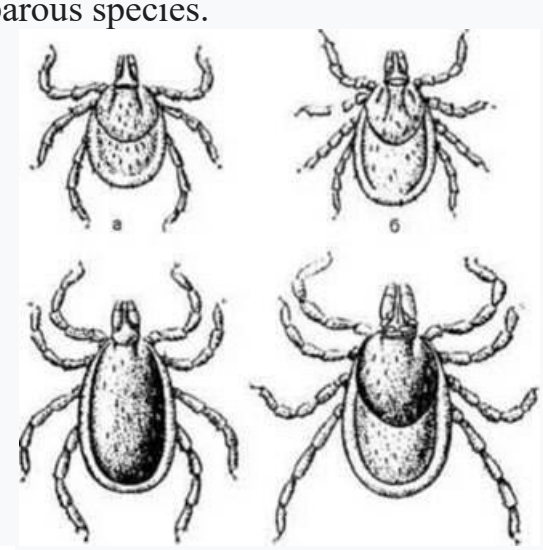


Fig. 53. Stages of tick development (taiga tick):
a - larva; b - nymph; c - adult (male from the dorsal side); d - adult (female from the dorsal side).

The organisms on which ticks feed are called host-hosts. Ticks are single-, double- and triple-host. In the former, all stages of development occur on the same host. In double-host ticks, the larva and nymph feed on one host, and the adult on another. In triple-host ticks, each stage feeds on a different host, so the development period can be long.

The greatest medical importance is given to the scabies mite, the blackhead mite, which belong to the order of acariform mites (Acariformes), and the ixodid, argas and gama mites, which belong to the order of parasitiform mites (Parasitiformes).

The scabies mite, or scabies mite (Acarus siro, syn: Sarcoptes scabiei) - the causative agent of scabies - an intradermal parasite.

Geographic distribution: widespread.

Localization: the stratum corneum of the epidermis of the skin.

Morphology. A very small tick: female - about 0.3 mm, male - about 0.2 mm long. The body is oval, with transverse folds, bears scales and long bristles directed backwards. The legs are very shortened, which is associated with adaptation to life in passages inside the skin. Eyes are absent. Respiration is carried out through the entire surface of the body. Mouthparts of the gnawing type.

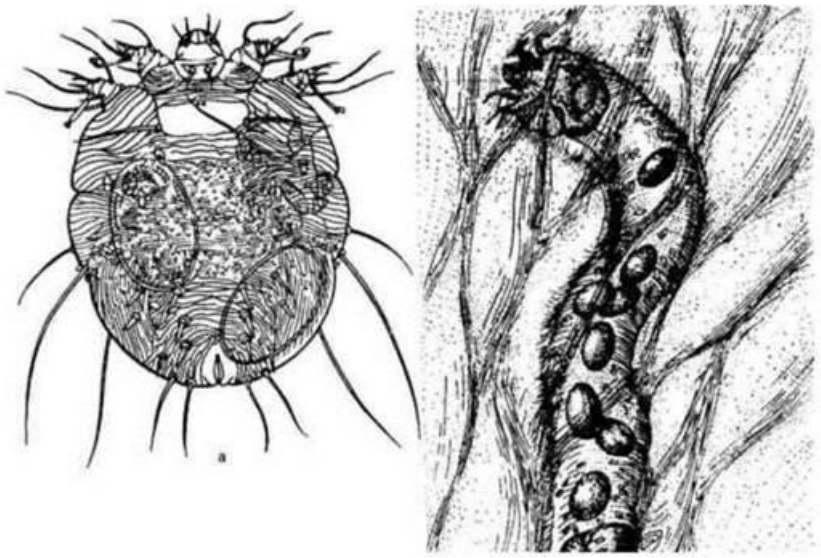


Fig. 54. Scabies itch:

a - female, dorsal view, contains 2 eggs; b - tick's journey in human skin, eggs at different stages of development and the female tick at the end of the journey are visible.

Life cycle. The mechanism of transmission of the pathogen is contact-household. Occurs during direct contact with the patient or when using his things, on which there may be ticks. To penetrate the skin, the itch mite chooses the most delicate areas (between the fingers, under the armpits, on the stomach). The length of the passage that the female drills per day reaches 2-3 mm (males do not make passages).

Along the length of the passage, females make ventilation holes. In the passages, the female lays eggs - 20 or more during her life (40-45 days). The female is located mainly at the head (blind) end of the scabies passage. Larvae emerge from the eggs in 3-5 days. The larvae molt and turn into nymphs. The nymphs emerge to the surface of the skin, molt and turn into sexually mature forms. After fertilization, the males die, and the females bite into the skin. They feed on the cells of the epidermis.

The main symptom of the disease is itching, which increases in the evening and at night, when the activity of the tick is activated. When combing, the passages are revealed. Ticks, their larvae and nymphs settle on the patient's body, scatter on linen and surrounding objects.

The source of infection with scabies is a sick person. Domestic and wild mammals also suffer from scabies, the causative agents of which are other types of scabies mites. Scabies mites of horses, dogs, pigs, sheep, goats, camels, wolves and other animals can parasitize humans.

Pathogenic action. Scabies is a parasitic disease, anthroponosis, characterized by damage to the epidermis of the skin and severe itching.

On the skin, there are visible tracks in the form of straight or winding lines, resembling healing scratches.

Laboratory diagnostics. Detection of scabies by microscopy of the contents of the tick tracks.

Prevention. Personal - maintaining cleanliness of the body, underwear, housing, careful observance of sanitary rules after contact with sick people and animals. Public

- identification and treatment of patients, sanitary supervision of dormitories, bathhouses, sanitary and educational work.

Demodex folliculorum - the causative agent of demodicosis (scab scabies).

Geographic distribution: widespread.

Localization: sebaceous glands, hair follicles.

Morphology. The mite has an elongated, worm-shaped body, at its front end there are 4 pairs of short jointed legs, each with two claws. Size of mites: females about 0.4 mm, males - 0.3 mm. The dorsal shield covers the front part of the back, behind it is the body, which has transverse striations. In one sebaceous gland there can be up to 200 mites. The source of infection is a sick person. The mechanism of transmission is contact-household: when in contact with a sick person, through bedding, towels, clothes on which the acne glandular tick is located.

Fig. 55. Acne gland.

Pathogenic action. Acne, rashes, inflammatory purulent areas, seborrhea, dermatitis appear on the skin. With a long course of the disease and mass infection, the skin becomes wrinkled and hyperemic. Pustules with lymph secretions are formed, eyebrows and eyelashes fall out.

Laboratory diagnostics. Detection of acne gland by microscopy of acne contents.

Prevention. *Personal* – observe the rules of personal hygiene, do not use other people's towels. *Public* – identify and treat patients, sanitary and educational work.

Family Ixodidae. Ixodidae are temporary ectoparasites of animals and humans. They live mainly in forest, forest-steppe and steppe zones.

Many species are carriers of pathogens of infectious diseases of humans and animals. In addition, during feeding, ticks inject toxic substances into the host's body with saliva, which cause a local and sometimes general reaction of the body.

The size of hungry adult ticks is 4-5 mm. Females after feeding on blood reach 10 mm or more. The male has a shield on his back that covers the entire upper part of the body.

In females, nymphs and larvae, the shield covers only the front part of the body. Behind this shield, the body is covered with thin chitin, which is easily stretched. This allows the male to absorb a large amount of blood, which is 200-400 times its weight in a hungry state. Males absorb much less blood. The proboscis (gnathosoma) consists of a base, a pair of chelicerae, an unpaired serrated plate - the hypostome and four-membered palps, with the help of which they choose a place for sucking. The hypostome has sharp teeth directed backwards. The chelicerae carry powerful hooks. Thanks to these adaptations, the tick's mouthparts are firmly held in the skin of the host.

Ticks wait for prey in the open, which has led to the emergence of special adaptations in them. Thus, ticks can starve for a long time, but once attached to the host, they suck blood for a long time, sometimes for several days. The process of tick biting is painless (at all stages of development), because ticks secrete special anesthetic substances, thanks to which their suction remains unnoticed.

Development with metamorphosis and includes 4 phases: egg, larva, nymph, adult. Phase change in blood-sucking ticks is possible only after feeding on blood. Among the ixodid ticks there are single-, double- and triple-host ticks.

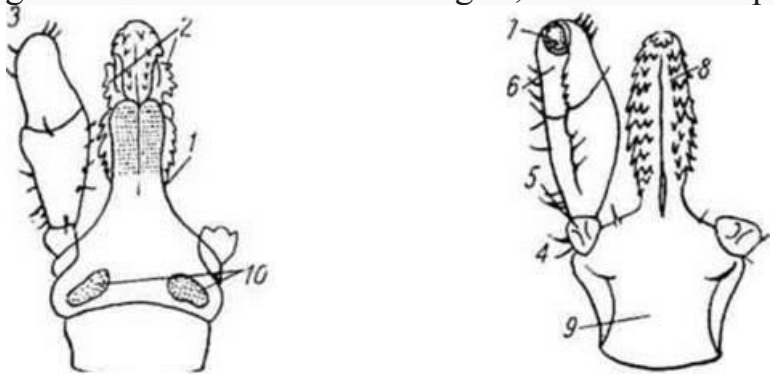


Fig. 56. Mouthparts (proboscis) of a female dog tick (Ixodes ricinus):

single-, double- and triple-host ticks. In single-host ticks, on the left - dorsal side; on the right - ventral side; 1 - chelicerae case; 2 - chelicerae hooks; 3 - palp; 4-7 - palp segments; 8 - hypostome; 9 - base of proboscis; 10 - pore fields (sensory organs).

At all stages of development, there is a mass death of ticks. However, females are characterized by high fertility (they can lay up to 17,000 thousand eggs). Eggs are laid on the ground once in their life, after which they die. Adult ticks attack large mammals, where they suck blood, after which they are fertilized. The fertilized female falls to the ground and begins to lay eggs. After that, she dies.

The greatest medical importance is given to ixodid ticks of the genera Ixodes, Dermacentor.

Taiga tick (Ixodes persulcatus) - a temporary ectoparasite, carrier and natural reservoir of the pathogen (spring-summer) taiga encephalitis. The taiga tick is distributed mainly in the taiga east of the Urals, but is also found in Europe. The size of the male is 2.5 mm, the female - up to 4 mm. The color is brown. A three-host tick. Each stage of metamorphosis feeds on blood from hosts of different species.

The larva feeds on small vertebrates (rodents, hedgehogs, birds), then goes to the soil and molts there. Nymphs feed on chipmunks, squirrels, hares. The hosts of adult forms are cattle, elk, deer. Adult ticks also attack humans. The full development cycle from egg to sexually mature stage lasts at least three years.

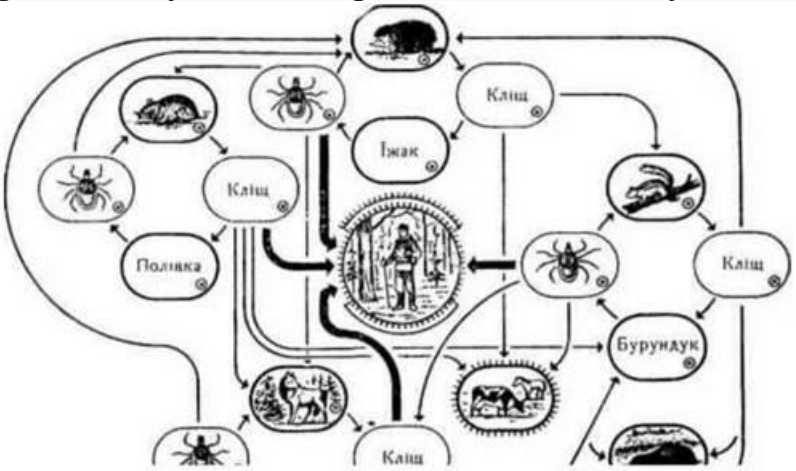


Fig. 57. Circulation of the taiga encephalitis virus in nature.

The virus is the causative agent of taiga encephalitis, marked with crosses in the figure; the virus carriers are the taiga tick, wild mammals and birds that inhabit the taiga are components of the natural focus. Humans and domestic animals become infected through bites of infected ticks.

Taiga encephalitis is a severe viral naturally-focal transmissible disease, which is accompanied by brain damage and high mortality. The virus is transmitted between animals, and from them to humans, through the bite of an infected taiga tick. An infected female tick transmits the virus to her offspring through eggs - transovarially.

By storing the virus in their body and transmitting it to their offspring over several generations, ticks play the role not only of a carrier, but also of a natural reservoir of the causative agent of taiga encephalitis.

In the 1930s, participants in special expeditions led by Academician E.N. Pavlovsky found out the role of the taiga tick in the epidemiology of encephalitis and developed preventive measures.

Virologists - participants of these expeditions - under the leadership of L.O. Zilber, discovered the causative agent (virus) of taiga encephalitis. Based on this work, a preventive vaccine was created. The discovery of natural foci of taiga encephalitis allowed E.N. Pavlovsky to substantiate the theory of natural foci of transmissible diseases.

Prevention. Personal - protection against tick bites (special clothing, repellents), inspection of clothing and body to remove attached ticks. Public - destruction of ticks in places of their mass existence, which are often visited by people, using poisons (acaricides), preventive vaccinations.

Dog tick (Ixodes ricinus). The dog tick is a temporary ectoparasite, a carrier of tularemia and spring-summer encephalitis pathogens. It parasitizes on farm animals, as

well as wild ones. It can attack humans. It is widespread in the forest and forest-steppe zones of Europe. In size, structure and development cycle, it is similar to the taiga tick.

Dermacentor pictus - a temporary ectoparasite, a carrier of tularemia pathogens. Common in the forest zone.

D. marginatus - a temporary ectoparasite, a carrier of tularemia pathogens, brucellosis. Common in the steppe zone.

Argas ticks (Argasidae). Argas ticks are distributed mainly in semi-desert and desert areas. Unlike Ixodes ticks, they do not have scutes. The body is covered with uneven chitin with a characteristic welt along the entire edge of the body. The mouthparts are located ventrally in a special recess and are not visible from the dorsal side. They live in closed biotopes (caves, burrows, adobe buildings).

They are more protected from adverse conditions, die less than Ixodes ticks, so they do not have adaptations for intensive reproduction. The female lays only hundreds, and sometimes dozens of eggs. On the other hand, these ticks have to be content with the prey that falls into the shelter, and the range of their hosts is very wide (vertebrates, from reptiles to humans).

They have the ability to quickly become saturated while the host is in the shelter. Blood sucking lasts from 3 to 30 minutes. Since the food is less abundant, fewer eggs mature, but the female lays them several times during her life. Due to the fact that the biotope may not be visited by hosts for a long time, ticks can starve for years, so their development, as shown by E.N. Pavlovsky, is delayed up to 20-28 years. The development cycle includes several nymphal stages (from 2 to 7). The most medically important is the village tick.

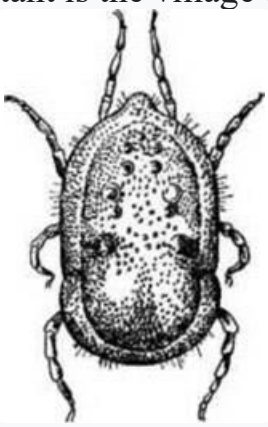


Fig. 58. Village tick: male (top view).

Village tick (Ornithodorus papillipes) is a transient ectoparasite, a vector of tick-borne relapsing typhus pathogens (spirochete). Tick-borne relapsing typhus is a naturally focal transmissible disease, a zoonosis.

Natural reservoirs of spirochetes are various species of rodents, bats, and the house tick, which temporarily parasitizes them and whose female is able to transmit the typhus pathogen to her offspring transovarially. Humans are infected through bites of infected ticks.

Geographical distribution: Central Asia, Afghanistan, Iran, India.

Morphophysiological characteristics. The village tick is dark gray. The length of the female is 8.2 mm, the male is 5.8 mm. There are no eyes. Adult ticks can starve for up to 13 years.

Prevention of tick-borne relapsing typhus. Personal - it is necessary to protect yourself from tick bites, not to stay in caves, adobe buildings and other tick habitats for a long time, to use repellents. Public - the destruction of ticks and rodents.

The best effect is given by the demolition of old adobe buildings that are inhabited by ticks. They are replaced by European-style houses.

Family Gamasoidea. A large group of small ticks 0.3 - 4 mm long. Some Gamas mites are permanent, others are temporary ectoparasites of birds and mammals. **Medical importance** is given to Gamas mites that parasitize birds (swallows, swifts, chickens, pigeons) and rodents. From them, ticks transmit pathogens of viral diseases to humans.

Topic 28. Insects: lice, cockroaches, bedbugs, fleas. Class Insecta (Insecta)

The most numerous class of the phylum Arthropoda, which unites all tracheal-breathing arthropods with three pairs of limbs. The science of insects is called entomology.

The body of insects is divided into three sections – *head, thorax and abdomen*. On the head - a pair of segmented antennae, oral apparatus, a pair of compound (compound) eyes, often there are simple eyes. The oral apparatus consists of three pairs of limbs - a pair of upper jaws (mandibles) and two pairs of lower jaws (maxillae). The second pair of lower jaws fuse, forming the lower lip. The upper lip is a chitinous outgrowth.

Tongue (hypopharynx) – chitinous protrusion of the floor of the oral cavity. Depending on the feeding conditions, the following types of mouthparts are distinguished: gnawing-chewing, pricking-sucking, licking-sucking.

The thorax consists of three segments, each of which is attached to a pair of legs (hexagonal). Depending on the living conditions and adaptations to different methods of movement, the legs are: walking, running, jumping, swimming, digging.

In flying insects, wings are attached to the second and third or only to the second segment of the chest - plate-like skin outgrowths pierced with tracheal tubes (veins). In some insects, the second pair of wings is reduced, and rudiments are preserved - the buzzers, which are organs of balance. Wingless insects are known. They are divided into primary and secondary wingless. Primary wingless are ancient insects, in which the absence of wings is evidence of a primitive organization. Secondary wingless have lost their wings due to a parasitic lifestyle (fleas, lice).

The body covers are represented by a chitinized cuticle, hypodermis and a basement membrane. The musculature is highly differentiated and formed by striated muscles. The derivatives of the covers are glands: poisonous, waxy, odorous, silk-secreting. The body cavity is a mixocoel, filled with hemolymph.

The digestive system consists of the oral cavity with salivary glands, pharynx, esophagus, chole, chewing stomach, midgut (often with pyloric appendages) and hindgut with anus.

Excretory organs - Malpighian vessels (flow into the hindgut), fat body (accumulates toxic substances).

The respiratory organs are tracheae (a system of branched tubes of various diameters), opening with respiratory openings (stigmas). The terminal tubes (tracheoles) penetrate even into individual cells. Thus, the respiratory system performs the function of the circulatory system in transporting oxygen to the tissues.

The circulatory system is relatively poorly developed due to the peculiarities of the respiratory system. It is not closed. The heart and aorta are located on the dorsal side. Hemolymph circulates through the circulatory system.

The nervous system consists of the suprapharyngeal and subpharyngeal ganglia and the peripharyngeal commissures, which together form the peripharyngeal ring, and the abdominal nerve chain. The suprapharyngeal ganglion, which is often called the brain, reaches a special development.

The sense organs - touch, smell, sight, taste, hearing - reach a high level of development. Insects are characterized by complex forms of behavior, which are based on instincts. They reproduce only sexually, are dioecious, and have well-defined sexual dimorphism (differences between females and males). Postembryonic development is direct (lower insects) and with metamorphosis (transformation): incomplete metamorphosis (egg-larva-adult), complete metamorphosis (egg-larva-pupa-adult).

Medical significance. Among insects, the following are known: 1) carriers of pathogens, including mass (epidemic) ones; 2) ectoparasites; 3) poisonous insects; 4) pathogens. The following orders are of greatest medical significance: order Lice, order Fleas; order Bedbugs; order Cockroaches; order Diptera.

Order Lice (Anoplura).

Wingless blood-sucking insects. Specific parasites of mammals. Each species parasitizes on a specific host and does not pass on to individuals of other species. Head, body and pubic lice parasitize on the human body.

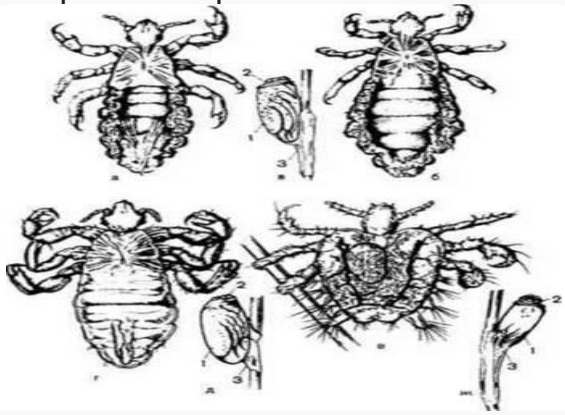


Fig. 59. Human lice:

a - head louse, male; b - female; c - nit (egg) of a head louse; d - body louse, male; c - body louse nit; e - pubic louse; f - pubic louse nit; 1 - egg; 2 - cap; 3 - adhesive substance.

Head louse (Pediculosis humanus capitis).

Localization: the scalp.

Morphology. Gray insects. The length of the male is 2-3 mm, the female is 3-4 mm. The body is flattened in the dorso-ventral direction, consists of a head, thorax and abdomen. On the head there is a pair of short, thick antennae, a pair of simple eyes (sometimes absent), a stinging-sucking mouthparts, which in a calm state is retracted inside the head and is not visible from the outside. The thoracic segments are fused, carrying three pairs of legs. The foot has a movable claw, with which the lice cling to the hair. There are no wings. There are deep notches on the sides of the abdomen. The last segment of the abdomen in the female is bifurcated, in the male it is rounded. In males, the copulatory apparatus is visible at the end of the abdomen.

Life cycle. Development with incomplete metamorphosis (*egg-larva-imago*). Eggs (nits) are glued to the hair with the secretion of adhesive glands. All development takes place on the human body. A larva emerges from the egg, which after three molts turns into an adult. The larva and the adult feed on blood. The lifespan of an adult louse is 27-38 days. During this time, the female lays up to 150 eggs. Development from the egg to the sexually mature stage lasts 2-3 weeks.

Medical significance. Head louse is a permanent human ectoparasite, the causative agent of pediculosis (lice). Lice bites are accompanied by itching, scratching and skin irritation. With a strong infestation, the so-called slough (gluing of hair) may form. However, the main medical significance of head louse is that it is a specific carrier of pathogens of epidemic (lice) recurrent and (less often) typhus. The pathogens of endemic relapsing and typhus are transmitted by ticks.

The pathogen of typhus (Rickettsia Provacek) is found in the intestines of lice, where it enters with the patient's blood. The development of the pathogen in the body of the louse lasts 4-7 days, after which it is able to spread the disease. Human infection occurs when louse feces are rubbed into the bite site.

The causative agent of louse-borne relapsing typhus (Obermeyer's spirochete) is located in the hemolymph of the louse, where it enters from the lice's intestine while feeding on the patient. The number of spirochetes sufficient to infect a person appears from 5-6 days, the maximum number from 8-21 days after louse infection. Human infection occurs when a louse is crushed and the hemolymph is rubbed into the blood while scratching the bite site.

This method of infection is called contamination.

Prevention. Personal - to prevent pediculosis, it is necessary to regularly wash the body with a simultaneous change of underwear, keep clothes and housing clean.

Public - detection and treatment of pediculosis, sanitary supervision of places of mass stay of people: stations, hotels, trains, steamers, baths, hairdressers; periodic examinations for pediculosis in kindergartens, schools; sanitary and educational work.

Body louse (Pediculosis humanus corporis).

Localization: underwear, clothing, when fed with blood passes to the body.

Morphology and life cycle. In appearance and development, it is very similar to P. humanus capitis. Currently, they are classified as different subspecies of the same

species P. humanus. It has larger sizes: the male is 2.1-3.75 mm long, the female is 2.2-4.75 mm. The body is light gray or whitish in color. Distinctive external signs - less deep notches along the edge of the abdomen, less pronounced pigmentation of the lateral segments of the abdomen, antennae on the head are thinner and longer. Development with incomplete metamorphosis (egg-larva-imago). Eggs are glued to the surface of clothing. All stages of development occur on humans. Life expectancy is up to 48 days. During this time, the female lays 300 eggs - twice as many as the main one. The development cycle lasts up to 16 days.

Medical significance. The clothes louse is a permanent human ectoparasite, the causative agent of pediculosis, a specific carrier of the causative agents of epidemic (louse-borne) typhus and relapsing typhus. The role of the clothes louse as a specific carrier of the causative agent of typhus was established in 1909 by the French bacteriologist and parasitologist S. Nicole (Nobel Prize, 1928).

Epidemic relapsing and typhus fevers are obligately transmissible diseases, anthroponoses, which can take the form of epidemics, covering large masses of people. In 1874, G.M. Minh and in 1881, I.I. Mechnikov proved by experiments on themselves that the blood of patients with epidemic relapsing typhus is contagious. In 1876, O.O. Mochutkovsky established by experiments on himself that the blood of patients with epidemic typhus is also contagious.

Prevention. As with head lice.

Pubic louse, or flat louse (Pediculosis pubis).

Localization: pubic hair, sometimes on the eyebrows, eyelids, armpits.

Morphology and life cycle. Pubic louse is smaller than head and clothing louse: males are about 1 mm long, females - 1.5 mm. The body is short, wide, the chest and abdomen are almost not delimited. The life span of the pubic louse adult is 17-26 days. During this time, the female lays about 50 eggs. Development with incomplete transformation.

Medical significance. A permanent ectoparasite, causative agent of phthiriosis (lice). Does not tolerate pathogens.

Prevention. The same as for other types of lice.

Order Fleas (Aphaniptera).

Fleas are wingless blood-sucking insects, ectoparasites of humans and animals. Typical representatives are the human flea and the rat flea.

Human flea (Pulex irritans). The body is flattened laterally. On the head - a pair of simple eyes, short antennae, a prickly-sucking mouthparts. There are no wings. The hind pair of legs is longer than the others, of the jumping type. The abdomen consists of 10 segments, in males the tip of the abdomen is curved upwards.

On the surface of the body there are hairs, bristles, teeth and denticles, which are important for taxonomy.

Development with complete metamorphosis (egg-larva-pupa-adult). Eggs are laid indoors (cracks, floor cracks, dry garbage), in natural conditions - in rodent burrows.

The egg hatches into a white, worm-like, legless larva that feeds on decomposing organic matter and flea excrement. The larva forms a cocoon and pupates. An adult flea lives up to 1.5 years and feeds on blood. The flea development cycle, depending on the temperature and humidity of the environment, lasts from 19 to 270 days.

Medical significance. Flea bites are painful, cause irritation of nerve endings in the skin, a person feels itching, which is accompanied by scratching, secondary infection, suppuration. But the main significance is that fleas are carriers of plague pathogens. Plague (syn.: black death) is an acute, especially dangerous, naturally focal, facultatively transmissible disease of a bacterial nature.

Natural reservoirs of plague are various rodents: rats, shrews, ground squirrels, hamsters, gerbils, voles. The most dangerous are the rat flea (Xenopsyllacheopis), the shrew (Oropsyllasilantievi), and other fleas. The human flea also transmits the plague pathogen. Fleas become infected by sucking the blood of infected animals.

The plague pathogen multiplies in the flea's stomach, forming a plug that closes its lumen («plague block»). When the flea wants to suck blood again, the block prevents the blood from flowing, then the flea regurgitates it in the bite wound and introduces a large number of bacteria into the host's body.

Infection is also possible when a person rubs the feces of infected fleas together with plague bacteria into bite wounds or into scratches on the skin. There are other ways of infection, so plague belongs to the facultatively transmissible diseases. In addition to plague, fleas can transmit pathogens of endemic typhus fevers, as well as the pathogen of tularemia.

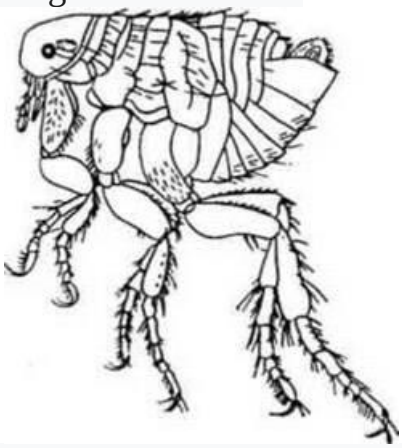


Fig. 60. Human flea (Pulex lrritans).

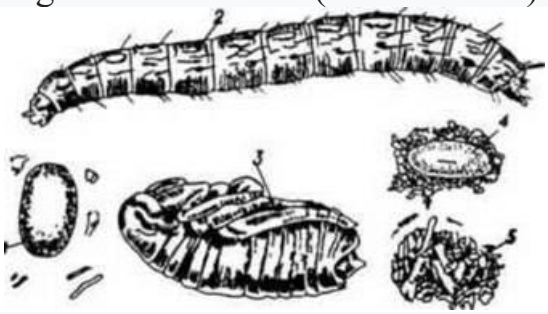


Fig. 61. Development of fleas:
1 - egg; 2 - larva; 3 - pupa; 4 - cocoon, cleaned of foreign particles; 5 - normal appearance of the cocoon.

Prevention. Maintaining cleanliness in the premises, wet cleaning, eliminating places where fleas breed - cracks, cracks in the floor. Insecticides are used to destroy fleas in rooms or on clothes. In natural conditions, rodents (and fleas with them) are destroyed in burrows using pesticides.

Order Hemipteroptera or Bedbugs (Heteroptera)

The front wings are half rigid, membranous to the free ends. Most species feed on plant juices. Some bugs have switched to a parasitic lifestyle. *The bed bug and the kissing bug are of medical importance.*

Bed bug (Cimex lectularius).

Geographic distribution: ubiquitous in human dwellings.

Morphology. The body is reddish-brown, flattened in the dorsal-ventral direction. The length of females is 6 mm, males 5 mm. On the head are long jointed antennae, a pair of compound eyes, a stinging-sucking mouthparts. The thorax consists of three segments, each of which carries a pair of legs. On the upper side of the second segment is a pair of rudimentary elytra, behind the third pair are odorous glands that emit a specific odor.

The segmented abdomen of the female has a rounded shape, while in the male it is narrower, and the posterior end of the male's abdomen is asymmetrical due to the presence of a notch here, in which the sickle-shaped, curved copulatory organ is located.

Life cycle. Development with incomplete metamorphosis. The female lays eggs in the same places where she lives - in the crevices of beds, furniture, walls, seams of mattresses, under wallpaper, picture frames. They reproduce very quickly. In one day, a female can lay up to 12 eggs, and in her entire life up to 500. Bedbug larvae go through 5 stages; the last fifth is called a nymph. The larva that has just emerged from the egg looks like an adult bedbug.

Larvae and adults feed on blood. They attack humans mainly at night. They can starve for a long time (several months). They tolerate low temperatures well; at a temperature of -17 °C they remain alive for about a day. They spread by bringing adults, larvae, eggs with clothes, furniture, carpets, etc. Often parasitize laboratory animals under unsanitary conditions of their maintenance.

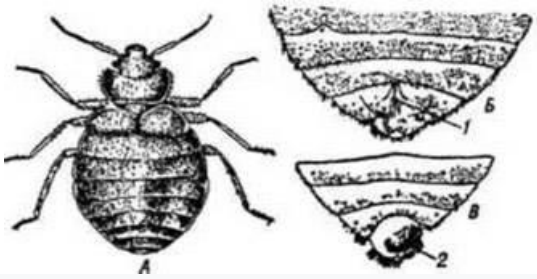


Fig. 62. Bed bug (Cimex lecturalius): a - female; b - posterior end of the female's body; c - posterior end of the male's body; 1 - opening of the copulatory bag; 2 - copulatory organ.

Medical significance. Temporary ectoparasite of a person. The bed bug's saliva contains a poisonous secret, so its bites are painful. Redness and swelling appear at the site of the bite. Their bites disrupt a person's normal sleep, which affects their health.

The transmission of pathogens of transmissible diseases by bedbugs has not been established. *Prevention.* Bedbug eggs are destroyed mechanically, larvae and adults - with the help of insecticides.

The kissing bug (Triatoma infestans) is a vector of trypanosoma (Tripanosoma cruzi) - the causative agent of American trypanosomiasis (Chagas disease).

Belongs to the family Reduviidae, genus Triatoma. Sizes are large - from 1.5 to 3.5 cm. They are nocturnal. They live in burrows of wild animals, nests of birds. Some species are closely related to humans, are found in mud houses, reed roofs. Temporary ectoparasites of animals and humans. They feed on blood.

When attacking a person, bedbugs bite near the eyes or on the lips where the skin passes into the mucous membrane (hence the name - kissing). Having sucked blood, the bedbug turns 180° and releases a drop of feces at the bite site, which contains trypanosomes. They penetrate either into the bite wound or into scratches on the skin. The incidence of bedbugs in foci of trypanosomiasis is up to 50%. The main preventive measure is improving social and living conditions (construction of modern-type houses). The destruction of bedbugs is complicated by the fact that they parasitize various animals.

Fig. 63. Kissing bug (Triatoma infestans).

Order Cockroaches (Blattoidea)

More than 300 species are known, in Ukraine about 20 species. Of medical interest are the synanthropic species black cockroach (Blatta orientalis) and red, or Prussian (Blattagermanica). The size of the first is 20-26 mm, the second - 8-11 mm. The body is flattened in the dorsal-ventral direction. The head is directed with the mouth organs downwards and is almost completely covered from above by a large shield-shaped pronotum.

Antennae – bristle-shaped, multi-segmented. Legs - running. Wings - two pairs. Forewings - leathery, hindwings - membranous (hidden under the elytra when at rest). In males of the black cockroach, the forewings are developed, in females they are reduced.

Males and females of the red cockroach have developed wings. Postembryonic development occurs with incomplete metamorphosis. They live in human dwellings, especially in kitchens, garbage chutes. They feed on food products consumed by

humans, various wastes. They are often found in dining rooms. During the day they hide in cracks, at night they go out in search of food.

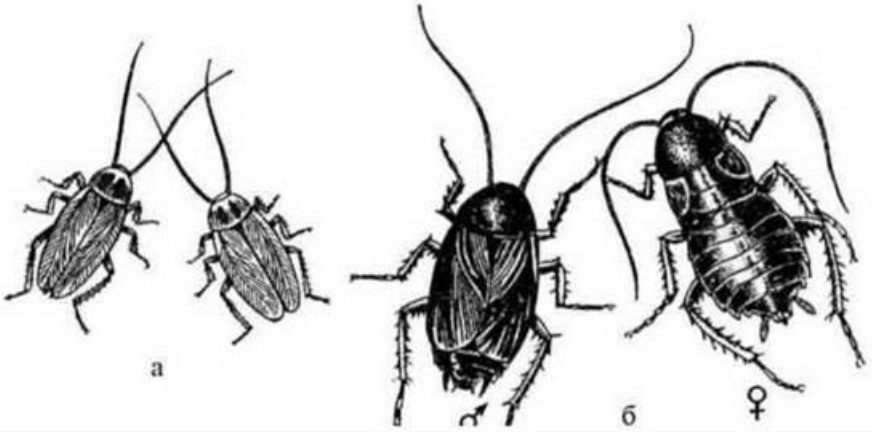


Fig. 64. Synanthropic cockroaches:
a - German cockroach (Blatta germanica); b - Black cockroach (Blatta orientalis).

Medical significance. Cockroaches are mechanical carriers of pathogens, primarily gastrointestinal. They carry pathogens of typhoid fever, dysentery, tularemia, diphtheria, helminth eggs, protozoan cysts. They can gnaw the skin epithelium of a sleeping person.

Topic 29. Diptera. Medical significance of arthropods. Order Diptera (Diptera)

Diptera are characterized by the presence of only one (front) pair of wings. The rear pair is modified into small appendages - buzzers, which perform the function of balance.

Family Culicidae. In Eurasia, three genera of mosquitoes are most commonly found: Anopheles (malaria mosquito), Culex and Aedes (non-malarial mosquitoes). Only females are bloodsuckers. There are about 10 species of mosquitoes of the genus Anopheles in Eurasia, of which the most common is the common malaria mosquito (A. maculipennis). The biology of mosquitoes was most fully studied by V.M. Beklemishev (1890-1962) and his students.

Morphophysiological characteristics. At all stages of development, malarial and non-malarial mosquitoes differ from each other. Anopheles eggs differ from Culex and Aedes eggs not only in shape, but also in the method of laying. Anopheles lay eggs scattered, singly, on the surface of the water. Each of them is bordered by a concave band and has a swimming chamber. Culex eggs have no band and chambers, and are laid on the surface of the water in boat-shaped clusters. Aedes eggs are laid on damp ground near drying water bodies and, less often, on the surface of the water in clusters or scattered.

Culex and Aedes larvae have a tube-shaped respiratory siphon on the penultimate abdominal segment. Therefore, they are located at an angle in the water, attaching the siphon to its surface. Anopheles larvae do not have a respiratory siphon and are located

horizontally in the water. *Pupae* are comma-shaped, differing in the structure of the respiratory tubes (siphonal horns). In Anopheles, the respiratory tubes are conical, in *Culex* - cylindrical.

At the imaginal stage, there are differences in the structure of the head appendages, the color of the wings and the landing. In Anopheles females, the mandibular palps are approximately equal in length to the proboscis, in non-malarial mosquitoes - short, making up 1/3-1/4 of the length of the proboscis.

In male Anopheles, the mandibular tentacles are equal in length to the proboscis, with club-shaped thickenings at the end; in non-malarial mosquitoes, they are usually longer than the proboscis, without a club-shaped thickening. On the sides of the mosquito's mouthparts are antennae. In males, they are covered with long hairs, in females, with short hairs.

The veins of the wings are covered with scales, which can form a pattern of spots. A. maculipennis has 4 dark spots in the middle of the wing, Culex mosquitoes do not have such spots. When landing, Anopheles mosquitoes hold the abdomen raised and at an angle to the surface. In other mosquitoes, the body is bent when landing, the abdomen is inclined towards the substrate or parallel to it.

Life cycle and biological features. Development with complete metamorphosis (egg-larva-pupa-adult). Eggs, larvae and pupae develop in water. Young winged Anopheles mosquitoes are initially found near water bodies in coastal vegetation. At this time, mosquitoes (females and males) feed only on plant juices. A few days later, at dusk, the males form swarms. The female flies into the swarm and leaves it with one of the males. After fertilization, the female searches for prey and sucks the blood of humans or animals. Blood is necessary for the development of eggs. To feed on blood, the females have a prickly-sucking mouthpart. The male's mouthparts are adapted for feeding on plant juices.

Anopheles females feed mainly indoors, so they fly from water bodies to settlements. The area of distribution of mosquitoes around anophelogenic water bodies reaches approximately 3 km. Having sucked blood, the female flies to some shelter and remains there until the digestion of the blood is completed and the fertilized eggs ripen simultaneously. Then the female flies to the water body and lays eggs.

The described life cycle of the female from the beginning of blood feeding to egg laying is called the gonotrophic cycle (Greek gonos - seed, sex cell, trophe - nutrition). After laying eggs, the female again searches for prey, feeds on blood. There can be 2-3-6 such cycles during the summer. The lifespan of the female in the summer period is about 1 month. Males die soon after mating; their lifespan is several days.

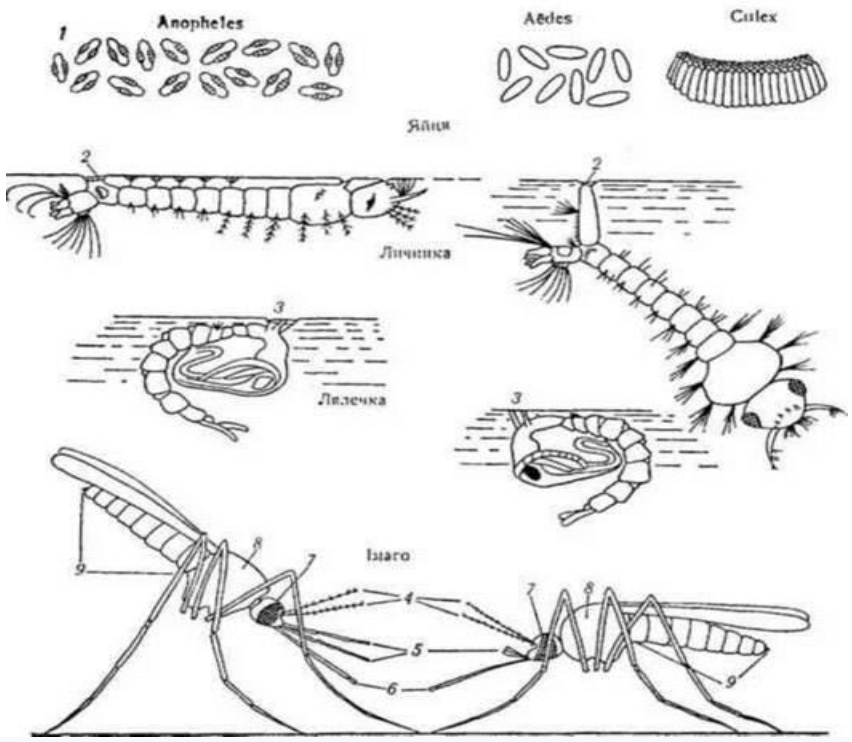


Fig. 65. The main differences between malarial and non-malarial mosquitoes:
1 - Anopheles egg floats; 2 - spiracles of larvae; 3 - respiratory tubes of pupae; 4 - antennae (antennae); 5 - mandibular palps; 6 - proboscis; 7 - eyes; 8 - thorax; 9 - abdomen of an adult mosquito.

Anopheles use ponds with stagnant or slowly flowing water to lay eggs. The number of eggs in one clutch varies from 60 to 350. Larvae hatch from the eggs, which breathe atmospheric air. Anopheles larvae live exclusively in clean or almost clean water bodies.

Reservoirs with a significant amount of organic matter and suspended particles, as well as shaded ones, are unsuitable for them. Therefore, in the fight against A. maculipennis mosquitoes, a good effect is given by planting the banks of reservoirs with trees with a large and spreading crown. The duration of larval development depends on the water temperature. Development begins at a temperature not lower than +10° C. The optimal temperature is +25 ° C.

The minimum larval development period is 15 days. Larvae feed on bacteria and plant debris, for which they filter water and swallow all particles that can pass into the mouth. This biological feature of mosquito larvae is used to destroy them by spraying powdered poisonous substances on the surface of water bodies. Larvae transform into pupae, and pupae into adults. The most common mosquito in our country, A. Maculipennis, was considered a single species. Today, it is known that it includes 6 twin species that differ in a number of biological features, in particular, in the nature of wintering. In all twin species of A. maculipennis, fertilized females overwinter. Some of them hibernate in basements, where they enter diapause, while others hibernate in barns, where they feed on animal blood throughout the winter. Males die in the fall.

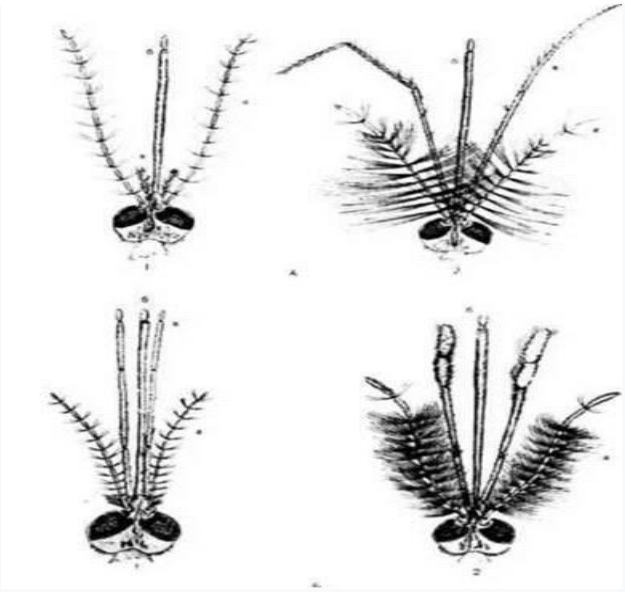


Fig. 66. The structure of the head of malarial (Anopheles) and non-malarial (Culex) mosquitoes:

A - Culex; B - Anopheles; 1 - female; 2 - male; a - antennae; b - proboscis; c - palps.

Mosquitoes of the genus Aedes differ from Anopheles in their biological characteristics. The breeding sites of most Aedes species are temporary water bodies: puddles, ditches, wetlands. The larvae of some species can develop in small vessels, including buckets, tubs, cans, etc.

Rotting organic matter does not harm them. A characteristic feature of Aedes mosquitoes is the non-simultaneous hatching of larvae from eggs of one clutch, it stretches for weeks and even months. This is an adaptation to life in periodically drying up reservoirs. If the reservoir dries up before the larvae complete their development and they die, then when they flood again, the larvae hatch from the remaining eggs. This ensures the existence of the species. For some Aedes species, which are called *monocyclic,* the development of one generation per summer is characteristic, for others - *polycyclic* - several generations. Adult mosquitoes are most active in the evening, but can attack prey during the day, especially in cloudy weather. During the day they hide in grass, bushes, holes near water bodies. Aedes mosquitoes hibernate in the egg stage.

Medical significance. Mosquito saliva, injected into the skin during bloodsucking, causes pain and local inflammation. Anopheles mosquitoes transmit malaria pathogens to humans, are intermediate hosts and vectors of filariasis pathogens. Some species of Aedes transmit pathogens of tularemia, Japanese encephalitis, lymphocytic choriomeningitis, yellow fever, dengue fever, anthrax; some species of Culex - pathogens of Japanese encephalitis, tularemia, filariasis.

Prevention and control measures. Personal - protection from mosquito bites. Public - destruction of mosquitoes at all stages of development. Mosquito control includes a number of measures:

1) destruction of small water tanks that are not used by humans; 2) spraying of toxic chemicals in water bodies that serve as places of spawning; 3) oiling of water bodies, which prevents access to oxygen; 4) cleaning water bodies from vegetation; 5) draining the area - land reclamation; 6) biological control methods: breeding of

gambusia fish that feed on mosquito larvae (but gambusia can live at water temperatures not lower than +5 °C); use of natural enemies (for example, attracting bats), pathogens of fungal, bacterial and viral diseases of mosquitoes; genetic methods (releasing sterile males into the wild); 7) zooprophylaxis - when designing settlements, livestock farms are placed between potential mosquito breeding sites and residential buildings, because mosquitoes willingly feed on the blood of animals; 8) destruction of winged forms in wintering places (basements, attics, barns) using insecticides. All insecticides are used so that they do not harm wildlife.

Family Lepidoptera (Psychodidae).

Mosquitoes of the genus Phlebotomus are temporary ectoparasites, specific carriers of leishmaniasis pathogens, papatachi fever.

Morphology. Small insects with long legs, bright yellow, gray or brownish color, body length 1.3-3.5 mm. Body and wings heavily pubescent with hairs. Attack at night and at dusk. They are found both near human habitation and in the wild, where they live in caves, burrows of rodents and other animals.

Fig. 67. Mosquito (Phlebotomus pappatasii).

Life cycle. Development with complete metamorphosis. Larvae develop in rotting garbage. Feed on organic matter. Pupae do not feed. Males feed on plant sap, females suck the blood of humans and animals. At optimal temperatures, 46 days pass from egg laying to adult development. Most females die after each clutch. Winged mosquitoes stay near the breeding sites. With the onset of cold weather, mosquitoes die. The larvae hatch from eggs laid by females of the last generation hibernate.

Medical significance. Numerous mosquito bites are painful, cause severe itching, papules on the skin, burning. People lose sleep, sometimes the temperature rises, there is a fever, general fatigue, etc.

Mosquito control measures include cleaning areas from debris, using contact insecticides in residential areas, and destroying rodents in burrows.

Family True flies (Muscidae).

Of this family, synanthropic flies are of medical importance - mechanical vectors of pathogens (housefly, blowfly) and pathogens of myiasis.

Housefly (Musca domestica) is a mechanical vector of pathogens of infectious and invasive diseases. The body length of females is 5.8-7.5 mm. Males are somewhat

smaller. The oral apparatus is licking-sucking. By secreting a lot of saliva with enzymes, the fly soaks solid food and sucks it. The legs have claws and sticky pads, densely covered with hairs, which allows flies to move along the ceiling and vertical surfaces.

The legs are also covered with hairs. On the hairs, the fly can carry pathogens of various infections, helminth eggs, cysts of protozoa. The presence of flies in rooms where patients with tuberculosis, typhoid fever, dysentery are located is especially dangerous. Up to 6 million bacteria were found on the body of the fly, and up to 28 million in the intestines. Outbreaks of epidemics of intestinal diseases occur in the summer period, when the number of flies reaches its maximum.

Development with complete metamorphosis. The female lays eggs wherever there is rotting organic matter (manure, human feces, garbage containers, landfills). She lays 100-150 eggs at a time and there can be 5-6 such clutches. The larva hatches from the egg after 12-36 hours. Its shape is worm-like, white, it has no legs, and its head is reduced.

The larvae pupate in the ground, where they burrow to a depth of more than 30 cm. The pupae are immobile. The development cycle from egg to adult lasts 10-26 days. The fly lives an average of 30-35 days.

The fight against flies in settlements includes the following measures: protection of food products from flies; improvement of settlements; carrying out sanitary measures that ensure garbage collection, timely cleaning of the territory; composting of manure; larvae are destroyed in places of fly breeding with insecticides, winged flies - using mechanical and chemical means.

The firefly, or autumn firefly (Stomoxys calcitrans) is a mechanical vector of anthrax and sepsis pathogens. It is widespread everywhere. In biology and morphology it is close to the housefly. The body color is gray with dark stripes on the chest and spots on the abdomen. The proboscis is very elongated and has plates with chitinous «teeth» at the end. By rubbing its proboscis on the skin, the fly scrapes the epidermis and feeds on blood, while simultaneously injecting poisonous saliva and causing severe irritation. Females and males attack mainly animals, but sometimes humans.

Control measures, as with a housefly.

Wolfart fly (Wohlfartia magnified). Viviparous. Larvae cause the disease myiasis. The fly is found in the middle lane and southern part of Europe. Adult insects are inhabitants of fields, feed on nectar of flowers. Larvae (120-150) are laid by the female during flight in open cavities: eyes, nose, ears, as well as on wound and ulcerated surfaces of mammals, and sometimes people, especially children who sleep in the open air.

The larvae are very mobile. With the help of special devices, they quickly burrow into the tissues, corrode them down to the bones, make passages, and destroy blood vessels. *Clinical manifestations* of myiasis are suppuration, bleeding, gangrenous processes, and severe pain. Eye damage can cause blindness. Fatalities are known.

The duration of parasitization of larvae in animals is up to 3-5 days. They overwinter in the soil, burrowing to a depth of up to 32 cm. Measures to combat fly larvae are complicated by the fact that they penetrate very deeply into the tissues.

They are removed surgically with tweezers with appropriate wound treatment.

Tsetse fly (Glossina palpalis) - a carrier of the causative agent of African trypanosomiasis (sleeping sickness) - trypanosome (Trypanosoma brucei gambiense). Viviparous. Common in western Africa. Size - 10-13.5 mm. Life expectancy 3-6 months. During this time, the female lays one live larva on the soil surface 6-12 times.

In the soil, the larvae turn into pupae, from which adult flies emerge after 3-4 weeks. They live mainly in thickets of bushes along the banks of rivers and lakes, near human habitation. They feed mainly on human blood, less often on the blood of domestic and wild animals.

To combat flies, bushes and trees are cut down along the banks of water bodies, near human dwellings, and along roads. Insecticides are also used.

Gnus and its components. The term "gnus" refers to all blood-sucking dipteran insects that attack humans and animals en masse (mosquitoes, midges, midges, gadflies, and some types of blood-sucking flies).

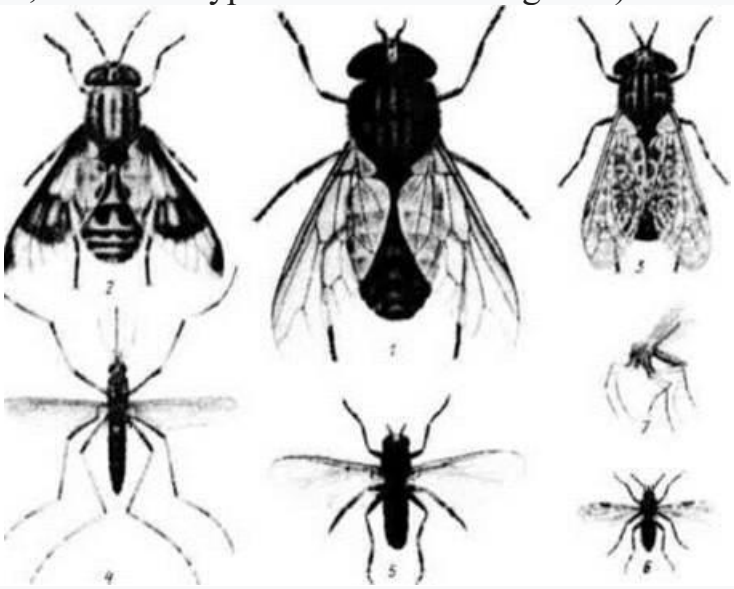


Fig. 68. The main components of the gnat: 1 - horsefly (Tabanus bromis); 2 - golden-eyed horsefly (Chrysops flavipes); 3 - rain-fly (Haematopota pluvialis); 4 - mosquito (Aedes communis); 5 - midge (Simulium sp.); 6 - sandfly (Culicoides); 7 - sandfly (Phlebotomus pappatasii).

The breeding places of the gnat are mainly river deltas, areas of artificial irrigation, rice cultivation, and standing water bodies. The species composition of the gnat depends on the landscape and geographical zone.

In the Siberian taiga, tundra, and other places, they appear in huge numbers, attacking animals and humans in clouds, causing great harm. In some cases, sensitization (increased sensitivity) to subsequent bites occurs, which can lead to a serious condition, even anaphylactic shock. People are deprived of normal rest, and their working capacity is reduced.

For individual protection, Pavlovsky nets, protective clothing made of special mesh fabric are used (then the bloodsucker's proboscis does not reach the surface of the skin), repellents (dimethyl phthalate, etc.).

Family Geratopogonidae. The bulk of bloodsucking bloodsuckers belong to the genus Culicoides. These are the smallest of the flying bloodsucking insects. The body length is 1-2.5 mm. Females attack humans and animals in the morning and evening hours. Larvae and pupae develop in moist soil, forest litter, tree hollows, and small standing bodies of water. Ticks are mechanical carriers of the tularemia pathogen, and in the tropics are specific carriers and intermediate hosts of nematodes (filariae).

Family Midges (Simuliidae). In appearance, they are similar to small flies. Body length is 2.5-4.5 mm. Females of most species suck blood. They attack only in the open air during daylight hours. Development occurs in rivers and streams. Midges are mechanical carriers of the tularemia pathogen, and in the tropics, midges of the genus Simulium are specific carriers of filariasis (Onchocerca volvulus, O.coecutiens).

Questions for Preparation

1. Principles of classification of parasites: obligate, facultative, temporary, permanent, endo- and ectoparasites.
2. Giardia. Morphology, routes of infection, methods of laboratory diagnosis, prevention.
3. Vaginal Trichomonas. Systematic position, morphology, development cycle, routes of infection, justification of laboratory diagnostic methods.
4. Biology of pathogens of cutaneous and visceral leishmaniasis. Systematic position, morphology, justification of laboratory diagnostic and preventive methods.
5. Pathogens of trypanosomiasis. Systematic position, morphology, justification of laboratory diagnostic and preventive methods.
6. Dysentery amoeba. Systematic position, morphology, development cycle, justification of laboratory diagnostic methods, prevention.
7. Balantidium. Systematic position, morphology, development cycle, infection routes, justification of laboratory diagnostic methods.
8. Malaria plasmodium. Systematic position, development cycle, fight against malaria, tasks of antimalarial service at the modern level. Types of malarial plasmodia.
9. Toxoplasma. Systematic position, morphology, development cycle, ways of infection, justification of laboratory diagnostic methods.
10. Type Flatworms. Classification, characteristic features of the organization, medical significance of representatives. Concept of bio- and geohelminths.
11. Liver fluke. Systematic position, morphology, development cycle, routes of infection, justification of laboratory diagnostic methods, prevention.
12. Lungworm. Systematic position, morphology, development cycle, infection routes, justification of laboratory diagnostic methods, prevention.

13. Chinese, lanceolate and blood flukes. Morphology, development cycles, medical significance.
14. Pork (armed) tapeworm. Systematic position, morphology, development cycle, infection routes, justification of laboratory diagnostic methods and prevention of taeniasis.
15. Bovine (unarmed) tapeworm. Systematic position, morphology, development cycle, routes of infection, justification of laboratory diagnostic methods and prevention of taeniarhiniasis.
16. Cysticercosis. Routes of infection and preventive measures.
17. Dwarf tapeworm. Systematic position, morphology, development cycle, routes of infection, justification of laboratory diagnostic methods, prevention.
18. Echinococcus and alveococcus. Systematic position, distribution, morphology, development cycle, differences in larval stages, routes of infection, justification of laboratory diagnostic methods, prevention.
19. Styozhak wide. Systematic position, morphology, development cycle, routes of infection, justification of laboratory diagnostic methods, prevention.
20. Human ascariasis. Systematic position, morphology, development cycle, routes of infection, basic methods of laboratory diagnostics, prevention. Larvae of animal ascarids as pathogens (larva migrans syndrome).
21. Gostrick. Systematic position, morphology, development cycle, routes of infection, justification of laboratory diagnostics methods, prevention.
22. Hairworm. Systematic position, morphology, development cycle, infection routes, justification of laboratory diagnostic methods, prevention.
23. Hookworms. Systematic position, morphology, development cycle, infection routes, justification of laboratory diagnostic methods, prevention.
24. Trichinella. Systematic position, morphology, development cycle, infection routes, justification of laboratory diagnostic methods, prevention.
25. Rishta. Systematic position, morphology, development cycle, infection routes, justification of laboratory diagnostic methods, prevention. Works of L.M. Isaev on the elimination of dracunculosis foci.
26. Filariae (filariae or Bancroft's wuchereria, brugia, loa loa, onchocerciasis). Morphology, development cycles, medical significance.
27. Laboratory diagnostics of helminthiasis. Ovo-, larval- and helminthoscopy.
28. Phylum Arthropoda. Classification, characteristic features of the structure, medical significance. Poisonous representatives of the phylum Arthropoda.
29. Ticks - pathogens of human diseases. Scabies mite and demodex mite.
30. Ticks - vectors of human diseases. Taiga, dog and village ticks.
31. Flies. Types of flies, features of structure and development, medical significance.
32. Mosquitoes. Types, features of structure and development, medical significance. Gnus and its components.
33. Lice. Types, features of structure and development, medical significance.
34. Fleas. Features of structure and development. Types of fleas. Bedbugs. Medical significance.
35. Synthetic theory as a modern stage in the development of the theory of evolution.

36. Ecology. Environment as an ecological concept. Types of environment. Ecological factors. Unity of organism and environment.
37. Biological variability of people in connection with biogeographical features of the environment. Formation of adaptive ecotypes of people.
38. Human as an ecological factor. Main directions and results of anthropogenic changes in the environment. Environmental protection.
39. Plants, mushrooms and animals poisonous to humans.

Recommended reading:

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3. Test Bank of Licensin exam «Krok-1» in Medical biology: Manual for independent learning of students of VI faculty for international students / autors: V.V. Myasoyedov, Yu.A. Sadovnychenko, O.B. Khromenkova, I.P. Meshcheryakova. – Kharkiv: KNMU, 2017. – 57 p.
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Reference to information resources on the Internet, video lectures, other methodological support:

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Електронне навчальне видання комбінованого використання
Можна використовувати в локальному та мережному режимі

Шерстюк Сергій Олексійович
Наконечна Світлана Анатоліївна
Зотова Алла Борисівна
Панов Станіслав Ігорович

МЕДИЧНА БІОЛОГІЯ

У двох частинах

ЧАСТИНА ІІ

Методичні рекомендації для самостійної
роботи студентів 1-го курсу навчання медичного факультету
з дисципліни «Медична біологія»

(Англ. мовою)

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