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Chair of Medical Biology and Genetics

L. P. GAVRILOVA, N. E. FOMCHENKO,
V. V. POTENKO

MEDICAL BIOLOGY

Ontogenesis, homeostasis, comparative anatomy of vertebrates,
genetics of human populations, human ecology,
and medical parasitology

Lectires for overseas students in English medium

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Представлен лекционный материал для подготовки к занятиям по медицинской биологии для студентов факультета по подготовке специалистов для зарубежных стран, обучающихся на английском языке.

В пособии авторами представлены современные сведения об онтогенетическом, популяционно-видовом и биосферном уровнях организации живого, а также экологических аспектах паразитизма.

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FOREWORD

The textbook represents the text of lectures at the course of Medical biology and genetics which has been reading for English-speaking students of faculty of specialists training for foreign countries of the Gomel State Medical University.

The sections ontogenesis, homeostasis, comparative anatomy of vertebrates, genetics of human populations, human ecology, and medical parasitology of Medical biology and genetics course is included in the textbook. The sections include the following material: prenatal and postnatal ontogenesis, organism aging, ontogenetic homeostasis, comparative anatomy of vertebrates, population and species levels of life organization, human ecology, and medical parasitology.

Authors will be rather grateful to everyone who will consider possible to state the critical remarks to address of offered methodical recommendations which will be perceived as expression of desire to assist in its improvement at the subsequent reprinting.

ПРЕДИСЛОВИЕ

Данное учебно-методическое пособие представляет лекционный материал для подготовки к занятиям по медицинской биологии для студентов 1 курса факультета по подготовке специалистов зарубежных стран УО «Гомельский государственный медицинский университет», обучающихся по специальности лечебное дело (код специальности: 1-79 01 01) на английском языке.

В пособие включены разделы курса медицинской биологии, которые содержат следующий материал: эмбриональное и постэмбриональное развитие, старение организма, онтогенетический гомеостаз, сравнительная анатомия позвоночных животных, популяционно-видовой уровень организации живого, экология человека и медицинская паразитология.

Авторы будут весьма благодарны всем, кто сочтет возможным высказать свои критические замечания в адрес предлагаемых методических рекомендаций, которые будут восприняты как выражение желания оказать помощь в его улучшении при последующем переиздании.

ONTOGENETIC LIFE ORGANIZATION LEVEL

Theme 1: Ontogenesis. Embryonic development

Plan:

1. Concept about ontogenesis. Types and the periods of ontogenesis.
2. General characteristic of embryonic developments.
3. Provisional organs. Mother-fetus relationship.
4. Features of embryonic developments of human.
5. The gene control of embryonic development.

1. Concept about ontogenesis. Types and the periods of ontogenesis

Ontogenesis (from Greek: ontos — an essence, genesis — development) — is a full cycle of individual development of each individual in which basis realization of the hereditary information at all stages of existence in the certain conditions of an environment lays. It begins from formation of a zygote and comes to an end death of an individual. Ontogenesis it is caused by long process of phylogenetic development of each species. Mutual relation of individual and historical development is reflected in the biogenetic law (Ch. Darwin, F. Muller, E. Gekkel), and later — in A. N. Severtsov doctrine about a phyloembryogenesis.

The first data on a structure of germs of the person and animals have been received still scientific antiquities — Aristotle and Hippocrates. But regular studying of embryonic developments began in XVII century after the description William Garvey (1578–1657) and Malpigi (1628–1694) structures of germs of some animals and birds.

Development of the doctrine about ontogenesis includes 3 periods: preformation theory, epigenesis, modern representation about development of a germ.

Preformation theory. Hippocrates believed, that in ovule or in a body of mother there should be small, completely generated organism. These belief have lain in the doctrine, with metaphysical representations that in development there are only quantitative changes (growth) later, and there are no qualitative changes (occurrence new). Preformation considering that a germ preformed in an egg, have received the name *ovist* (an armour. ovum — an egg). Preformation considering that the germ is incorporated in a man's gamete, named animalculists (an armour. animalculum — a small animal).

Preformist S. Bonne (1720–1790), aspiring to coordinate the given sciences and religions, has acted with «the theory of an investment». On his representation, in ovary «first-born woman Evy created by the god» there were all subsequent generations of people consistently enclosed each other.

Epigenesis. Opposite sights according to which the organism develops from the unstructured, homogeneous weight, for the first time stated by Aristotle. Development of epigenetic views is connected to Caspar Volf works (1733–1794).

Embryological researches of a developing germ of the hen have convinced him, that in an egg are not present preformed parts of the future organism, and the egg originally represents homogeneous weight. In 1828 by researches Charles Behr (1792–1876) the inconsistency as preformation theorya, and pure epigenesis has been shown. Ch. Behr has established, that contents of ovule are non-uniform also a degree of structure increase in process of development of a germ in an oosperm.

The modern understanding of development of a germ rejects sights both preformists, and epigenetics. Representation, that development is a simple expansion of previous rudiments, unscientific. To researches embryologists it is proved, that in development occurs new formation of tissues and organs. Development goes from simple to complex. The adult organism with its systems of organs is incomparably more complex than ovule. Strictly certain way of development eggs is determined by hereditary factors — genes of a nucleus of a zygote.

There are following basic types of ontogenesis: *indirect and direct. Indirect development* meets in larval form. This development (metamorphosis) with full or not full transformation. The larval type of development, meets at species which eggs are poor a yolk. For realization of vital signs at larvae there is a number provisional (temporal) organs absent in an adult condition.

The direct type of development in an egg is characteristic for the fishes kowtowing, birds, and also invertebrates which eggs are rich a nutritious material (yolk), sufficient for end of ontogenesis. A feed, breath and allocation at these germs is carried out developing at them by provisional organs.

The direct type of development, intra-uterine — is characteristic for the mammals and human. Ovule at this type of development almost do not contain a nutritious material. All vital signs of a germ are carried out through a parent organism. In this connection organs, first of all a placenta are formed of tissues of mother. This latest in the phylogenetic attitude the type of ontogenesis in the best way provides a survival of a germ, but newborn essences require feeding by a secret dairy glands — milk.

Ontogenesis divide into two periods of development: embryonic (prenatal) and postembryonic (postnatal).

2. General characteristic of embryonic developments

The embryonic period begins from the moment of penetration of sperm cell in ovule, i.e. formations of a zygote and comes to an end an exit of a new organism from egg covers or the moment of a birth.

In the embryonic period distinguish: a prezygotic period, a zygote, a cleavage, a gastrulation, histogenesis and organogenesis.

The prezygotic period is characterized by processes:

— Gametogenesis — formation of gametes;

— Amplification of genes — synthesis and storage r-RNA and m-RNA in egg;

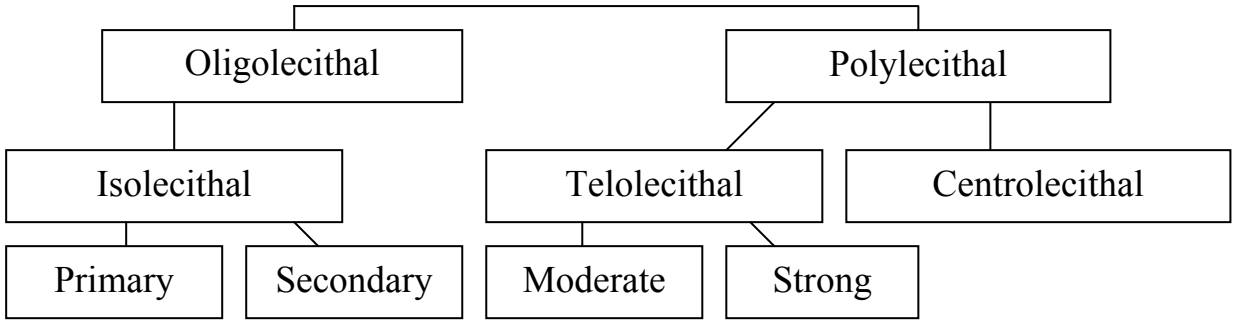
— Ooplasmic segregation — a differentiation of cortex of cytoplasms on zones;

— Formation of cortical layer of cytoplasm containing glycogen granules;

— The egg polarity are formed: vegetative, burdened by a yolk, and animal poles.

In ovule there is an accumulation of a yolk. Depending on amount of a yolk and character of its distribution distinguish some types of eggs:

Types of egg-cells



1. *Isolecithal eggs* contain a few yolk, and it is distributed in regular intervals on all cell. Such eggs meet at echinoderms, lancelet, mammals. At human — secondary isolecithal eggs.

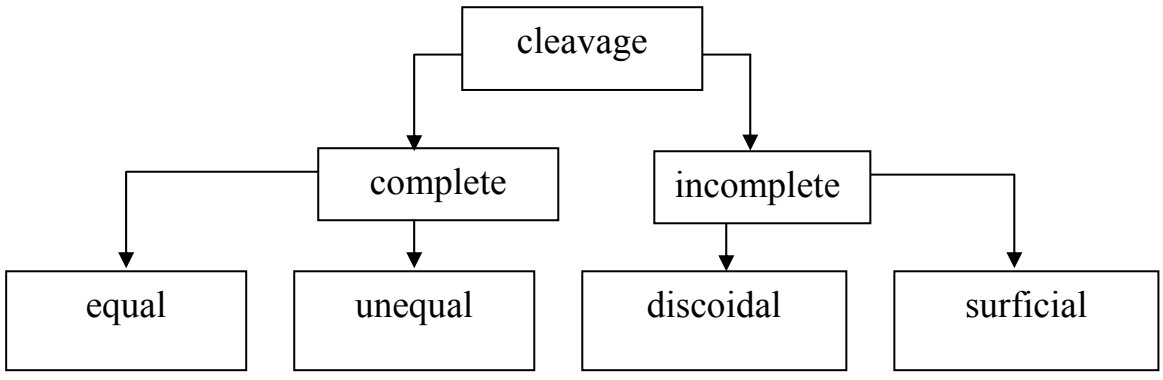
2. *Telolecithal eggs* contain a plenty of the yolk concentrated on a vegetative pole. The opposite pole containing a nucleus and cytoplasm without a yolk, refers to animal pole. Meet at molluscs, amphibious, reptiles, birds.

3. *Centrolecithal eggs* contain a plenty of a yolk in the center of a cell, and cytoplasm is located on periphery. These are eggs of insects.

At animals, who in postembryonic the period pass a stage of larvae (echinoderms, insects, amphibians), eggs contain a few yolk. Larva leaves the egg covers before the ending of development and continues it outside of egg. At many animals with non larval type of ontogenesis eggs are telolecithal. At animals with intra-uterine type of development (mammal) eggs are poor a yolk, and it is distributed in them in regular intervals.

Process of fertilisation in multicellular organism will consist in association sperm cell and ovule and formation of qualitatively new cell — zygotes. *The zygote* is a monocelled germ. At this stage a gene it is not active.

The basic types of cleavage



The following stage — cleavage of a zygote. In a basis of this process lays mitotic cell fission. However daughter cells formed as a result of division do not miss, and remain closely adjoining to each other. During cleavage daughter cells progressively decrease. To each animal peculiar the certain type of cleavage caused by amount and character of distribution of a yolk in ovule. The yolk brakes cleavage, therefore the part of a zygote overloaded with a yolk, split up more slowly or not split up at all.

In isolecithal, poor a yolk an oosperm of lancelet, the first furrow of cleavage as a crack begins on animal pole and is gradually distributed in longitudinal meridional direction to vegetative, dividing an egg to 2 cells — 2 blastomeres. The second furrow passes perpendicularly the first — are formed 4 blastomeres. The third furrow passes equatorial: arises 8 blastomeres. As a result of the subsequent cleavages in meridional and equatorial directions it is formed 16, 32, 64, etc. blastomeres.

As a result of lines consecutive cleavages groups of cells, closely adjoining to each other are formed. At some animals such germ reminds a berry of a mulberry or a raspberry. It has received the name morula (an armour. morum — a mulberry berry) — a multicellular sphere without a cavity inside.

In telolecithal the eggs overloaded with a yolk — cleavage can be complete equal or unequal and incomplete. Blastomeres a vegetative pole because of an abundance of an inert yolk always lag behind in rate of cleavage from blastomeres animal poles. Full, but unequal cleavage is typical of eggs of amphibians. At fishes, birds and some other animals split up only the part eggs located on animal a pole; occurs incomplete discoidal cleavage.

During cleavage the number blastomeres increases, however blastomeres do not grow till the sizes of an initial cell, and with each cleavage become more finely. It speaks that mitotic cycles of a cleavage zygote have no typical interphase; the presynthetic period (G1) is absent, and synthetic period (S) begins still in telophase previous mitosis. During cleavage, mitosis follow quickly one after another, and by the end of the period all germ only negligible is larger than a zygote. At this time blastomeres already differ on character of cytoplasm, under the contents of a yolk, the sizes that influences their further development and a differentiation.

Cleavage eggs comes to an end formation of blastula.

Blastula is a multicellular single-layered germ.

In cells of blastula the nucleus-plasma ratio is established typical for each species of animals. Since blastula, cells of a germ name embryonic cells. At lancelet blastula it is formed after achievement by a germ of 128 cells. By virtue of accumulation of products of ability to live blastomeres between them there is a cavity (blastocele, or a primary cavity). At full uniform cleavage (as at lancelet) blastula has the vesicle form with a wall in one layer of cells which is named blastoderm. A stage blastula there passes germs of all types of animals.

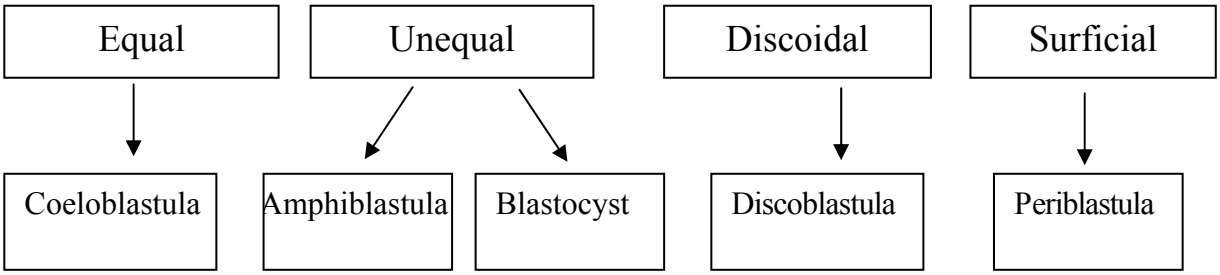
At mammals, cleavage is complete unequal, since in eggs it is not enough yolk. In various blastomeres it goes with a different rhythm, and it is possible to

observe stages 2, 3, 6, 7, 9, 10, etc. blastomeres. One of them (light) settle down on periphery, others (dark) are in the center. The surrounding germ is formed of light trophoblast cells which cells carry out auxiliary function and is direct in formation of a body of a germ do not participate. Trophoblast cells possess:

1) Ability to dissolve a fabric due to what the germ takes root into a wall of a uterus;

2) Exfoliate from cells of a germ, forming a hollow vesicle. The cavity of trophoblast is filled by a liquid, diffuse in it from tissues of a uterus. The germ at this time looks like nodule, located on an internal wall of trophoblast. As a result of the further cleavage the germ takes the form of a disk split on an internal surface of trophoblast.

Blastula types



At all multicellular animals following for the blastula stage of development is *gastrulation* which represents process of moving of embryonic a material with formation of two or three layers of a body a germ, named germinal layers. In process of gastrulation it is necessary to distinguish two stages:

1) Formation of ectoderm and endoderm — a two-layer germ;

2) Formation mesoderm — a three-layer germ.

At animals with isolecithal type of eggs gastrulation goes by invagination, i.e. embolies. A vegetative pole blastula is invaginate inside. Opposite poles of blastoderm are almost closed, so blastocele either disappears completely, or remains as an insignificant cavity, and from a sphere there is a two-layer germ.

The external layer of cells carries the name *ectoderm*. The internal layer refers to *endoderm*. The formed cavity refers to *gastrocoel*, or a primary gut, and the entrance in a gut has received the name *blastopore*, or a primary mouth. Edges of it approach, forming the top and bottom lips. At archaeostomatous to which the majority of types invertebrate concerns, blastopore turns to a final mouth, at secondarystomatous (echinoderms and chordates) from it formed an anal orifice or it grows, and the mouth is formed on the opposite end of a body.

Other ways of gastrulation are: delamination, epibolia, immigration and the mixed way.

At delamination cells of a germ share in parallel its surface, forming external and internal germinal a leaf.

Epibolia meets at the animals having telolecithal eggs. At this way of gastrulation fine cells animal poles acquire and cover outside large, rich with a yolk of a cell of a vegetative pole which become an internal layer.

Formation of gastrula by immigration is typical for *Coelenterata*. This way consists in mass active moving cells of blastoderm in blastocele.

More often the mixed type of gastrulation when simultaneously pass also emboly, and accretion, and migration takes place. So proceeds, for example, gastrulation at amphibious.

At a stage of two germinal lists development of *Spongia* and *Coelenterata* comes to an end. At all organisms concerning to types, worth at higher steps of evolution, develop three germinal leafs.

The third, or the average germinal leaf refers to *mesoderm* as it is formed between external and internal leafs.

Distinguish two basic ways of mesoderm formation - *teloblastic and enterocoelic.*

The *teloblastic* way meets at many invertebrates. It consists that close blastopore from two sides of a primary gut during time of gastrulation is formed on one large cell — teloblast. As a result of duplication of teloblasts it is formed mesoderm.

The *enterocoelic* way is characteristic for chordates. In this case from two sides from a primary gut an evagination are formed — pockets, or coelomic bags. Inside pockets there is a cavity representing continuation of a primary gut — gastrocoel. Coelomic bags come apart a primary gut also expand between ectoderm and endoderm. The cellular material of these sites gives rise mesoderm. The dorsal mesoderm department, laying on each side from a nervous tube and a chord, is dismembered on segments — somites. Its ventral department forms the continuous lateral plate which is taking place on each side of an intestinal tube. Somites are differentiated on three departments: medial — sclerotome, central — myotome and lateral — dermatome. In ventral mesodermal anlage can be distinguished parts nephrogonotom (a somite leg) and splanchnotom. The splanchnotom anlage is divided on two leaf between which the cavity is formed. It refers to as a secondary cavity, or coelome. The visceral leaf borders with an endodermal intestinal tube, and parietal - lays directly under ectoderm.

Histogenesis — process of formation of tissues.

Organogenesis — formation of organs.

Differentiated on three embryonic leafs, the germinal material gives rise to all tissues and organs.

From *ectoderm* the tissues of nervous system which are very early standing apart develop. At chordates it originally has the form of a nervous plate. This plate grows more intensively other sites ectoderm and then caves in, forming a groove. Duplication of cells proceeds, groove edges are closed, there is a nervous tube which lasts along a body from the forward end to back. On the forward end of a nervous tube by the further growth and a differentiation the brain is formed. Shoots of nervous cells of the central departments of nervous system form peripheral nerves. Besides from ectoderm develop an external cover of a skin — epidermis and its derivative (nails, hair, grease, and sudoriferous glands, enamel of the teeth, perceiving cells of organs of sight, hearing, sense of smell, etc.).

From *endoderm* the epithelial tissue covering organs respiratory, in part of urinogenital and digestive systems, including a liver and a pancreas is develops.

From *mesoderm: myotome* gives rise to skeletal muscles, nephrogonotom — to eliminative organs and sex gonads. The cells forming visceral and parietal of splanchnotom leaf, are a source of epithelial lining a secondary cavity of a body — coelome. Due to elements of sclerotome a cartilaginous, bone, and connecting tissues of internal organs, blood vessels, smooth muscles of guts, respiratory and urinogenital ways are develop. In formation of heart takes part also visceral the leaf of splanchnotom. Dermatome gives rise to a connective tissue of a skin.

Glands of internal secretion have a various origin: one of them (epiphysis, a part of a hypophysis) develop from anlage of nervous system, others — from ectoderm. Adrenal glands and sex glands are mesoderm derivatives.

In process of embryonic developments very much early stand apart primary sex cells. At mammal and the person primary sex cells stand apart at early stages organogenesis. Further they move to a place of a final arrangement and are part sex glands.

Organogenesis. In this stage it is possible to allocate two phases.

The first — neurulation, will consist in formation of a complex of axial organs: a nervous tube, a chord and intestines. The germ at a neurulation stage refers to neurula. The nervous tube is formed as a result of lowering a layer of cells ectoderm, formations in the beginning nervous groove which edges then are closed. The forward, expanded department in the further development the brain, other part of a nervous tube forms a spinal cord.

As distinctive feature of the first phase organogenesis that in the morphological reorganizations accompanying with formation of the central nervous system, all germ is involved almost serves.

The second phase consists in construction of other organs, purchase by various sites of a body of the form typical for them and features of the internal organization, an establishment of the certain proportions. Development of other organs represents spatially limited processes.

Formation of a chord on time corresponds to the earliest stages neurulation and occurs by isolation on an average line of a cellular material from a rudiment, the common with entoderm and mesoderm — walls of a primitive gut.

Organogenesis comes to the end basically by the end of the embryonic period of development. However the differentiation and complication of organs proceeds also in postembryonic ontogenesis. The described processes are connected not only to active cellular duplication primary embryonic anlages, but also with their significant moving, change of the form of a body of a germ, formation of apertures and cavities, and also with formation of some time germinal (provisional) organs.

3. Provisional organs. Mother-fetus relationship

Purpose of provisional organs — maintenance of vital abilities of a germ in various conditions of environment.

Embryonic development of organisms with different type of ontogenesis proceeds in various conditions. In all cases of development, necessary connection of a germ with environment is provided with the special extraembryonic organs functioning temporarily and named provisional. The degree of development and function of these organs are various. For all animals with non larval type of development, which eggs are rich a yolk (fishes, reptiles, birds), it is characteristic such provisional body as *yolk bag or sac.*

The blood vessels forming on all surface of a yolk a dense capillary network grow into walls of yolk bag. Cells of a yolk bag wall allocate the enzymes splitting nutrients of a yolk which act in blood capillaries and further in an organism of a germ. The yolk bag is also the first blood-forming organ of a germ, a place of duplication of blood cells. At mammal reduced the yolk bag is part of umbilical cord.

Amnion develops at truly ground animals. Amnion carries out functions of an exchange and protection against drying and mechanical influences. Amniotic fluid in which the developing embryo is shipped, represents a water solution of fibers, sugars, mineral salts, contains also hormones and urea. In the development the structure of this environment is changes. In obstetrical practice amniotic fluid departing before act of delivery, name waters.

Vertebrates, possessing amnion (reptiles, birds and mammal), are united in group of the higher vertebrates, or *amniotes*. The lowest vertebrates, not having amnion a (cyclostomes, fishes and amphibious), make group *anamniotes*.

Allantois — outgrowth a back gut of a germ. It is most advanced at animals developing in an egg — reptiles and birds where serves as a place of accumulation of nitrogenous waste products of a metabolism. Allantois merges with chorion and the chorion-allantois cover is formed, rich by blood vessels through which the embryo absorbs oxygen, gives carbonic acid and products of an exchange.

Chorion, or villous cover, carries out function of an external germinal environment. It is named so owing to development on its surface of the big number of villi. Villi of chorion grow into a mucous membrane of a uterus. The place of the greatest branching of chorion villi and the closest their contact to a mucous membrane of a uterus carries the name of a children's place, or *a placenta.*

At mammal and the person ovule it is poor a yolk, therefore provisional adaptations of a developing organism have the features. Yolk sac is pawned at early stages of embryogenesis, but does not develop, and is gradually reduced, stratified. Allantois also it is not advanced. The rudiment of it is part of new specific provisional organ — umbilical cord.

4. Features of embryonic developments of human

Embryogenesis of human is divided into 3 periods:

1. An initial stage — 1-st week;
2. Embryonic — 2–8 week;
3. Fetal — since 9 weeks and till a birth.

After fertilisation the zygote within three days moves to a uterine (fallopian) tube, being on a stage of cleavage. For the fourth day it is formed *blastocyst.* On the seventh — *implantation* of the blastocyst in mucous a uterus is observed. At a stage of the embryonic period on ventral side of a embryonic disk it is distinct endoderm as a thin layer of cells, there is a cavity of amnion. A embryotrophy is diffusive. For 14 day occurs *placentation* and the embryonic bag is formed. For 16 day there is a formation embryonic mesoderm, with 16–21 formation of a nervous tube (histogenesis, organogenesis) is observed.

Rudiments of hands and legs, end of development of heart are observed on 3 week of intra-uterine development.

Formation of a brain occurs on 6 week. The full anlage of all systems of organs is observed at the end of 8 weeks, during this period the sizes of an embryo achieve 40 mm, weight — 5. With 9 weeks begins the fetal period which is coming to the end with a birth.

5. The gene control of embryonic development

The basis of process of ontogenesis is made with the hereditary information received from parents. Its realization depends on conditions of the external and internal environment. The general scheme of ontogenetic processes includes three stages:

1. The information for expression and repression of genes. Genes receive the information from the next cells, products of a metabolism of hormones, etc. factors for the activation.

2. The information from genes as processes of a transcription and translation for synthesis of proteins.

3. The information from proteins for formation of tissues and organs. During of ontogenesis in future ovule (oocytes) there is a synthesis of r-RNA, ribosomes, t-RNA, necessary for an initial stage of development (cleavage, blastula formation). There is an amplification of genes (multiplication) r-RNA in cytoplasm, m-RNA. Chromosomes thus look like «lamp brushes». On these loops there is a synthesis m-RNA. Genes r-RNA are used for synthesis of protein molecules of ribosomes of a cell. Genes m-RNA are used for translation for a long time (reserved). Genes of sperm cell thus do not function. Due to function plasmagenes of a plasmotype the differentiation cortex cytoplasms ovule on zones (ooplasmic segregation) is observed. At fertilisation, it is brought by a gene of sperm cell in ovule. The genotype of a zygote is not active due to full repression of genes. Function plasmagenes of a plasmotype causes strengthening of a differentiation cortex on zones.

Cleavage is adjusted at the beginning by extremely information, contained in an egg. Storage in oocytes m-RNA provides active synthesis of protein. By a gene of mother and the father during this period it is not transcribed.

At a stage blastula becomes more active a genes of sperm cell. The genetic information blastomeres provides synthesis of proteins. Down to late blastula that

part of genetic information which concerns the common metabolic processes for all sharing cells is realized. Then repression of tissue-specific genes, i.e. a differentiation of cells of a embryo is observed.

Gastrulation it is supervised due to the genetic information embryonic cells. Functioning of the certain genes by a principle expression and repression provides synthesis of proteins and a anlage of embryonic lists of an embryo.

Histogenesis and organogenesis it is provided due to the genic information of cells of an embryo. Different populations of stem cells give rise to various organs and tissues. Process is supervised by function of the certain genes by a principle expression and repression.

In process induction relations between tissues and organs, i.e. influence of one tissue on another, development directing it is established. So a rudiment of a chord contacting with ectoderm, therefore epidermal cells are differentiated not in epithelium of skin but in a nervous tube. This phenomenon refers to as an embryonic induction.

It is supposed, products of activity of genes of cells, rudiments of a chord activate activity of sites of chromosomes of cells endoderm which define development of nervous system.

Formation of a phenotype depends on realization of the hereditary program in concrete conditions of environment.

Influence on an organism of mother during pregnancy of various teratogens: physical, chemical, biological, can cause damages of development of an embryo, occurrence of abnormalities or stillbirth.

Teratogens are: quinine, alcohol, caffeine, protozoa (toxoplasma), viruses (roseola), drugs (thalidomide, hormones), ionizing radiations. The critical periods of ontogenesis are: implantation, placentation, child birth, and also the periods histogenesis and organogenesis of an embryo.

Theme 2: Postnatal ontogenesis. The organism aging

Plan:

1. Postembryonal development, its periods.
2. Growth and development, their neuroendocrinal regulation.
3. Medical aspects of types of human constitution.
4. Ageing of an organism, its biological aspects.
5. The gene control of postembryonal development.

1. Postembryonal development, its periods

Postembryonal development is a stage ontogenesis, beginning the moment of an exit of a embryo from egg covers or a birth and coming to an end death of an organism. There are two kinds postembryonal developments: direct and indirect.

At direct — postembryonal ontogenesis divide into three periods: prereproductive, reproductive and postreproductive.

At indirect development organisms undergo metamorphoses which can be full or incomplete. Full of metamorphoses includes stages: an egg – a larva – a pupa – an adult organism. In incomplete to a metamorphosis the stage of a pupa is excluded. At formation of an adult individual the further development goes on a direct way. Larva stages differ from the adult form. For them, the provisional organs providing their development during this period are available. Metamorphoses it is characteristic for coelenterates, flat and round worms, mollusks, arthropods and amphibians. Biological value a metamorphosis is one of adaptations to conditions of the environment, promoting a survival.

The pre-reproductive period at direct development name still the period of growth and morphogenesis. It is characterized by continuation beginning still in embryonic stage of organogenesis and increases in the sizes of a body. Newborns differ in the sizes, and also maturing of some organs and proportions of a body. To the beginning of this period all organs reach that degree of a differentiation at which the organism can exist and develop outside of an organism of mother or outside of egg covers. Since this moment the digestive path, organs of breath and sense organs start to function. Nervous, blood and secretory systems begin the function in a embryo. During the pre-reproductive period finally develop specific and individual features of the organism, and individual reach the typical sizes.

After other organs the genitals is differentiated. When its formation comes to an end, there comes the second period of postnatal ontogenesis — *the reproductive period* or the period of a maturity during which there is a reproduction. Duration of the second period at some species (a day-fly, a silkworm) lasts some day, at others — it is a lot of years (mammals, a human).

After the reproductive period there comes *the postreproductive period* or the period of an old age. An old age — it is natural and inevitably coming final period ontogenesis. Approach of an old age is connected to ageing an organism. These concepts should be differentiated strictly. Ageing is the reason of approach of an old age, i.e. the old age is consequence of processes of ageing.

After a birth, at human distinguish the periods (conditionally):

Newborn – till 10 days Chest - till 1 year Children's - till 11-12 years Teenage - till 15-16 years Youthful - up to 20-21 year	pre-reproductive
Mature - till 55-60 years	reproductive
Elderly - till 74 years Senile - till 90 years	postreproductive

Children's age — the period of proceeding development and perfection of functions. Development of a skeleton, its ossification, muscular weight proceeds, coordination of movements is improved. The backbone keeps flexibility that at wrong physical training can lead to deformation. The high level of a metabolism and energy, uniform physical development is marked. Sense organs reach perfection. Nervous processes are characterized by force and steadiness. All kinds of braking are well expressed. However performance of fine and exact movements, active attention, concentration is still complicated, the fast exhaustion accompanying with neurotic infringements develops.

Teenage — the period of rough transformation of an organism. Activity of hypothalamic-pituitary systems provides processes of puberty, formation of secondary sex traits, intensive development of all physiological systems, development of a skeleton comes to the end, coordination of movements is improved. The subcortical influences intensify, regulating activity of a cortex is weakened. Occuring shifts of hormonal system and imperfection of nervous regulation can cause various vegetative infringements. There is a formation of character and the person. This age is characterized by emotionality, with the excitability, the reduced serviceability and fatigue.

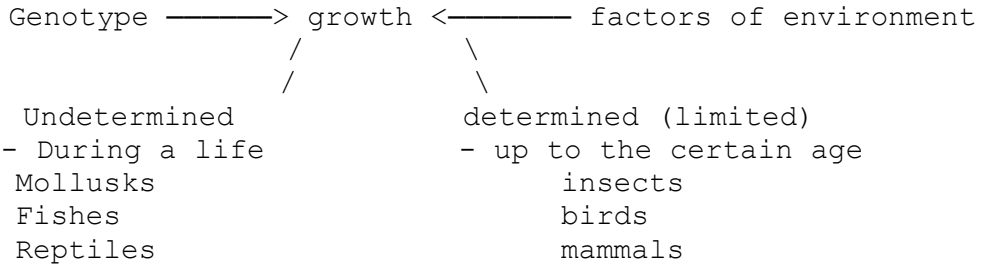
At *youthful age* — formation of all organs and systems of an organism comes to the end. The hormonal balance that favors to work of nervous system is established. The role of a cortex in regulation of all functions grows, processes of braking intensify. Process of formation of emotions, consciousness comes to the end. Growth stops, there comes the period of a sexual maturity. Intellectual and physical serviceability grows.

Growth is the most typical feature of ontogenesis. Growth is the process accompanying with increase of amount of cells and accumulation of weight of extracellular formations, caused by a metabolism. The weight of a body increases until speed of assimilation above speed of dissimilation.

2. Growth and development, their neuroendocrinal regulation

Postnatal growth is reduced to development and increase in already existing cells, instead of formation of new. Exception is made with a fatty tissue. The number of fatty cells is capable to increase constantly down to the pubertal period (13–15 years).

The scheme of growth types



The human growth constants per year:

1) 1 year of a life — 1,3;

2) From 1 up to 12 — 0,7;

3) Puberty (12–16 years) — 1,6;

4) After 16 years — 0,6.

The most intensive growth is observed on 1 year of a life (23–25 cm), on the second year of 10–11 cm, on the third — 8 cm, with 4 till 7 years — year at growth of 5–7 cm, from 11–12 years at girls, and at boys till 16 years flare in 7–8 cm per year is observed.

All tissues and systems of organs grow non-uniformly.

1. The general type: a body, organs of breath, a muscle, a bone. Peak of activity — in 1 year of a life and the period of puberty.

2. Lymphoid type. Intensive growth of a tissue just one year, and to 20 years is observed decrease in rate.

3. Brain type. Intensively develops by 10–12 years and reaches the sizes of a brain of the adult person.

4. Reproductive. It is few growth till the period of puberty, and then fast rate.

C. Majnot and I. I. Shmalgauzen investigate dependence of growth on a differentiation of tissues of an organism. It is established, that embryonic and low-differentiated tissues grow faster than differentiated. With the years the quantity of the first progressively decreases, as results in falling intensity of growth. I. I. Shmalgauzen has given to this law mathematical equation:

Cv t = const

Where Cv — intensity of growth; t — age.

Factors of growth are exogenous and endogenous.

Exogenous factors it: a nutrition, vitamins.

For normal development a normal nutrition and presence of vitamins is necessary. Vitamin A — influences visual acuity (is part of rhodopsin), development of epithelium, growth of an organism. Vitamin Д — adjusts an exchange of calcium and phosphorus. Vitamin E influences on gametogenesis, C — growth of an organism, durability of vascular walls, vitamins B_1 and B_6 — on nervous system, $_{B2}$ and PP — on development of mucous membranes, a skin, B_{12} — on hematosis.

Endogenous factors are the hormones regulating the growth processes, formed in gonads of internal secretion. *The hypophysis* is the central endocrine gonad. The anterior lobe of hypophysis develops the tropic hormones: thyrotropic, regulating function of a thyroid gland, adrenocorticotropic — function of adrenal glands, gonadotropic — function of ovary and testicle (follicle-stimulating hormone and luteinizing hormone). Own hormone of anterior lobe — somatotropin or growth hormone influences synthesis of protein that provides reproduction of cells, hence, growth and accumulation of a biomass. Hypofunction results in occurrence dwarfism, hyperfunction — gigantism. Hyperfunction at mature age results in development of acromegaly disease. Hormones of a thyroid

gland (thyroxin and 3-iodothyronine) strengthen oxidizing processes in mitochondria. Congenital insufficiency results to cretinism, hyperfunction causes thyrotoxicosis.

Parathyroid glands produce parathormone which influences a metabolism of calcium and phosphorus.

The cortex of adrenal glands produces aldosterone, corticosterone and the glucocorticoids regulating a diuresis, a blood pressure, a mineral and carbohydrate exchange. The brain substance produces adrenaline and noradrenaline which provide regulation of a tone of vessels.

Langerhans islets of pancreas produce insulin and glucagon, regulating a carbohydrate exchange.

Leydig cells of testicle produce testosterone, influencing formation of secondary sexual traits and provides regulation spermatogenesis.

Theca-cells of ovary produce estradiol and progesterone providing ovogenesis, ovulation and formation of secondary sex traits.

3. Medical aspects of types of human constitution

As parameters of growth the increase in weight, volume, the linear sizes of a body, etc. can serve. With the characteristic of growth of an organism, its constitution, character of behaviour the constitution conception is applied. (constitutio — a condition, addition, property).

The constitution — set of morphological, functional characteristics of an organism which has developed on the basis of the hereditary information, under influence of modifying factors of environment.

The constitution includes concept not only morphological, but also physiological features of an organism, its reactance, resistibility to illnesses, feature of exchange processes.

For an estimation of the constitution of human many classifications are offered. In 20–30 years E. Krechmer's system has been accepted. He considered the constitution congenital, has established dependence of a constitution on temperament and allocated three types of a constitution: *picnic, leptosomic, athletic.*

Picnic — wide with round forms individual, a plenty of fat, strong, thickset, need for dialogue, smooth changes for mood.

Leptosomic — long, thin, extended.

The athletic — brawny, with a wide thorax and shoulders and narrow hips.

Physiologist Chernorutskij M. V. divided people on: *asthenic persons, hypersthenic persons, normosthenics.*

V. Sheldon has suggested to divide people as a constitution on *endomorphic, mesomorphic and ectomorphic types* (the theory about development of all systems from 3 embryoinal lists).

Endomorphs are characterized by round-spherical forms, the tendency to adiposity.

Mesomorphs are the muscular type, are classical Hercules.

Ectomorphs are a lanky person.

To thicket there are combinations of types. In total theoretically 300 possible combinations. Really there are 76 variants of somatotypes.

Somatotypes remain constants during all life: appearance, the sizes of a body, but not somatotype vary.

V. Sheldon allocates conformity of temperament to components of the constitution:

to endomorphic type there corresponds slackness of a bearing, ease in dialogue, smooth changes in mood;

to ectomorphic type opposite attributes are characteristic;

to mesomorphic type there correspond confidence of movement, aggression at alcohol.

There is a hypothesis explaining connection between the constitution and temperament. According to the genetic theory, the genes determining features of a constitution, have pleiotropic action, influencing on development of endocrine glands and the nervous system, determining biological features of temperament. Environment, including social has great value also.

The constitutional features are studied with the help of biochemical methods: the quantity of a muscular tissue correlates with end-products of an exchange androgens of adrenal glands and testosterone of testicle (17-ketosteroids).

Almost in all schemes, alongside with the basic tendencies of a constitution, additional traits — features of a structure of a head, the person, a neck, finitenesses, hair distribution, etc. are reflected.

The constitutional features correlate with predisposition to diseases.

Already at the sources of occurrence of concepts of the constitution of human developed in close connection with the doctrine of «predisposition» of an organism to the certain diseases.

Persons of leptosomic type (ectomorphs) fall ill with a tuberculosis is more often. For them hypererethism and the reactance, the increased frequency of neurosises, a negative dystonia, a gastritis, stomach ulcers and a duodenal gut, a hypotonia is characteristic.

At persons of picnic type (endomorphs, hypersthenics) hypertensions, to an atherosclerosis, cholelithic illnesses, a late stage of a diabetes come to light the increased propensity to illnesses of a metabolism, endocrinopathy, and also.

There is a connection between the constitution and mental diseases. At persons of ectomorphic type the big frequency of schizophrenia is observed. The manic-depressive psychosis is revealed more often at persons endo- and mezomorphic types.

At the same time the specified tendencies are found out far from being always. During too time is not subject to doubt, that at the modern person, physical and which mental health is appreciably caused by the social environment, the constitution thoroughly levels possible influence of «selection» within the limits of constitutions and between constitutions.

4. Ageing of an organism, its biological aspects

Studying of laws of ageing of an organism makes a subject special biological discipline — *gerontology*. Features of development, current, treatment, the prevention of diseases at old men are studied with *geriatrics*.

Not being the expert the gerontologist it is possible to distinguish on appearance of human the young man from the old man, to determine with accuracy of 5–10 years age of the person. Deep wrinkles, the flabby skin, lowered corners of a mouth, gray with age whisky — characteristic external attributes of age. At the same time, if to carry out special researches there is, that a difference in such parameters, as arterial pressure, frequency of a rhythm of intimate reductions, an electrocardiogram, electroencephalogram (EEG), a level of sugar in blood, the data of the analysis of gastric juice, will be minimal.

Attributes of ageing are shown at different levels of the organization of an organism: molecular, cellular, tissue, system, and organism.

On a organism level — external attributes: change of a bearing, the form of a body, reduction of the sizes of a body, a gray hair, loss of elasticity of a skin, a wrinkle, easing of sight of hearing, memory impairment, decrease of compact and spongy substance of a bone, change of an obverse department of a skull. Vital force easy decreases, arterial pressure, an atherosclerosis, easing of functions of a thyroid gland, reduction of functions of sexual hormones, reduction of the basic exchange increases.

At a cellular level — reduction of water in cytoplasm, change of active transport of ions, glycolysis strengthening, reduction in ATP and phosphocreatine contents in heart, a brain, skeletal muscles, changes RNA and DNA.

On molecular — there are mistakes of reading of RNA information and infringement of synthesis of the certain proteins. In cytoplasm of a cell free radicals collect. Assimilation does not fill dissimilation. It is reduced mitotic activity, intensify chromosomal aberrations. However many of homeostatic parameters do not change: arterial pressure, frequency of intimate reductions, an electrocardiogram, EEG, a level of sugar in blood, the composition of gastric juice.

Age changes are different: parameters of one are reduced (reductions of heart, function of a thyroid gland, visual acuity); and others — do not vary (sugar in blood, эритроциты, leukocytes, hemoglobin); at the third — raise (synthesis of hypophysial hormones, a level of cholesterol in blood, sensitivity of cells to humoral and chemical factors).

Age changes are shown during the different periods. So the thymus atrophy arises at human in 13–15 years, fading of ovary functions — in 48–52 years. In a bone tissue of change arise early, but develop slowly, in CNS — late, but it is fast.

There is paradox above which thinks Democritus already. He wrote: «the old age — is damage of all body at full undamageness all its parts». This seeming contradiction has deep biological sense. Despite of structural changes at ageing, due to processes of regulation there are adaptive mechanisms. They counteract

fading of an exchange and functions, promote their preservation or resist to sharp change. That is why at the certain stage of ageing, despite of some obvious structural changes, can the optimum level of activity of some systems will be kept still.

Ageing is inevitably and naturally increasing in time, a multilink process developing long before an old age, inevitably the leader to reduction of adaptive opportunities of an organism, increase in probability of death. Ageing — result of restriction of mechanisms of self-control, reduction in their potential opportunities at primary changes in regulation of the genetic apparatus.

For an explanation of processes of ageing by present time it is put forward about 300 various hypotheses, the majority from which represent only historical interest.

There are power (M. Rubner), hormonal (S. Voronov), gene-toxic (I. Mechnikov), overstrain of CNS (I. Pavlov), connective tissue (A. Bogomolets), adaptive-regulatory (V. Frolksis), and genetic theory but the uniform theory is not present.

The gerontology of today aspires to open primary changes and all subsequent circuits of the relationships of cause and effect leading to deep infringements of activity of an organism. The majority of researchers agree that primary mechanisms of ageing are connected to shifts in the genetic apparatus, in infringement of biosynthesis of protein.

Preconditions of these sights are the following facts. Life expectancy — a specific attribute. Hence, the mechanisms determining life expectancy are somehow fixed during evolution, predetermined in ontogenesis an organism.

If to take into account, that there is a certain sequence of shifts in genes regulators; one of them change earlier and considerably, others — practically do not change, the third are activated, — that becomes clear non-uniformity, undirected manifestation of ageing of an organism.

In 1975 V. Frolksis has acted with a substantiation *adaptive-regulatory theories* of ageing, according to which ageing is a complex multicomponent internally inconsistent process of infringement of ability to live of an organism, and process of occurrence of the important mobilization adaptive mechanisms, process of fading of an exchange and function and occurrence of active mechanisms of their suppression. Primary changes at ageing develop in *regulatory* genes which result in infringement of activity of a cell, its destructions.

Connection between ageing of an organism and number of divisions of its somatic cells was studied. It is revealed, that the number of cell fissions decreases with increase in age of the donor.

Progeria. Cells of patients with Werner's syndrome possess reduced ability to division and in culture. The basic clinical symptoms of this autosome-ressesive disease — cataract, poliosis, early arteriosclerosis, changes of skin, diabetes, the increased frequency of malignant growth, chromosomal instability, and untimely aged face. Expected life expectancy is reduced.

Due to mechanisms of self-control during ageing there are important adaptive mechanisms at different levels of ability to live of an organism (strengthening of sensitivity to mediators and hormones). They in many things determine

life expectancy of an individual. Value of them not absolute. In some cases accompanying adaptable mechanisms shifts can promote infringement of a metabolism of an organism.

Death is a natural phenomenon. It is prepared by all course ontogenesis. The death always finds the expression in the form of this or that accident. The death of human even in extreme old age comes as a result of the different reasons (at infringement of a coordination of exchange processes in an organism, and an organism with environment). The casual reasons can cause untimely death in any period ontogenesis.

At multicellular organisms, the death is always shown under influence of microbes.

At monocellular organisms meet two forms of end ontogenesis:

1) Death from the casual reasons with formation of a corpse;

2) Natural end of ontogenesis by division.

As after division does not remain a corpse, attempts to approve (A.Vajsman) were undertaken, that the Protozoa are potentially immortal. Representation about immortality is antiscientific. It is borrowed from religious — mystical representations about immortality of soul. According to religious sights, death — the instant act caused by branch of non-material soul from a body. The biology has completely denied this representation, having proved, that the death is a slow, consistently made process. After death of an organism as whole its part continue some time to live and perish in known sequence (a cell of brain cortex → of liver → of heart → of peripheral organs).

The modern science has allowed to specify concept «death». Soviet scientist V. A. Negovsky has suggested to distinguish clinical and biological death. The clinical death is characterized by the discontinuance of heartbeats, absence of breath, reflex reactions. However is the first and still convertible process of dying. At the moment of clinical death all organs and tissues remain alive, their metabolism remains ordered. Its duration is 3–5 minutes. In a condition of clinical death it is possible to achieve restoration of ability to live of an organism. Now, methods of revival of an organism of human are successfully used in clinics.

The biological death comes later and is characterized by the disorder chemical reactions in cells, autolysis and decomposition of a tissue. Biological death is irreversible process.

5. The gene control of postembryonal development

1. In the pre-reproductive period the gene control is carried out due to the following processes of change of a hereditary material:

— DNA synthesis due to replication;

— Function of specific genes due to their selective activity;

— Regulation of activity of genes by hormones;

— Group repression of genes of one of X-chromosomes at women;

— Synthesis of proteins due to the genetic information of somatic cells.

2. During the reproductive period:
— DNA and proteins synthesis due to selective activity of genes;
— Hormonal regulation;
— Group repression of genes of one of X-chromosomes at women.
3. Postreproductive period:
— Infringement of DNA synthesis due to accumulation of harmful mutations;
— Synthesis of normal and abnormal proteins due to selective activity of genes, accumulation of intermediate products of an metabolism which are mutations;
— Weakening regulation of genes by hormones;
— Repression and expression of the certain genes.

Theme 3. Ontogenetic homeostasis

Plan:
1. Concept about a homeostasis.
2. The general (cybernetic) laws of homeostasis of living things.
3. Gene, cell and system mechanisms of homeostasis.
4. A role nervous and endocrine systems in maintenance of homeostasis.
5. Biological rhythms. Medical value of chronobiology.
6. Homeostatic mechanisms of an organism during the different age periods.

1. Concept about a homeostasis

Homeostasis — it is property of an alive organism to keep a relative dynamic constancy of the internal environment. The homeostasis is expressed in a relative constancy of a chemical composition, osmotic pressure, stability of the basic physiological functions. The homeostasis is specific and caused by a genotype.

Illness of the person is consequence of homeostasis disturbance and ways of its restoration.

Alive organism is the open system having communication with an environment by means of nervous, digestive, respiratory, excretory systems, etc.

During a metabolism, with food, water, at gas exchange in an organism various chemical compounds which in an organism are exposed to changes act, enter into structure of an organism, but do not remain constantly. The assimilated substances break up, allocate energy, products of disintegration leave in an environment. The destroyed molecule is replaced by new and so on.

Integrity of polypeptide structure is not broken by cells. An organism is open, dynamic system. In conditions of continuously varying environment the organism supports a steady condition during a certain time.

Greek *homoios* — means, a similar, and *stasis* — a condition — a relative dynamic constancy of structure and the internal environment of an organism. This phenomenon is evolutionary developed, as adaptable property of an organism to conditions of an environment.

Conservation of integrity of individual properties of an organism is one of most general biological laws. This law is provided in a vertical number of generations with mechanisms of reproduction, and during a life of an individual by mechanisms of a homeostasis.

The phenomenon of a homeostasis represents evolutionary produced and hereditary-fixed adaptable property of an organism to usual conditions of an environment. However these conditions can quickly or is long to fall outside the limits norm. In such cases of the phenomenon of adaptation are characterized not only restoration of usual properties of the internal environment, but also short-term changes of function (for example, increase of a rhythm of heartbeats and increase in frequency of respiratory movements at intensive muscular work). *Reactions of a homeostasis can be directed on:*

1) maintenance of known levels of a stationary condition;

2) elimination or restriction of harmful factors action;

3) development or conservation of optimum forms of interaction of an organism and environment in changed conditions of its existence. All these processes define adaptation.

Therefore the concept of a homeostasis means not only a known constancy of various physiological constants of an organism, but also includes processes of adaptation and coordination of the physiological processes providing unity of an organism not only in norm, but also under changing conditions of its existence.

The basic components of a homeostasis were determined by C. Bernar and V. Cannon. It is possible to divide it into three groups:

A. Substances providing cell needs (carbohydrates, proteins, fats, water, nonorganic substances and their ions, oxygen, hormones);

B. Surrounding factors, affecting cell activity (osmotic pressure, temperature, pH).

C. Mechanisms, providing structural and functional integrity (heredity, diversity, regeneration, immune responsiveness).

2. The general (cybernetic) laws of homeostasis of living things

The principle of biological regulation provides internal state of an organism, and also interrelation of ontogenesis and phylogenesis. This principle is abundant. At its studying, cybernetics originated from it — a science about purposeful and optimal control of complex processes in wildlife, in a human society, the industry (Berg I. A., 1962).

The alive organism represents complex controlled system where there is an interaction of many variables of the external and internal environment. The general for all systems is presence of *input* variables which depending on properties and laws of system behavior will be transformed to *output* variables.

Output variables depend from input variables and laws of system behavior.

Influence of output signal on a managing part of system refers to *as a feedback* which is of great importance in self-control (homeostatic reactions). Distinguish *a negative* and *positive* feedback.

The negative feedback reduces influence of an input signal on size of output signal by a principle: «the more on an output, the less on an input». It promotes restoration of a homeostasis of system.

At *a positive* feedback the size of an input signal increases by a principle: the more on an output, the more on an input. It strengthens the arisen deviation from an initial condition that results in disturbance of a homeostasis.

However all kinds of self-control operate by one principle: a self-deviation from an initial condition that serves as stimulus for inclusion of mechanisms of correction. So in norm pH of blood is from 7.32 to 7.45. Shift pH on 0.1 results in disturbance of heartbeats. This principle has been described by Anokhin P. K. in 1935 and named a principle of a *feedback*. It serves for realization of adaptive reactions.

The general principle of homeostatic reactions (Anokhin P. K. Theory of functional systems):

Deviation from an initial level ⟶ signal ⟶ switching on regulatory mechanisms on the principle of a feedback ⟶ correction of changes (normalization).

So, at physical work, level of CO_2 in blood increases ⟶ shift of pH in acid side ⟶ the signal in an oblong brain in the respiratory center ⟶ centrifugal pulse to intercostals muscles shifted the respiration intensity ⟶ decrease of CO_2 in blood and pH is restored.

3. Gene, cell and system mechanisms of homeostasis

Homeostasis mechanisms function at gene, cell and system levels.

Gene mechanisms of homeostasis. All phenomena of organism's homeostasis are genetically determined. Already at a level of primary gene products there is a feed-forward «one structural gene — one polypeptide». Also colinearity exists between primary structures of DNA and polypeptide. In the hereditary program of individual development of an organism formation of species-specific characteristics not in constants, but in varying conditions of environment in limits norm of reaction is provided. Two DNA strands has essential value during both it replication and reparation. And both have the direct relation to maintenance stability of genetic material function.

From the genetic point of view it is possible to distinguish elementary and system manifestations of homeostasis. As examples of elementary manifestations of homeostasis can serve: the gene control of blood clotting factors, the gene control of histocompatibility of tissues and organs that allow the transplantation (transfer of organs and tissues and their engraftment).

The replaced part refers to *as a transplant.* The organism from which take a tissue for transfer, is *the donor* to whom replace — *the recipient*. The success of transplantation depends from immunology reactions of an organism. Distinguish autotransplantation, syngenic transplantation, allotransplantation and xenotransplantation.

Autotransplantation — exchange of tissues in the same organism. Thus antigens of a transplant do not differ from proteins of the recipient. Immunology reaction does not arise.

Sygenic transplantation is carried out in monozygotic twins having the same genotype.

Allotransplantation is transfer of tissues between individuals belong to same species. The donor and the recipient differ on antigens, therefore in land vertebrates usually observed a long replantation.

Xenotransplantation — the donor and the recipient belong to different species. This kind of transplantation is possible in the some invertebrates but in land vertebrates such transplant rejected.

At transplantation the great significance has the phenomenon of immunological tolerance to donor cells owing to host reaction. Suppression of immunity in case of tissues transfer (immunodepression) is reached by: suppression of activity of immune system, irradiation, introduction of antilymphocyte serum, hormones of a cortex of adrenal glands, chemical preparations — antidepressants (imuran). The primary goal is to suppress not simply immunity but transplantation immunity.

Transplantation immunity is determined by the genetic constitution of the donor and the recipient. The genes responsible for synthesis of antigens, causing reaction to the replaced tissue, refer to as genes of tissue incompatibility.

HLA (Human Leukocyte Antigen) system is the main genetic system histocompatibility in human. Antigens are full enough submitted on a surface of leukocytes and determined with the help of antiserums. The structure of the system in human and animals is identical. Uniform terminology for the description of loci and alleles of HLA system is accepted. Antigens are designated: HLA - A1; HLA - A2, etc. New antigens is designated — W (Work). Antigens of HLA system is divided into 2 groups: SD (serum defined) and LD (leukocyte defined).

Antigens of SD group are determined by serological methods and encoded by genes of 3 subloci of HLA system: HLA-A; HLA-B; HLA-C.

LD — antigens are controlled by sublocus HLA-D the sixth chromosome, and determined by a method of the mixed cultures of leukocytes.

Each of the genes controlling the HLA antigens in human has a lot of alleles. So sublocus HLA-A — encode 19 antigens; HLA-B — 20; HLA-C — 5 «work» antigens; HLA-D — 6. Thus, it is already revealed about 50 antigens in human.

Identity of the donor and the recipient on antigens of HLA system is necessary at transplantation. Transfer of the kidney identical with recipient on 4 antigens of HLA system, provides survival rate in 70 % of cases; on 3 — in 60 % cases; on 2 — 45 %; on 1 — 25 %.

There are the special centers conducting selection of the donor and the recipient at transplantation, for example in Holland — «Eurotransplant». Antigens' typing is started also in Republic of Belarus.

Cell mechanisms of a homeostasis are directed on cell restorations of tissues and organs in case of disturbance of their integrity. Set of the processes directed on restoration of destroyed biological structures refers to *as regeneration.* Such process is characteristic for all levels: renewing of proteins, cell organelles, and cells. Restoration of functions of organs after injury or break of a nerve and

wound healing are important for medicine from the point of view these processes acquirement.

Depending on ability to regeneration, tissues and organs are divided on 3 groups:

1. Tissues and organs for which are characteristic a *cell* regeneration (bones, loose connective tissue, hematopoietic system, endothelium, mesothelium, mucous membranes of intestine, respiratory ways, and urinogenital system).

2. Tissues and organs for which are characteristic *cell and intracellular* regeneration (liver, kidneys, lungs, smooth and skeletal muscles, vegetative nervous system, endocrine glands, and pancreas).

3. Tissues for which mainly *intracellular* regeneration (myocardium) is characteristic or alone *intracellular* regeneration is characteristic (ganglia cells of the central nervous system). It covers processes of restoration of macromolecules and cell organelles by assemblage of elementary structures or by their division (mitochondria).

Physiologic and reparative regeneration were generated during evolution.

Physiologic regeneration is a natural process of restoration of elements of an organism during a life. For example, restoration erythrocytes and leukocytes, replacement of skin epithelium and hairs, and replacement of a milk teeth by permanent teeth. These processes are under influence of external and internal factors.

Reparative regeneration is a development of organs and the tissues that is lost at damage or wound. Process occurs after mechanical injuries, burns, chemical or radiation injuries, defeats as a result of illnesses, surgical operations.

Reparative regeneration is subdivided on *typical* (homomorphosis) and *atypical* (heteromorphosis). In the first case, regenerate organ which has been removed or destroyed, in the second, in a place of the removed organ develops another organ.

Atypical regeneration meets in invertebrates is more often.

Regeneration is stimulated with hormones *of hypophysis* and *thyroid gland*. Distinguish some ways of regeneration:

1. *Epimorphosis* or full regeneration — restoration of superficial wound, regeneration of organ's parts up to the whole (tail of lacerta, limb of newt).

2. *Morpholaxis* — reorganization of the part of organs up to the whole, only the smaller sizes. For this way typically not addition up to the whole but reorganization of new from the parts of old (limbs of cockroach).

3. *Endomorphosis* — restoration due to cell and intracellular reorganization of a tissue and organ. The weight of body comes nearer to initial due to increase in number of cells and their sizes.

In vertebrates reparative regeneration is carried out in the following form:

1. *Full regeneration* — restoration of an initial tissue after its damage.

2. *Restoratory hypertrophy* is characteristic for internal organs. Thus superficial wound is close up by scar, the removed part is not grown and the form of body is not restored. The weight of remains increases due to increase in number of cells and their sizes and comes nearer up to initial size. Liver, lungs, kidneys, adrenal glands, pancreas, salivary glands, and thyroid gland are recycled in mammals in this way.

3. *Intracellular compensative hyperplasy* of ultrastructures of a cell. Thus on a place of damage it is formed scar, and restoration of initial weight occurs due to increase in volume of cells, instead of their number on the basis of growth (hyperplasy) intracellular structures (for example, regeneration of nervous tissue).

System mechanisms are provided with interaction regulation systems: *nervous, endocrine and immune*.

4. A role nervous and endocrine systems in maintenance of homeostasis

Nervous regulation is carried out and coordinated by the central nervous system. Nervous pulses, acting in cells and tissues, cause not only stimulation, but also adjust chemical processes, an exchange of biologically active substances. Now it is known more than 50 neurohormones. So in hypothalamus it is developed vasopressin, oxytocin, releasing factors, regulating function of a hypophysis. Examples of system regulation of homeostasis are conservation of a constancy of temperature and arterial pressure.

From positions of a homeostasis and adaptation the nervous system is the main organizer of all processes of an organism. A reflex processes lay in a basis of the adaptation. Between different levels homeostatic regulations exists individual hierarchic subordination in system of regulation of internal processes of an organism.

The primary level makes homeostatic systems of cell and tissue level. Above them are submitted peripheral nervous regulation processes such as local reflexes. Further in this hierarchy systems of self-control of the certain physiological functions on the principle of «feedback». The top of this pyramid is occupied the cortex of cerebral hemispheres and brain.

In a complex multicellular organisms the direct and feedback intercommunication are carried out not only nervous, but also hormonal mechanisms. Each of glands included in hormonal system influences other organs of this system and in turn has influenced from it.

According with B. M. Zavadsky, *hormonal mechanisms* of a homeostasis is the mechanism with plus or minus of interaction, i.e. an equilibration of functional activity glands with concentration of a hormone. At high concentration of a hormone activity glands is weakened and vice versa. Such influence is carried out by action of a hormone on a gland producing it. At some glands, the regulation is established through hypothalamus and anterior lobe of hypophysis, especially at stress-reaction.

Hormonal glands are possible to divide into two groups relative to anterior lobe of hypophysis. Last is considered central and other hormonal glands are peripheral. This division is based that the anterior lobe of hypophysis produces so-called trope hormones which activate some peripheral hormonal glands. In turn, hormones of peripheral endocrine glands operate on anterior lobe of hypophysis, decreasing secretion of trope hormones.

The reactions providing a homeostasis, cannot be limited to any one endocrine gland, and encompass to some extent the all glands. Arising reaction gets

chain character and extends to other effectors. Physiological significance of hormones consists in regulation of other functions of an organism that is why chain character should be expressed in maximum.

Constant disturbances of the internal environment of an organism promote conservation of its homeostasis during a long life. If to create such conditions of a life at which nothing causes essential shifts of the internal environment the organism appears completely it is unarmed at a meeting with an environment and soon perishes.

Association in hypothalamus the nervous and hormonal mechanisms of regulation allows to carry out complex homeostatic the reactions connected to regulation of visceral function of an organism. Nervous and hormonal systems are the uniting mechanism of a homeostasis.

Example of the general response nervous and hormonal mechanisms is the stress condition which develops under adverse life conditions and there is a threat of disturbance of a homeostasis. At stress change of a condition of the majority of systems is observed: muscular, respiratory, cardiovascular, digestive, sense organs, blood pressure, and structure of blood. All these changes are express separate homeostatic reactions directed on increase of resistibility of an organism to adverse factors. Fast mobilization of forces of an organism acts as protective reaction to stress conditions.

At «somatic stress», the task is the increase of the general resistibility of an organism.

In a case of «mental stress» at painful and emotional influence it is included in addition functional changes of a condition of the cortex of cerebral hemispheres, limbic lobe of brain, sympathetic nervous system, medulla cells of adrenal glands and comes to the end with releasing of adrenaline in blood.

Homeostatic mechanisms active in a condition of stress, are capable to resist to adverse conditions up to the certain limit.

In development of stress-reaction distinguish three stages:

1) Mobilization of defence or anxiety mechanisms.

2) Increase of resistibility of an organism.

3) An exhaustion of defence mechanisms.

First two stages meet to preservation of homeostasis; the third stage comes at excessive influences and results in failure of mechanisms of a homeostasis.

5. Biological rhythms. Medical value of chronobiology

All life processes of an organism are under strict rhythm: day, month, year, etc. It is established, that problem of influence of geophysical factors on processes of human adaptation is closely adjoined to problem of biorhythms. The main attribute of rhythmic processes is their repeatability; under rhythms understand periodically repeating a natural phenomenon (A. M. Emme, 1967). Rhythmic fluctuations of organism' functions has name biological rhythms. They can be characterized, as regulation the qualitative changes of some charac-

ters of the biological processes occurring at different levels of the living things organization: cell, tissue, organism and population.

The rhythm of nervous system determines a rhythm of stimulation and inhibition. Endocrine glands have daily rhythmic activity and, at the same time, determine rhythms of some functions of an organism. To all cells of an organism resides the independent daily rhythm, not dependent on hormones.

The biological rhythms that coincide with duration of correspond geophysical cycles have name «ecological» or «adaptable». These are long-term, annual, seasonal, lunar, tidal and daily changes of vital activity.

On a degree of dependence on external conditions biological rhythms divide on *exogenic* and *endogenic*.

Exogenic rhythms depend on rhythms of geophysical and cosmic factors (photoperiod, temperature, atmospheric pressure, gravitation, etc.).

Endogenic rhythms take place under constant external conditions. There are daily rhythms of vital functions of an organism (mitotic cell division, releasing of hormones, etc.).

The analysis chronobiology laws promote to deep studying of biological mechanisms of a human homeostasis and purposeful use of the effective means raising stability to extreme environmental factors.

6. Homeostatic mechanisms of an organism during the different age periods

Estimating of human homeostasis in an old age is necessary to consider:

1. All homeostatic values are under complicated control. The same level of an exchange and function has unequal internal maintenance during the different age periods. So, arterial pressure at old and young people essentially does not differ. However at young it is supported due to increase in work of heart, and at old — due to a high vascular tone.

2. An initial level of some functions during the different age periods differs insignificantly. At the same time, reliability, potential opportunities, a range of the adaptation of functions at ageing essentially fall. If to use functional loadings, age distinctions in a level of activity of an organism can be clearly established. So, after physical loading at older persons the level of arterial pressure, rhythm of heartbeat, work of heart, and oxygen consumption come back to initial level more slowly.

Hence, the adaptive mechanisms arising during ageing appear already insufficient to keep a level of an exchange and function at various loadings.

So, the homeostasis is the big problem of modern biology and medicine because the phenomenon of a homeostasis means not only conservation of constancy but optimum restoration and the adaptation of an organism in ontogenesis to environmental conditions. Qualitative change of properties of an organism and its reactivity is related to mechanisms of a homeostasis in ontogenesis. Illness on its biological essence also represents a problem of a homeostasis, disturbance of its mechanisms and ways of restoration. On the basis of laws of a homeostasis development of effective methods of hygiene and rational therapy is developed.

Theme 4. Comparative anatomy of vertebrates

Plan:

1. Medical significance of knowledge on evolution of organ systems.
2. Evolution of skin coverings.
3. Evolution of skeleton. Changes in skeleton in process of anthropogenesis.
4. Evolution of brain.
5. Evolution of digestion organs.
6. Evolution of respiratory system.
7. Evolution of circulatory system.
8. Evolution of excretory and reproductive systems. Relation of excretory and reproductive systems.
9. Evolution of endocrine system.

1. Medical significance of knowledge on evolution of organ systems

The rather — anatomic data allow to track consecutive transformations of one and total body during its historical development and to understand mainstreams of evolutionary process.

Phylogenesis each system it is usually considered separately, but it is not necessary to forget thus, that an organism — a single whole. A goal of the anatomic analysis is the correct representation of evolution of organisms as a whole.

2. Evolution of skin coverings

Skin coverings of non-chordate animals are formed ectoderm and its derivatives. Evolution went from vibrating epithelium (turbellarian worms) to flat epithelium (flat, round, and annelid worms). In epidermis it is usual dispersed monocellular and multicellular glands which can be immersed in subject tissues, keeping in epidermis the excretory channel (skin glands of annelid worms, molluscs; salivary, arachnoid, poisonous, odorous glands of arthropods).

Connective tissue of skin at non-chordate animals is expressed badly (exception - echinoderms).

Skin coverings of chordate animals are formed by two components: epidermis of ectodermal origins and derma of mesodermal origins.

Evolution of integuments at chordate went on a way:

1) Transition from single-layered epithelium to multilayered;

2) Changes of a ratio between layers of skin towards the greater development of derma.

At anamniotic animal the structure of skin is characterized by the following features: — epidermis multilayered with a plenty of the mucous cells functioning as monocelled glands; — derma with dense lines of collagenic and elastic fibres, settling down correct alternating layers — longitudinal and vertical.

At amniotes in connection with an exit on land is observed the replacement mucous epithelium by a dry keratinizing cover. This transformation was the important adaptation during their evolution and moving on land.

Epidermis of amniotes shares on two layers: Malpighian layer and keratinizing. At reptiles and birds, as against mammal, in skin are absent glands (except for a small amount of special purpose glands — femoral glands of lizards, musky gland of the crocodile, oil gland of birds). At the mammal skin, on the contrary, is very rich by glands — sudoriferous, grease, lacteal. Due to a keratinizing layer of amniotes its derivatives — keratinizing plate, scales, feathers, claws, nails are formed.

Speaking about derivatives of skin chordate, it is necessary to remember, that scales of fishes are bone origins, instead of keratinizing.

3. Evolution of skeleton. Changes in skeleton in process of anthropogenesis

At non-chordate animals, the true skeleton are not present also its function can carry out various formations both ectodermal and entodermal origins, sometimes - mesodermal origin.

At chordate animals for the first time there is an axial skeleton (chord) and at vertebrate animals it is differentiated on three parts: an axial skeleton, a skeleton of a head, and a skeleton of limbs.

The axial skeleton during evolutionary development undergoes a number of changes which carry out different parts of a body. These changes can be shown to two basic tendencies:

— strengthening of an axial skeleton which is expressed in replacement during evolution of a chord by a cartilaginous skeleton and the subsequent replacement of cartilaginous skeleton by a bone skeleton;

— a differentiation of an axial skeleton on parts (in fishes — trunk and tail skeleton; in amphibious — cervical, trunk, sacral, and tail skeleton; in reptiles — cervical, chest, lumbar, sacral, and tail skeleton, etc.).

In process of anthropogenesis it is necessary to relate to characteristic changes of an axial skeleton:

— formation of spinal curvatures in connection with orthograde;

— change of the form of a thorax — flattening in dorsoventral direction and widening in lateral direction.

The skull skeleton is consist of two parts: a brain skull or neurocranium serving as a receptacle for a brain; and a visceral skull giving a support to organs of breath of the lover vertebrates.

Formation of a brain skull is due to merging of three pairs the cartilages pawned in a forward part of a chord — parachordal, trabecular, and ophthalmic.

The visceral skeleton is pawned as the device strengthening branchiate system, seizing a forward part of a digestive tube and is differentiated on a maxillary arch (for capture of food), a hypoglossal arch (for an attachment to a cranium) and branchiate petals.

The visceral skeleton is well advanced only in sharks. At land vertebrates it is reduced: the top part of a maxillary arch grows together with a bottom of a cranium, of a hypoglossal arch are formed bones of an internal ear, and the rests of branchiate arches turn to cartilages of a throat and a skeleton of language.

The facial skeleton is new formation.

In process of anthropogenesis the skull has undergone the next changes:

— intensive development of neurocranium;

— change of parameters — higher, instead of flattened;

— change of a ratio between facial and brain parts in towards reductions of facial;

— chin formation in connection with development of speech.

Appendicular skeleton. Distinguish pair and unpaired limbs (fins — back and tail). The skeleton of pair limbs will consist of zones which serve as a support for free limbs.

In a basis of a structure of limbs land vertebrates the uniform scheme lays. It is common for upper and lower limbs. Three basic bones of a shoulder girdle and pelvic girdle, and bones of free limbs:

— scapula — ilium;

— coracoid bone — ischial bone;

— procoracoid bone — pubic bone;

— humeral bone — femoral bone;

— radial and ulnar bones — fibula and tibia;

— hand bones — foot bones.

Changes of appendicular skeleton during anthropogenesis:

— expansion of pelvis that results of displacement of the centre of gravity;

— opposition of the big finger of a hand;

— development of the foot arch.

Inherited defects of skeletal system to take one of the first places: — defects of growth of tubular bones; — imperfect bone formation (often crises in result of cortical shell thinning of a tubular bone, spongy substance thinning); — aplasia of coccygeal vertebra or/and lumbar spine; — increase in vertebra number in lumbar and sacral parts; — doubling a lumbosacral part; — flattening of vertebras, union of vertebras; — absence of bone union handles with body of V lumbar vertebra (spondylolysis); — union (inseparability) of vertebras that is more often in a cervical part; — aplasia of ribs; — nonclosure (aplasia) of vertebras handles with aplasia of spinous process of vertebras — spina bifida; — additional ribs (usually cervical) as rudiments; — union of ribs among themselves or a lowerbone; — syndactyly — an incomplete reduction of interdigital space in process of embryogenesis; — polydactyly; — olygodactyly.

4. Evolution of brain

Formation of a brain at all vertebrates begins with formation in the anterior part of a nervous tube of three buds or brain vesicles: forebrain, midbrain, and hindbrain. Further the forebrain vesicle shares cross-section constriction on two parts. First of them forms a anterior part of a brain or telencephalon which at the majority vertebrates forms so-called cerebral hemisphere. From a second part of a forebrain vesicle a diencephalon develops. The midbrain vesicle does not share and will entirely be transformed to an mesencephalon. The hindbrain vesicle is

also divided into two parts: in its anterior part the metencephalon or a cerebellum is formed, and the medulla oblongata which without sharp border passes in a spinal cord is formed of a posterior part.

During formation of five brain vesicles the cavity of a nervous tube forms a number of expansions which carry the name brain ventricles. The cavity of a telencephalon carries two lateral ventricles, diencephalon — the third ventricle, an medulla oblongata the fourth ventricle, in mesencephalon is a sylvian aqueduct that connects 3-rd and 4-th ventricles. The metencephalon has no a cavity.

In each part of a brain distinguish a roof, or a cloak and a bottom, or the basis. The roof is made with the parts of a brain laying above ventricles, and a bottom — under ventricles.

The substance of a brain is non-uniform. Dark sites — grey substance, light — white substance. White substance — a clump of nervous cells with myelin sheath (it is a lot of lipids which give albesent painting). Grey substance — a clump of nervous cells between elements of neuroglia. The layer of grey substance on a surface of a roof of any part of a brain has the name of a cortex.

Thus, in all vertebrates the brain will consist of five parts located in the same sequence. However, a degree of their development is different in representatives of various animal classes. These distinctions are caused by phylogenesis. There are three types of a brain: ichtiopsydic, zauropsydic and mammalian.

ICHTIOPSYDIC TYPE. Fishes and amphibians have ichtiopsydic type of brain. The brain of fishes has a primitive structure that is expressed in the insignificant sizes of a brain in the whole and weak development of forebrain. The telencephalon is small and is not divided into hemispheres. A roof of a telencephalon is thin. The great bulk of it is formed with a bottom where nervous cells form two clumps — striped bodies. Two olfactory buds depart from a telencephalon. In essence, a telencephalon of fishes is only the olfactory center.

The diencephalon of fishes is covered by telencephalon and mesencephalon. Its roof has a outgrowth — epiphysis, and a bottom has funnel with adjoining to it a hypophysis and optic nerves.

An mesencephalon — the most advanced part of a brain of fishes. It is the visual center of fishes, will consist of two visual lobes. On a surface of a roof there is a layer of grey substances (cortex). It is the supreme part of a brain of fishes as here there come signals from all stimulus and reciprocal pulses are here again developed. The cerebellum of fishes is advanced well, as movements of fishes are variegated.

The medulla oblongata in fishes have strongly advanced visceral lobes, is connected to strong development of organs of taste.

The brain of amphibians has a number of progressive changes that is related to transition by a life on land which are expressed in increase in total amount of a brain and development of its forebrain. Simultaneously there is a division of a telencephalon into two hemispheres. The roof of a telencephalon will consist of a nervous tissue. In the basis of a telencephalon the striate bodies lay. Olfactory lobes are sharply separated from hemispheres. The telencephalonon is only olfactory center.

The diencephalon is well seen from above. The roof of it forms an appendage — epiphysis, and a bottom — a hypophysis.

The mesencephalon is less in the sizes, than at fishes. Hemispheres of the mesencephalon are well expressed and covered with a cortex. It is leading part of CNS since here there is an analysis of the received information and development of reciprocal pulses. It keeps value of the visual center.

The cerebellum is advanced poorly and looks like the small cross-section platen at a first line of rhomboid fossa of medulla oblongata. Weak development of a cerebellum corresponds to simple movements of amphibians.

ZAUROPSYDIC TYPE. To zauropsydic to type of a brain carry a brain of reptiles and birds.

At reptiles the further increase in volume of a brain is observed. The telencephalon becomes the largest part due to development of striped organs, i.e. the basis. The roof (cloak) remains thin. On a surface of a roof for the first time during evolution there are nervous cells or a cortex which has a primitive structure (three-layer) and has received the name of an ancient cortex. The telencephalon ceases to be only the olfactory center. It becomes leading part of CNS.

The diencephalon is interesting by a structure of dorsal appendage (parietal body or a parietal eye) which achieves the best development in lizards, getting structure and function of body of sight.

The mesencephalon decreases in sizes, loses the value of a leading part, its role as visual center decreases.

The cerebellum is advanced rather better, than at amphibians.

For a brain of birds typically further increase in its total volume and the huge size of the telencephalon covering with self all other parts, except for a cerebellum. The increase in a telencephalon which, as well as at reptiles, is a leading part of a brain, occurs due to a bottom where striped organs strongly develop. The roof of a telencephalon is advanced poorly, has small thickness. The cortex does not receive the further development, even is exposed to return development — disappears lateral part of a cortex.

The diencephalon is small, epiphysis is advanced poorly, the hypophysis is expressed well.

On the average a brain visual lobes since sight plays the leading part in a life of birds are advanced.

The cerebellum achieves the huge sizes, has a complex structure. In it distinguish an average part and lateral ribs. Development of a cerebellum is related to flight.

MAMMALIAN TYPE. Evolution of a brain has gone in a direction of development of a roof of a telencephalon and hemispheres. The increase in the size of a telencephalon occurs due to a roof, instead of a bottom, as at birds. On all surface of a roof there is a layer of grey substance — a cortex. A mammal cortex is not homologous to an ancient cortex of reptiles, carrying out a role of the olfactory center. It is completely new structure arising during evolution of nervous

system. At the lowest mammals a surface of a cortex smooth, at the supreme mammals — it forms the numerous crinkles sharply increasing its surface. The cortex gets value of a leading part of a brain that is characteristic for mammalian brain. Olfactory lobes are strongly advanced, since at many mammals are a sense organ.

The diencephalon has characteristic appendages — epiphysis and hypophysis. The mesencephalon is reduced in sizes. Its roof, except for longitudinal furrow, has also cross-section. Therefore instead of two hemispheres (visual lobes) it is formed four tuber. Anterior are connected to visual receptors, and posterior — with acoustical.

The cerebellum progressively develops, that is expressed in sharp increase in the sizes of body and its complex external and internal structure.

In an medulla oblongata the way of the nervous fibres coming to a cerebellum, and on the bottom surface — longitudinal platens (pyramids) on each side stands apart.

5. Evolution of digestion organs

The general directions of evolution of digestion organs of vertebrates:

1. Differentiation of an intestinal tube.
2. Lengthening of intestine.
3. Increasing of intestinal absorption.
4. Development and complication of digestive glands.
5. Improving of mandibular apparatus.
6. Differentiation of teeth.

The digestive path begins a mouth which roof is formed by the basis of a skull. At the lowest chordate a weak differentiation of a digestive tube and hepatic outgrowth are characteristics. The digestive path of fishes in comparison with the lowest chordate animals is differentiated: a mouth, a pharynx with gill-slit, a stomach, thin and thick intestines with folds and villi. There are a pancreas, a liver, a bilious vesicle, a sacciform stomach, a jaw, and teeth.

At amphibians — the mouth is not separated from pharynx. Dental system is homodont. Appear salivary glands for wetting food, chemical action do not render. In a mouth-pharyngeal cavity choanae, eustachian tubes, and a guttural crack are open. A cavity goes on a gullet passing in a stomach. The intestine is divided on small and large parts, opening in a cloaca. There are a liver, a pancreas, and fine single-row teeth.

At reptiles — the mouth cavity is detached from pharynx. Dental system is homodont. There are hypoglossal, lip, and dental glands. At snakes dental glands are transformed in poisonous glands. Rudiments of the secondary palate are lateral folds of the top jaw. A structure pharynx, a gullet, a stomach have no essential difference from those at amphibians. The bud of cecum is formed on border of small and large intestines. The length of intestines increases, the cloaca is present.

At mammal — the digestive path achieves the greatest differentiation. The external part of digestive system is formed on sides of pharynx. There are 4 branchiate pharyngeal pockets. From I is develops a guttural duct, an average ear; from II — a tonsillar sinus; from III–IV — thymus and thyroid glands. The mouth is separated by the hard palate which proceeds in soft palate, separating a mouth cavity from pharynx. Dental system is heterodont. The number of teeth is reduced.

Oral glands achieve the greatest development. There are fine mucous and salivary glands. Rhinopharyngeal tubes, eustachian tubes, and larynx are open in a pharynx. There is variety of stomach glands. The intestines are differentiated on parts — a duodenum, small intestine, large intestine, cecum, and rectum.

The defects of digestion organs meet frequency 3,4 on 100 openings. There are athresy of esophagus, macro and microesophagus, gastroptosis (lower positioning of stomach), Merckell's diverticulum, situs viscerus inversum, neck fistulas.

6. Evolution of respiratory system

The respiratory system of fishes is represented by gills. In evolution, the number of branchiate partitions is reduced, but the number of branchiate petals increases. Gills are formed of embolies pharynx as branchiate bags (at fishes of 5 pairs) and then partitions with petals.

At amphibious sacciform lungs are similar to air bladder of lobbe-finned fishes. These are two bags, connected with the dense guttural-tracheal chamber. Walls of bags are smooth, thin, with small partitions. Airways are poorly differentiated, as the basic organ of breath is the skin.

At reptiles, the skin is not participating in breath. Lungs have cell structure and therefore they have larger respiratory surface. Progressive changes in airways: the reptilians have upper (nose cavity) and lower (larynx, trachea, bronchi) respiratory pathways. Trachea are formed cartilaginous rings, being divided, it gives two bronchial tubes.

Birds have a spongy lung penetrated with bronchi.

Mammals have a treelike branching of bronchi. On the ends of bronchi, alveoluses is situated. The diaphragm divides a cavity of a body on chest and abdomen. A lung surface of mammals in 50–100 times more than body surface, i.e. the basic directions of evolution it is changing of gill breathing to lung breathing, increase the respiratory surface, and isolation of airways.

Defects of human respiratory system are preserving of gill's slits, athresia of trachea, tracheal-esophagus fistula, agenesia (absence) and hypoplasia (underdevelopment) of lung or its lobe, additional lobes or lung, lung's cyst.

7. Evolution of circulatory system

Sponges, coelenterates, flat and round worms have not the blood system. Delivery of oxygen and nutrients is carried out due to diffusion of tissue liquids at presence of the ramified cavities.

Closed blood system at non-chordate animals appears for the first time at annelid worms as the dorsal and ventral vessels connected among themselves by several ring vessels, going around of intestines. Movement of blood occurs on a dorsal vessel to the head end and on ventral vessel to back, due to a pulsation dorsal and ring vessels.

Arthropods and molluscs system open-ended, but have arteries and veins.

The blood system vertebrates is constructed basically on the same type, as blood system of the lowest chordate and even annelid worms. Its basis is made with the ventral and dorsal vessels connected by anastomoses in walls of a gut and walls of a body.

The basic tendencies in evolution of blood system of vertebrates:

— isolation of a muscular vessel — a heart;

— differentiation of vessels on blood and lymphatic;

— occurrence of 2-nd circle of blood circulation;

— development of adaptations for differentiation of arterial and venous blood stream.

At the lowest chordate and lancelet the blood system closed also has one circle of blood circulation. The role of heart carries out a pulsing vessel — a ventral aorta. In a ventral aorta venous blood from organs acts and goes to branchiate arteries (150 pairs) where is oxidized and there from already oxidized arterial blood acts in pair roots of a dorsal aorta. The last, merging, form a dorsal aorta which carries blood on all body, breaking up on arteries and capillaries. As a result of gas exchange blood becomes venous. Venous blood from fore-part acts in paired cardial veins, and from dorsal - in dorsal cardial veins. At a level of a ventral aorta they incorporate in cardinal sinus running into a ventral aorta. Besides from internal organs (intestines) venous blood gathers in intestinal vein which enters into a liver under the name portal vein of a liver and there branches on huge quantity of venous capillaries. From here blood again gathers in a hepatic vein and runs into a ventral aorta.

Presence of a uniform circle of blood circulation also is typical of the lowest vertebrates (fishes). Their blood system almost completely repeats the scheme of lancelet blood system.

Differences of progressive character are:

— occurrence of the two-chambered heart consisting of an atrium and ventricle; heart of fishes contains only venous blood which acts from organs on venous vessels in a venous sinus, behind that an atrium, ventricle and on a ventral aorta in branchiate arteries where is oxidized;

— branchiate arteries, as differ from lancelet vessels, break up to capillaries and by that increase a respiratory surface;

— except for portal systems of a liver, fishes have portal a system of kidneys; it is formed thanks to cardial veins which in kidneys break up to a net of capillaries.

In land vertebrates, both venous and arterial blood is poured in heart, due to formation of 2-nd pulmonary blood flow. Therefore in amphibians and reptiles are the mixed streams of blood, and only in birds and mammals, due to formation of four-chamber heart, streams of blood are divided. For land vertebrates it is typical that the system of branchiate vessels with capillaries is replaced by circles of an aorta. Further cardial veins are gradually replaced dorsal cava veins. Reptiles and mammal from cardial veins still have secondary vessels. Venous vessels of a head are united in anterior cava veins. Due to change to four-footness vessels of limbs progressively develop. Portal vein of kidneys is gradually replaced by intrarenal with a filtration from blood of products of disintegration. In mammals the portal systems of kidneys are not present.

In embryogenesis, heart is originated from strait tube which grows and curves further to S-shape tube. The dorsal thin-walled half of rudiment is shifted on the dorsal side, moves anterior and forms an atrium. The anterior part remains on the ventral side and forms ventricle with wide muscular wall. The part of a tube behind an atrium forms a venous sinus (bosom), ahead from ventricle at the lowest vertebrates the muscular tube — an arterial cone develops.

In front of heart the unpaired ventral aorta is develops from which pair vessels (arterial arches) departs on branchiate partitions. These arches cover to a pharynx and incorporate on its dorsal side in a dorsal aorta, giving in front to head the carotid arteries. The number of arterial arches in vertebrates is insignificant and corresponds to number visceral arches. In cyclostomes from 5 up to 16 pairs, at fishes — 6–7 pairs, at land vertebrates are pawned 6 pairs arterial arches.

First two pairs at all vertebrates are exposed to a partial reduction, are kept as maxillary and hypoglossal arteries.

At land vertebrates 3–6 arterial arches are under a number of transformations. The third pair arches lose touch with a dorsal aorta and passes in carotids. The fourth pair arches receive significant development and gives arches (or to roots) of dorsal aorta. At amphibians and reptiles these arches are advanced symmetrically. At birds the left arch will atrophy and kept in an adult condition only right arch.

In mammals the left arch of aorta is kept only. The fifth pair arches are reduced; only at tailed amphibians is kept as an insignificant channel. The sixth pair arches give pulmonary arteries and loses touch with arch of aorta. Embryonic contact of pulmonary arteries with arch of aorta have name Botallo's duct and is kept in an adult condition at tailed amphibians, some reptiles, sometimes in human.

Except for own blood system, vertebrates have also the open-ended lymphatic system consisting of vessels and glands. Branchings of lymphatic vessels are connected with intercellular spaces. The lymphatic system is addition to blood in maintenance of metabolism.

DEFECTS OF BLOOD SYSTEM. Inherited heart diseases most frequently consist in defects (nonclosure) interprecordial and interventricular septum that results to occurrence 3-x chambers and is very rare 2-x chambers heart.

From vascular infringements, the deviations in development of an aorta and the large vessels being derivatives of branchiate arches have the greatest clinical value.

Most frequently (from 6 up to 32 % on a data of different authors) meet nonclosure of Botallo's duct (distal part of the left artery of VI branchiate arch connecting pulmonary artery with an arch of an aorta). In the embryonic period when lung do not function, such connection is necessary. At adults it results in disorders.

Sometimes the human embryo does not have reduction of the right artery of IV branchiate arch and a root of aorta on the right. In result two arches of an aorta covering a gullet and a trachea in «arterial circle» which with the years is gradually narrowed develop, that results in infringement of swallowing and demands surgical intervention.

In human embryogenesis from ventricle one common arterial trunk leaves only, which further is divided by a spiral partition on pulmonary an artery and an aorta. In 2,1 % of cases the partition does not develop in postembryonic period that results in receipt in blood system of the mixed blood. Change of a direction of the partition dividing an aorta and pulmonary an artery is possible. Last can grow not on a spiral and is direct. In this case the aorta will depart from right ventricle, and pulmonary artery — from left (it is transposition of aorta and pulmonary artery).

In human, Fallo tetrad is considered one of the hardest inherited heart diseases and vessels. It is characterized by pulmonary artery stenosis, aorta dextraposition, defect in interventricular septa, and hypertrophy of right ventricle.

Other human developmental anomalies of heart and vessels are possible also.

8. Evolution of excretory and reproductive systems. Relation of excretory and reproductive systems

In the lowest multicellular (sponges, coelenterates), the isolated excretory organs are absent. In flat and round worms appears special excretory system of protonephridic type. In annelid worms, secretory system is metanephridic type which is not changed in arthropods.

Evolution of excretory system in chordates is included changes from nephridium in the lowest chordate to special organs — to the kidneys consisting of the big number of excretory tubules, united by the common excretory duct and consecutive change of three tubule types.

The prekidney or protonephros has the most primitive structure. It is found in all vertebrates in early stages of embryonic period, but short time does not function almost, the basic excretory organs during all life there is a secondary kidney or metanephros.

The primary kidney or mesonephros functions at the lowest vertebrates — fishes, amphibians — during all life. In the land vertebrates — reptiles, birds, mammals it is kept only in the embryonic period.

In embryonic period of land vertebrates, except for prekidney and primary kidney, the third anlage in the segments of a body laying behind primary kidney, metanephros or a secondary kidney is formed still.

Nephron of secondary kidney has no funnel. Therefore connection with coelome is completely lost. Nephron begins directly with Bowman's capsule surrounding vascular glomerule, otherwise, with malpighian corpuscle. Vascular glomerules here are larger than in mesonephros. From everyone initial nephron by budding it is formed a few secondary nephrons, as a result the quantity of nephrons grows and also a general secretory surface increases.

Excretory system of vertebrates has close connection with reproductive system, which is caused by it phylogenesis.

In the majority of vertebrates, gonads are formed as paired folds of mesonephros. First, male and female gonads have an identical structure, there is a gland specialization later and there is a connection with various parts of excretory system for each sex. In females of anamniotic animals, ureter of prekidneys (Muller's duct) is transformed in oviduct, and products of dissimilation are deduced independently through a primary kidney and it ureter (Wolffian duct). Simultaneously there is a connection between testicle and a primary kidney. Them epithelium, covering a wall of a cavity of a body are formed strands, connecting ducts a primary kidney and testicular tubules. Male's sex cells through testicular tubules get in a kidney and ureter (Wolffian duct) and bring out. Ureter therefore has name a urogenital channel.

In females of amniotes, as well as in anamniotic animals, oviduct develops from the remains of a prekidney and from ureter (Muller's duct). In males of amniotes, ureter is completely reduced. Ducts of anterior part of a primary kidney (Wolffian duct) turn in spermaduct. Because of formation of a secondary kidney, it loses function of urinary excretion, as distinct from males of anamniotic animals.

In oviduct of reptiles and birds, the differentiation on parts is observed. Anterior part of oviduct in turtles, crocodiles, and birds produces a protein. The dorsal part of oviduct produces skinny (at reptiles) or calcareous (at birds) shell.

In result of zoogony in mammals, the differentiation of oviducts does not become more complex. Oviducts are subdivided into 3 parts: Fallopian tubes, a uterus and a vagina. In placentary animals there is unity of distal parts of oviduct in different levels. In result the double uterus (rodents), a bicorn uterus (carnivorous animal, artiodactyles) or simply a uterus (monkey, human, and some night bats) can develop.

Human has different anomalies of uterus and vagina corresponding to phylogenetic stages of change of this organs during evolution. These anomalies, as a rule, are connected to abnormal unity of Muller's ducts. Most frequently there is a bicorn uterus, sometimes — double uterus. Bifurcation of a uterus bottom, cryptorchism — testicle is not omitted in scrotum, hermaphroditism.

9. Evolution of endocrine system

1. Glands of a brain origin: — the bottom appendage of a brain — a hypophysis; — the top appendage — epiphysis.

2. Branchial glands, develop from epithelium of a head gut, in the field of the branchiate apparatus as outgrowth of ventral walls of pharynx: — thyroid gland; — parathyroid glands; — thymus.

Thymus is anlage at the end of 1-st month of intra-uterine development in epithelium of pharyngeal gut in the field of III, IV pairs of branchiate pockets as strands of multilayered epithelium.

Anlage of a hypophysis is on 4–5-st week of ontogenesis. From epithelium the top part of a mouth of a germ, the pocket (outgrowth) the basis of a brain going aside is formed.

Epiphysis arises as outgrowth of roof of diencephalon.

Thyroid arises as outgrowth of ventral walls of pharynx between I and II pairs of branchiate pockets. Epithelial strand grows and develops on 2 parts. Parathyroid glands arise from epithelium of III and IV pairs of branchiate pockets.

Adrenal glands arise as coelome thickenings: the cortex arise from epithelium on both sides of mesentery, the medula has a neural origin (neuroblasts of sympathetic ganglia) and develops as sympathetic ganglion.

POPULATION-SPECIES LIFE ORGANIZATION LEVEL

Theme 5. Population and species levels of life organization

Plan:

1. Population and its characteristics.
2. Human population structure.
3. Action of evolutionary factors on human populations. Genetic processes in populations.
4. Genetic polymorphism of a human population.
5. Problem of a genetic load and frequency of hereditary diseases.

1. Population and its characteristics

Species are submitted by populations. Population is a group of individuals of one species for a long time occupying the certain territory inside which it is carried out panmixia and individuals isolated from the other groups of individuals.

The population represents ecological, morphophysiological and genetic unity of individuals of a species. It is indivisible unit in evolution or independent evolutionary structure. The population represents elementary evolutionary unit.

Evolve not individuals but groups of individuals — populations. It is smallest of the groups, capable to independent evolution. Populations are characterized by ecological and genetic characteristics. Ecological characteristics: size of occupied territory, density, number of individuals, age and sex structure, dynamic of population.

The genetic characteristic of a population is a gene pool (a full set of genes of a population). The gene pool of population possesses:

1) Unity (The unity of a gene pool of a population consists in an attempt to, a species as the closed system, keep the uniformity on hereditary properties);

2) Genetic polymorphism (Heterogeneity of the natural populations rich in mutations. At absence of pressure of external factors this heterogeneity is in the certain balance.);

3) Maintain equilibrium of genes in a population.

A population includes individuals with dominant and with recessive traits which are not taking place under the control of natural selection. However dominant allele does not replace recessive allele. It is known as Hardy-Weinberg law. For an ideal population, in which a big number of individuals, free mating (panmixia), absence of mutations, migrations, and natural selection.

In an ideal population a ratio of dominant homozygotes «AA», heterozygotes «Aa» and recessive homozygotes «aa» remain to constants:

If frequency of a gene «A» is equal p, and frequency of a gene «a» is equal q, their concentration is equal Ap + aq = 1. The combination of gametes gives distribution of genotypes under the equation $(Ap + aq)\ (Ap + aq) = (Ap + aq)^2 = 1$

Values p^2, 2pq and q^2 — remain constants. This clarifies the fact that individuals with recessive traits are kept with dominant. The ratio of homozygotes and heterozygotes does not vary at different variants of reciprocal crossings.

♂ \ ♀	Ap (0,5)	aq (0,5)
Ap (0,5)	AA p^2 0,25	Aa pq 0,25
aq (0,5)	Aa pq 0,25	aa q^2 0,25

Hardy-Weinberg law indicate that in a big population with panmixia where there is no selection, mutations, migrations, the constancy of distribution homozygotes and heterozygotes is observed. Knowing frequency of a recessive gene, it is possible to determine under the equation frequency of dominant allele and vice versa.

2. Human population structure

In human genetics, a population is group of people occupying certain territory and freely marrying, on number they are big and small. Large human populations will consist not of one, and the several anthropological groups distinguished by origin and spread out in the big territories. Such populations include more than 4 thousand person. The human population is not panmictic population, and represents huge set of the numerous closed groups. In real human populations the law of distribution of genes under Hardy-Weinberg equation appears limited; because of the evolutionary factors have result in change of a gene pool.

3. Action of evolutionary factors on human populations. Genetic processes in populations

Influence of elementary evolutionary factors on change of a gene pool of human populations is reduced to action of mutation, migrations (isolation), gene drift, and natural selection.

Mutational process is the constant elementary evolutionary factor; it provides variability of a population on individual genes. Mutations are an elementary evolutionary material. Frequency of occurrence of separate spontaneous mutations is within the limits of 10^{-4}–10^{-8}. Pressure of mutational process is defined by change of allele frequency comparing to another. Mutational process constantly supports heterogeneity of a population. But quantity of heterozygotes «Aa» is essential exceed the quantity homozygotes «aa», as the majority of pathological mutations is recessive. Taking into account a number of genes in human (about 32000), up to 10 % of its gametes carry mutant genes. Dominant mutations are expressed in the first generation and treated to action of natural selection at once. Recessive mutations expressed only in a homozygous condition. Accumulation of mutant alleles promotes combinative diversity, heterogeneity of a population. Average value of human heterozygosity is 6,7 %, in averages in vertebrates — 6,0 %. Richness of a population by recessive alleles reduces fitness of individuals and refers to as a genetic load. Presence of genetic load in human populations is explained by occurrence of 5 % of progeny with genetic defects.

Isolation is appearance of any barriers limiting migration. It promotes divergence - to differentiation of populations into separate groups and change of frequencies of genotypes. In human populations, ecology-ethological isolation is more essential. It includes religious, moral-ethical restrictions of marriages, class, clan, property, professional restrictions, and etc. Isolation of populations result in related marriages (inbreeding) and gene drift.

Gene drift is a random fluctuation of allele frequencies in small populations. It results in change of genetic structure of populations as a result of any reasons. Drift of genes is shown in two kinds: in space and in time. Drift of genes is promoted by the isolated population size: reduction of number is raises random fluctuation of allele frequency of this or that gene. Random growth of frequency of one any mutation is usually caused by primary reproduction in isolated populations. This phenomenon refers to «founder effect». It arises when some families create a new population in new territory. In it the high degree of marriage isolation that promotes fastening of one alleles and elimination others is supported. Consequences of «founder effect» are non-uniform distribution of hereditary diseases of human populations in the Earth.

Natural selection carries out function of stabilization of a gene pool, and also maintenance of a hereditary variety in human populations. The basic action of natural selection is preservation of individuals with useful and loss with harmful traits, and also differential reproduction (the contribution of an individual to a gene

pool of a population at selective duplication). Frequency of some genes in a human population varies under influence of selection. As confirmation of action of selection factors of finding-out of the reasons of spontaneous abortions serve in human populations and perinatal mortality rate in human. So more than 42 % of spontaneous abortions occur owing to lethal effect of chromosomal anomalies. Perinatal mortality rate in 6,2 % of cases is caused by a chromosomal pathology. Among it is dead the given birth 6 % have lethal chromosomal anomalies. Chromosomal anomalies spontaneous abortions during 2–4 weeks of the first trimester of pregnancy of 70 %, in the second — cause 30 %, in the third — 4 %.

Action of selection provides ability of an organism to bring the contribution to genetic structure of the future generation. It is carried out by two ways:

1) Selection on survival rate;

2) Use of the genetic factors influencing on reproduction. Change in gene pools of populations always occurs under influence of a complex of evolutionary factors. The great value has a ratio of selection and pressure of mutations. If given allele it is supported by selection, then carriers of it allele as more adapted, are characterized by primary reproduction. In result selection supersedes all others alleles. Mutations counteract selection, therefore concentration allele remains in balance.

Natural selection in human populations affect as against homozygotes (dominant and recessive), and heterozygotes.

The special situation develops, when selection increase the survival rate of heterozygotic individuals at full loss negative homozygous forms till the period of reproduction. This form of selection has received the name balanced selection. Thus it is typical, that heterozygotes (Aa) are more viable, than each of homozygotes (AA, aa) separately. The phenomenon of balanced selection can be considered on an example sickle cell anemia in human. Individuals, homozygous on gene $Hв^S$ ($Hв^S$ $Hв^S$), suffer from a malaria, while heterozygotes ($Hв^A$ $Hв^S$) are quite healthy though them erythrocytes contain both $Hв^A$ and $Hв^S$. Frequency such heterozygotes in the Western Africa makes about 40 %, whereas among Afro-American — only 9%. Owners of genotype $Hв^A$ $Hв^S$ are steady against the activator of a tropical fever that is especially important for children in the age of from 6 months till 5 years. Children have the passive immunity received from mother, and after 5 years they develop active immunity against the parasite. At stability against a malaria heterozygotes $Hв^A$ $Hв^S$ it is expected, that frequency of gene $Hв^S$ should be higher in the most malarial areas of the world, that actually indeed. Presence of $Hв^S$ among the Afro-American is evidence of their origin from areas of high concentration heterozygotes.

4. Genetic polymorphism of a human population

Polymorphism is any variety of forms of the same species of organisms. Polymorphism is the most universal phenomenon of a life. J. B. S. Haldane has named the person the most polymorphic species on the Earth. In human practi-

cally all traits are polymorphic (color of eyes, hair, the form of a nose and a skull, blood group, and etc.). Polymorphism can be result of discrete intrapopulation variability of hereditary character, can be determined by norm of reaction. Genetic polymorphism arises due to fixation in populations of different mutations. Therefore it classify on genic, chromosomal and genomic.

Genic polymorphism is caused by presence of two or more alleles. For example, ability of people to feel taste of phenylurea is defined by dominant allele (TT, Tt), recessive homozygotes (tt) — do not feel. Inheritance of blood groups is defined by three alleles — A, B, O. Chromosomal polymorphism is concerned with chromosomal aberrations, and genomic — with change of chromosome sets in karyotype (aneuploidy).

Polymorphic genetic systems by their supposed nature include three groups: transitional, neutral, balanced.

Transitional polymorphism results from change of genetic structure of a population on an examined locus. One new allele in changed conditions of environment becomes more favourable and replaces «wild». Such polymorphism cannot be stable because of natural selection. Sooner or later «wild» allele will be replacев by new and the population will be monomorphic on «new» allele. Speed of such process cannot be noticed during a life of one generation. At neutral polymorphism because of random stochastic processes (gene drift, founder effect) occurs random change of allele frequencies. For example, occurrence of distinctions in nonadaptive traits (adherent or free earlap). Changes of allele frequencies to these traits it is carried out on the mechanism of drift of genes, than and the neutral type of their evolution is explained.

Balanced polymorphism is the polymorphism caused by complex balance between selection against both homozygotes for the benefit of heterozygotes. Recessive genotype is exposed to stronger elimination, than dominant. Distinctions in elimination speed of two these genotypes support constant, stable equilibrium existence in a population of both alleles with own frequency for everyone. It stability of such polymorphism also speaks. The systems of the balanced polymorphism connected to selection on a malaria — abnormal hemoglobin, thalassemia, insufficiency of glucose-6-phosphate dehydrogenase in erythrocytes are most full investigated. Stability of these polymorphisms disappears as a result of malaria decrease. Balanced polymorphism turns in transitional. However for decrease in allele frequencies already completely pathological genes as there is no need in protection against a malaria, some tens generations should pass these.

The big number of polymorphic systems open to the present time in human with significant number alleles results to that practically each person possesses a unique set of genes that allows to speak about biochemical and immunological individualities of the person. It is of great importance in medical practice, is especial in medico-legal examination.

Usually hereditary predisposition has multifactor character and is defined by set of genes with prevailing effect of one or several genes. For an establishment of

these genes use biochemical and immunological methods of human genetics. Now it is described more than 130 polymorphic loci coding polymorphic proteins. These are: enzymes, antigenes, transport proteins, etc. Obviously, that about one third of structural genes of the person (i.e. not less than 17,000) should have multiple alleles, i.e. to code polymorphic products of a metabolism. In such wide range for genetic recombination the opportunity of occurrence of individuals with adverse combinations of the genes determining hereditary predisposition to diseases is incorporated. Taking into account genetic polymorphism, for concrete definition of the genetic factor of predisposition to illness compare frequency of occurrence of those or other polymorphic proteins (antigenes) at the given illness and in control group of healthy people. There are numerous data on associations of illnesses with immunological markers — antigenes of blood groups ABO, systems HLA, with blood globins and with secretion. In particular, predisposition of people with II group (A) blood to a cancer of a stomach, a thick gut, ovary, cervix of the uterus, to rheumatism, ischemic illness of heart, thromboembolism, etc. is established. People with 1 group of blood (O) are predisposed to diseases of a stomach and duodenal ulcer, etc.

5. Problem of a genetic load and frequency of hereditary diseases

Researches of S. S. Chetverikov, N. V. Timofeev-Resovskii, N. P. Dubinin, V. G. Dobzhanskii in the 30-th years showed a wide circulation of lethal mutations in the populations that represented opening a phenomenon of a genetic load. The genetic load can be defined as relative decrease in viability of a population in comparison with an optimum genotype.

A man submits to all same laws of mutational and population genetics, as all other organisms. For it the genetic load also is characteristic. About it indicate the facts of wide distribution in human of congenital hereditary diseases. Among them it is a lot of the diseases caused by presence of recessive genes. In this case the sick child is born from externally healthy parents. By calculations, about 100 different hereditary illnesses are present in each generation that affect about 4 % of newborns. Volume of a genetic load and its nature studied in human by the analysis of consequences from related marriages. Descendants from a marriage of relatives test on themselves influence of a genetic load as high percent of dead birth and high death rate about one year and is higher. So, on the supervision which have been carried out in France (Setter, 1958), deadborn in related marriages make from 26 up to 50 on 1000 given birth, whereas in unrelated — from 19 up to 21 on 1000 given birth. The genetic load is understood not only as the lethal mutations are passing in a homozygous condition, but also all spectrum of mutations lowering adaptive properties of individuals. In a population distinguish a genetic load of three kinds: mutational, balanced, and transitive.

The mutational load arises due to repeated mutations. Its volume is determined by frequency of mutations in all loci giving negative changes. The bal-

anced load takes place when selection in different directions operates on homozygotes and heterozygotes (an example with $Hв^S$). Transitive load arises at changes in conditions of environment when allele, earlier providing adaptive norm, becomes negative. In these conditions of frequency of both alleles — the old which has lost adaptive value, and new — are still great enough, it causes polymorphism and appreciable display of a genetic load due to old allele.

The problem of a genetic load in human has great value for modern medicine since hereditary diseases get the increasing densities in burdening of mankind by illnesses. The knowledge of genetics of congenital illnesses, degrees of richness them in populations, is necessary for geography of genes of illness for applied medicine. These problems are extremely important for anthropology, for understanding of the future biological evolution of human. The question on a genetic load gets special value in connection with problems of protection of an environment from pollution.

According to the Gomel city maternity home on 23440 childbirth in 1994 it was totaled — 133 congenital defects; from them: 54 — defect of neural tubes, 7 chromosomal anomalies (Down, Patau, Edwards). From 227 children of regional clinical hospital of Gomel it is revealed 164 persons (72 %) with intimate pathologies.

THE BIOSPHERAL LIFE ORGANIZATION LEVEL

Theme 6. The ecology. The anthropoecology

Plan:

1. The basic concepts of ecology.
2. The biological systems investigated by ecology.
3. Anthropoecology, its aims and tasks.
4. Biological and social aspects of adaptation.
5. Ecological differentiation of humankind.
6. Anthropogenous ecosystems.

1. The basic concepts of ecology

Ecology — a science studying relationships of organisms and their communities with environment, other organisms and communities. It is a science about structure and functions of wildlife which studies a life on higher organization level.

The ecology investigates three basic levels of the living matter organization:

- separate individuals and influence of environmental factors on an organism and its adaptation;
- populations and change of their number under the influence of environmental factors;
- communities, their composition, structure, and patterns of functioning.

Ecology subject are biological macrosystems: populations, communities, ecosystems, their dynamics in time and space.

Its theoretical and practical ***problem*** — to open patterns of processes, to manage them in the conditions of increasing influence of the anthropogenous factors, and to rational use of biosphere natural resources.

Ecology methods:

- field — studying of populations in a natural condition;
- experimental — the analysis of the separate facts in controllable conditions;
- biological modeling — reconstruction in artificial systems of processes of wildlife;
- mathematical modeling — use the models a predator-prey, a parasite-owner for ecological simulation.

2. The biological systems investigated by ecology

The closest relationships develop between the organisms populating a certain site of an inhabitancy.

Environment is all set of elements which operate on the individual in a place of its dwelling. Homogeneous sites of environment, for example: the forest, the field — name **a biotope.** Community of the organisms populating the biotope has name **a biocenosis.** The unity of biocenosis and biotope is called **as a biogeocenosis.**

The term is entered in 1940 by V. N. Sukachev: *«The biogeocenosis is a dynamic and stable community of plants, animals, and microorganisms which are in constant interaction and immediate contact to ingredients of atmosphere, hydrosphere and lithosphere».* It is rather stable spatially limited internally homogeneous natural system which is carrying out functionally interrelation of living organisms and environment, characterised by a certain energy condition, metabolism, and information.

As biocenosis components are in unity, the ***ecosystem*** definition was offered by A. Tensley in 1935. It is any unity including all organisms on the given site and their relationships with a physical environment in such manner that an energy stream creates certain trophic structure and species diversity. Unlike a biogeocenosis which border is limited to community limits the ecosystem has no certain border and covers space of different extent.

The element of the environment capable to make direct impact on a living organism at least on one of ontogenetic stages is called as ***an environmental factor.***

Environmental factors can be classified as follows:

- the abiotic;
- the biotic;
- the anthropogenous.

Any individual, population, and community test simultaneously influence of many factors, but only some of them are vital. Such factors are called as ***limiting***

and their absence or concentration which is lower or higher the critical levels make impossible the environment developing by organisms of a certain species.

Thanks to presence of limiting environmental factors for each biological species there is an ***optimum*** and ***limits of tolerance.***

Ability of a species inhabit different environments is expressed by magnitude of ecological valency. Species with small valency are called ***stenotopic,*** with as big valency — ***eurytopic.***

The special role in biogeocenosis belongs to food chains. Food chain consists of a number of the trophic levels which sequence corresponds to direction of energy stream.

Progressive decreasing of the assimilated energy among trophic levels corresponds with structure of ecological pyramids. By a rule of an ecological pyramid the quantity of biomass, energy and number of individuals at each subsequent level of a food chain decreases ten times in comparison with previous.

Biocenosis is the main component of biogeocenosis**.** As indicators ***of structure and functioning*** of biocenoses serve:

— A species composition;

— Number of trophic levels;

— Primary productivity;

— Intensity of an energy stream and circulation of substances.

The structure of biocenoses develops during evolution and each species evolves so that to take a certain place in a biocenosis. In a biocenosis the state of adaptiveness of species to each other or coadaptations which serves as an obligatory condition of its stability is reached.

The coadaptation condition is reached also between species-antagonists: predator — prey, owner — parasite.

In biocenoses, all possible interactions of organisms are found out:

— Symbiosis (mutualism, commensalism, parasitism),

— Antibiosis,

— Food chains,

— Competitions (intra-and interspecific).

Consecutive change of biocenoses (ecosystems) continuously arising within one biotope is called as a ***succession.***

Distinguish ***a primary and secondary succession.*** The succession comes to the end with a ***climax*** — formation of community which species composition changes further slightly.

Climax communities are characterised by a stable equilibrium condition that is shown in their ability to revert to the original state after the short-term external actions changing conditions of existence, and also to resist to these influences.

Distinguishing feature of main natural climax communities is big biomass but small primary productivity. In most productive of them it is used only 1–2 % of solar energy in photosynthesis reactions. And they do not give enough production to support growing humankind.

Opposite ratio — rather small biomass and high primary productivity — are typical for ***agrobiocenoses*** which owing to this is economy favorable. However, without a constant energy source, human management and protection, they will changed by natural biogeocenoses.

3. Anthropoecology, its aims and tasks

Anthropoecology or human ecology is the term designating a complex of questions concerning interactions of human with environment. Human ecology combines sociological, philosophical, economic, geographical, medical, and biology problems.

The human ecology studies patterns of occurrence, existence, and development of human ecosystems which represent communities of people which are in dynamic relationship with environment and satisfy the requirements thanks to it. The sizes of such systems are various depending on number and character of the organization of human populations. It can be ***isolates, demes, nations, supranational associations*** differing on a way of manufacture and life, and ***humankind as a whole.***

In definition of the size of a human ecosystem the natural settings have great value. The most numerous modern populations (> 80%) inhabit 44 % of lands: tropical forests, savannas, and temperate climate zones. On the contrary, on droughty lands and in a zone of deserts (18 % of a land) only 4 % of populations are placed.

The presence of human communities that have a dominating role in development of all system is the main distinctive line of human ecosystems in comparison with natural ecosystems.

Interaction of people and natural habitat is carried out in two directions.

1. There are changes biological and social indicators ***of individuals*** and ***community as a whole,*** referred on satisfaction of the demands shown to the person by environment.

2. Reorganization ***of the environment*** for satisfaction of demands of the person.

The ratio in time varied towards prevalence of the second direction. The ***individual and group*** fitness of human communities in the inhabitancies differing on natural conditions, forms of managing, and culture is the general result of biological and social processes in human ecosystems. Thus, the person adapts for conditions of a life not only physiologically, but, first of all economically, technically, and emotionally.

Among questions of human ecology great significance in a biology course has: health protection of people, biological variability of people, medical-biological characteristic of man-made ecosystems.

Human in an inhabitancy, on the one hand, is object of action of environmental factors, with another — itself affects on environment.

The mankind, during of working and intellectual activity, extends the accessible energy sources up to use of nuclear and thermonuclear reactions. It has allowed humankind to overcome natural limitations of its growth.

Human is an environmental factor with global influence on environment. Features of its implication are:

1. Adaptation of human in any environmental niches due to energy supply and technical equipment that gives conditions for a population grows.

2. Energy which people manipulate uses them on inhabitancy change.

3. The ecological optimum of human on the basis of its biological mechanisms is limited. Possibility of wide settling is reached not by change of its biology but by environment development.

Factors of natural and artificial environments have constant effect on human.

4. Biological and social aspects of adaptation

Results of action of natural factors which differ in different regions of the Earth throughout mankind history are shown now in ecological differentiation of humankind and its separation on ***adaptive types.***

Formation and natural change in the historical development of ***economic-cultural types*** of human communities is the result of action of social factors.

Formation of economic-cultural types depends on human natural habitat. This dependence was strongest at early stages of development of a human society.

Environment, from the point of view of its suitability for human existence, possesses criteria of quality. According to the World Health Organization, these criteria are: the population health and full physical and mental health.

Influence of abiotic factors of environment at individual level can cause deviations of physiological and biochemical rates of an organism from norm.

The basic interactions of human with environment on the organism level are shown as follows: components of environment cause the change of physiological processes in an ontogenesis and influence on adaptation to unfavorable factors of environment. For example:

- deficiency of cobalt causes decrease of nucleotide exchange;
- excess of molybdenum causes disorder of purine exchange and sedimentation of urinary acid. The molybdenic abudant podagra is developed;
- the copper deficiency causes disorder of lipids exchange and delay of erythrocytes maturing;
- excess of strontium causes chondrodystrophia and dwarfism;
- deficiency of iodine causes endemic struma;

Adaptation is property of a living matter. The norm of health is defined as an optimum condition of live system at which the maximum adaptability is provided. Properties of adaptation are a measure of human health.

Distinguish three conditions of vital activity of an organism concerning influence of an environment: a physiological condition, strains, adaptations, and pathological. For each inhabitancy the climatic factors are characteristic. Adaptation to a climate is necessary for maintenance of conditions of growth, development, and physical activity.

Adaptation processes are influenced by individual properties of the constitution. There are 3 adaptive types of people: ***sprinters, stayers and admixed type.*** Gradual emaciation of organism's reserves is shown in formation and an exacerbation of chronic diseases and appearance of signs of early ageing. To it promote:

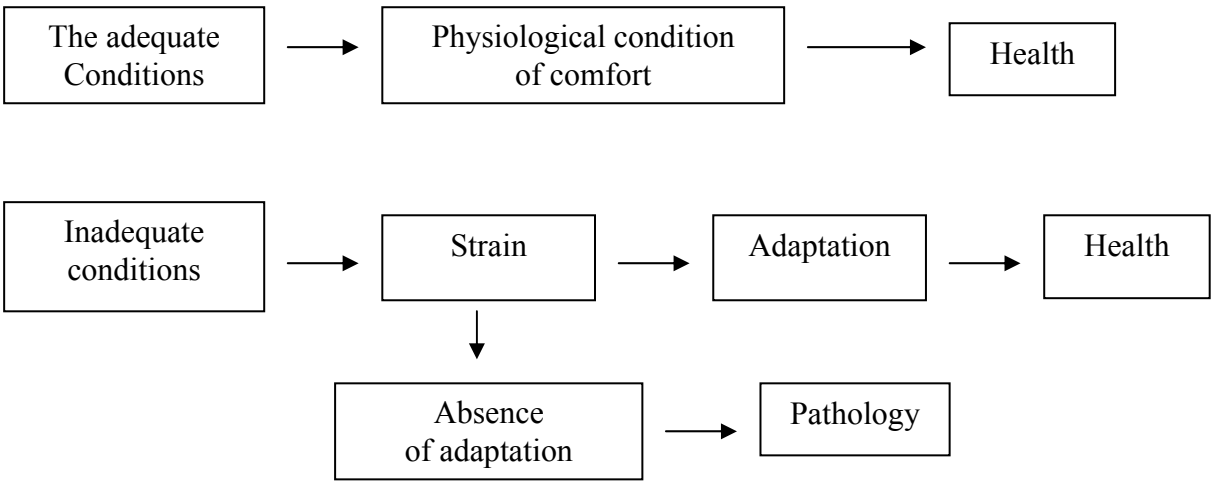
1. Long chronic inadequate influence of environment (a modern way of life);
2. An exit from illness without conservation of a natural biorhythm. The insufficient genetic adaptation of human is shown in it.

Distinguish three groups of adaptation of human to environment conditions:

- ***individual,*** arising throughout a life.
- ***population,*** in the population formation.
- ***group,*** hereditary fixed.

Social mechanisms of adaptation have the increasing significance. Studying of processes of adaptation is a basis of scientific theory of prophylactic medical examination of the population. Adaptations have the mediated character and testify to presence of different levels of ecological relationships of people. For a survival in extreme conditions, human produces artificial ecosystems. All biological and social aspects of adaptation are directed on conservation of health of the person.

The human life condition is characterized by following processes:



5. Ecological differentiation of humankind

Adaptation at population-species level leads to an ecological differentiation of human, or formation of adaptive types, or ecological differentiation of humankind.

Complex of the signs forming adaptive types of people from different geographical zones divide on two groups:

The general	The specific
Indicators of musculoskeletal mass of a body;	Are connected with prevailing conditions in the given inhabitation: a hypoxia, a hot or cold climate.
Amount of immune proteins of blood serum.	

The adaptive type is norm of biological reaction to prevailing conditions of environment and is shown in development of a sign complex:

— morphologic-functional,

— biochemical,

— immunological.

The specified signs cause the best fitness in certain environment. The sign complex peculiar to concrete adaptive type does not depend on a racial and ethnic membership.

The combination of the general and specific elements forms the basis of the following adaptive types:

- The arctic type,
- The tropical type,
- The type of zones of a temperate climate,
- The mountainous type,
- The deserted type, etc.

Features of certain adaptive type are formed in an embryogenesis. So, differences in body proportions between Negroid and Caucasians are quite visible to the end of the fetal period of development. Presence of various adaptive types is evidence of high human variability which is one of preconditions of people settling.

The arctic type. People of this type use more meat for food. It causes strong development of musculoskeletal system and increasing size of thorax. Rising of level of hemoglobin and mineral substances in bones is observed.

The tropical type. People of this type use less animal proteins for food. They characterized by low level of metabolism. Formation of the elongated body, decreasing of muscular mass, reduction of size of thorax, and excessive sweating due to increased number of sweat glands are registered.

The type of zones of a temperate climate. People of this type are formed in the conditions of seasonal rhythms of the nature, at irregular distribution of heat and moisture. It stays on intermediate position between inhabitants of the arctic and tropical regions.

The mountainous type. The hypoxia is a major factor of traits formation. The mountainous type is characterized by the raised level of metabolism, elongation of tubular bones of skeleton, widening of thorax, and increasing of oxygen in blood due to increasing number of erythrocytes.

The deserted type. It is characterized by lower metabolism, decreasing of hemoglobin in blood.

6. Anthropogenous ecosystems

Man-made ecosystems are artificial created and controllable by human systems.

Distinctive line of man-made ecosystems consists that the primary environmental factor is community of people and products their industrial and public work.

In a man-made ecosystem the artificial environment prevail over natural.

The major modern man-made ecosystems concern: cities, agrocenoses, rural settlements, and transport communications.

Cities are peculiar environments. They have arisen 7000 years ago. Annually number of urban population is enlarged, that leads to change of an ecological inhabitancy. In 1950 the urban population amounted 28 %, in 1970 — 40 %, and in 2000 — 70–90 % of total human population.

In spite of the fact that an urbanization as a whole the phenomenon progressive: concentration of manufacture, labor productivity raising, better public health organization, and better food supply, however arises variety of problems:

1. Change of natural habitat;
2. An abundance of waste;
3. The favorable situation for transfer of infections and invasions is produced;
4. Duration of solar illumination is reduced;
5. High population density leads to an overstrain of nervous system;
6. Breakdown of physical activity;
7. Food disbalance.

Cities as the special man-made ecosystem have both positive and negative sides. So, for example, the urbanized environment is characterized by rising of a standard of living, decreasing of the common sickness rate that is shown in growth of average life span. However, rate of illnesses not having a wide circulation earlier are raised. Sickness rate of organs of blood circulation, respiratory apparatus, and nervous system among urban populations in 1.5–2 times higher than in rural populations.

Theme 7. Ecological basis of parasitism. Introduction in parasitology

Plan:

1. Parasites and their characteristic
2. Host of the parasites
3. The ways of parasite invasion into organism of the host
4. Parasitic diseases and their classification.
5. The concept about natural region of parasitic disease

Parasitism is a form of co-habitation of two genetical diverse organisms of different species at which one organism (parasite) uses other (host) as a source of food and place of living, doing to it harm but as a rule not killing it.

Parasitism forms are extremely various. Distinguish obligate and facultative, temporal and constant, true and false, ecto- and endoparasitism.

1. Parasites and their characteristic

«Parasites are such organisms which use other living organisms as a source of food and place of living, particulately or completely put on the hosts a problem of regulation of the relationships with an external environment» (Dogel V. A, 1947).

The parasitism phenomenon has overall character in the nature. It is known over 50 thousand species of parasites, 500 from which can parasitize at human.

Parasites depending on an inhabitancy divide on two big groups: ecto- and endoparasites.

The animals dwelling on a human body concerned to ectoparasites. Basically, it is arthropods. Ectoparasites can be constants (for example, louses) if all life cycle spend on integuments of body and temporal (mites, mosquitos, flies, etc.) which are on human body only at the moment of a feeding (a blood suction).

Endoparasites depending on localisation in a human body categorise on: — intracellular (Leishmania, Plasmodium, Toxoplasma); — tissue (dysenteric ameba, trypanosomes, Balantidium, schistosomes, filarias, Medina worm, larvae of trichina worm, itch-mites, etc.); — organ (Opisthorchis, Clonorchis, Fasciola, Paragonimus, etc.); — cavity (pork and beef tapeworms, fish tapeworm, ascarid, pinworm, hookworm, whipworm, etc.).

All endoparasites are constant parasites of human. The same parasite can live in various organs of the host (Echinococcus, larvae of pork tapeworm). Some parasites can migrate inside of the host body until reach a living place (ascarid, hookworm).

Parasites having only one host are named monoxenic or monohost parasites. For example, dwarf tapeworm and pinworm parasitize only at human. The majority of monoxenic helminthes (ascarid, whipworm, hookworm, etc.) in development cycle are required in exit of an egg from the host in an external environment.

Endoparasites which need two and more different hosts are called heteroxenic or multihost (Plasmodium, pork and beef tapeworms, flukes, etc.)

Now all helminthes are divided on geohelminthes, biohelminthes and contact helminthes.

Geohelminthes are worms in which development of invasive larvae needs in external environment, usually in soil. Human invasion occur through contaminated unwashed vegetables and fruits (for example, ascarid, whipworm), or through direct contact of skin with soil (for example, hookworms).

Biohelminthes are worms which life cycles needs in change of hosts (all trematodes, cestodes, filarias, trichina worm, etc.)

Contact helminthes are worms which life cycle can pass completely in a human body without an exit in an external environment (dwarf tapeworm, pinworm).

2. Host of the parasites

With representation about a parasite the concept about its host is linked. The host of a parasite is an animal or human in which body the parasite temporarily or constantly lives and reproduces by sexual or asexual ways.

Change of the host is caused by staging of life cycle of a parasite. Larval stages, as a rule, develop in an organism of one species, and mature — in other species. Basically, the change of hosts by parasites is caused by the alternation of generations reproducing by sexual or asexual ways.

The definite or final host — in which body the parasite reaches a mature stage and reproduces by sexual way. So, human is the definite host for the majority of cestodes, trematodes, and nematodes.

The intermediate host — in which body develops a larval stage of parasite. Human is the intermediate host for Plasmodium, Echinococcus, Alveococcus, etc. For development cycle of some parasites (Opisthorchis, Paragonimus, fish tapeworm, etc.) is required two or several intermediate hosts.

Second intermediate host has name **additional** host. So, at Opisthorchis: the first host is mollusc Bithynia leachi and additional host is Cyprinidae fishes (roach, tench, ide, carp, bream, etc.).

At many parasites the change of hosts is not related to alternation of generations but carried out during development of the same individual of a parasite. For example, the harvest mites (Trombiculidae family) are the vectors of spotted fever in Siberia (in a larva and nymph stage, it attacks various small rodents; and in adult stage — large mammals or human).

The same host can have a considerable quantity of parasites of one species or different species. At one person, the pinworms, whipworms, dysenteric amebas, Plasmodium, and etc. can simultaneously parasitize.

The obligate hosts are the host in which body a parasite has the best survival rate, growth, and fertility. Human is the obligate host for dysenteric ameba, Ascaris, Ancylostoma, and other parasites.

The facultative host — in which body a parasite can dwell but not completely adapt. For example, human is the obligate host for fish tapeworm. However fish tapeworm can parasitize and in an organism of a fox but its size do not reach the big length and life span does not exceed two months.

The reservoir host — the organism in which there is no development of a parasite; the accumulation of parasite in invasion stage is observed only. For example, the pike, eating the additional host (Cyprinidae fishes) of fish tapeworm, accumulates in the tissues the larvae of the parasite (plerocercoids).

3. The ways of parasite invasion into organism of the host

Parasites can enter into a human body by different ways: through a mouth, skin, blood, placenta, and etc. Distinguish the following ways of human invasion:

1) **The oral way** is the most widespread. Through a mouth with contaminated vegetables, fruit, and meat the human can swallow cysts of the Protists and larvae of helminths.

In some events the oral way of invasion can be supplemented by interintestinal or transplacental ways of invasion. At interintestinal invasion, all stages of helminth development occur in intestine without an exit in an external environment. This way of invasion is observed at dwarf tapeworm, dwarf treadworm.

At transplacental invasion, invasional stages of a parasite at the pregnant woman can enter through a placenta into a fetus. It is observed at Toxoplasma

and leads to development of a inherited toxoplasmosis. Transplacental way of invasion is described also at malaria, the African trypanosomiasis, visceral leishmaniasis, and ancylostomiasis.

2) **Transdermal way** of invasion (penetration of invasion larvae through the intact skin) is characteristic for Schistosoma, Ancylostoma, Necator and other parasites.

3) **Contact way** of invasion is caused by direct transfer of the exciter from infected to the healthy person or at contact with the contaminated linen, medical toolkit etc. It is observed at invasion by the urogenital trichomona (sex contact), itch-mites, and louses.

4) **Transmittional way** of invasion is characteristic for sanguivorous arthropods. Distinguish two variants of this way: inoculation and contamination. At **inoculation** the exciter is actively introduced into blood of human or an animal during active destruction (biting) of integuments of the host. At **contamination** the exciter is put by sanguivorous arthropods on the intact skin of human which then can actively rub the exciter to relieve an itch.

Inoculation and contamination can be two kinds: specific and mechanical. For **specific inoculation**, the intensive reproduction of parasites in a vector's organism is characteristic at first, and then there is its entering in a host body. It is observed at malaria, leishmaniasis, and trypanosomiasis. **The mechanical inoculation** is observed when parasite stays in mouthparts of transmitter but does not reproduce and then is enter in host at blood suction. In this way the biting fly transmit exciter of anthrax. **Specific contamination** is observed when parasite reproduces in an intestine of a transmitter and then is ejected with feces on the skin of host where it is rubbed in by human. In this way the louse transmits the Provachek rickettsia (the exciter of typhus) and flea transmit the plague bacterium. At **mechanical contamination** transmitters (flies) can transmit on food the cysts of Protists, eggs of helminths, and bacteria of intestinal infection (dysentery, typhoid, etc.).

The important role in exciter conservation in the nature belongs to so-called **transovarial** way of parasite transfer in which the female can transfer the parasite to progeny through the sex cells. This way is typical for taiga encephalitis exciter. Ixodes mites can transfer this parasite in twelve generations. Village mite can transfer of exciter of relapsing fever in three generations.

4. Parasitic diseases and their classification

The diseases of human caused by the pathogenic Protists, helminthes, or arthropods are called invasions unlike the infections caused by pathogenic bacteria, spirochetes, or viruses.

Human invaded with any parasite can be a source of invasion not only for other people but also for itself. Such phenomenon is called autoinvasion. Repeated parasite invasion of the person who already suffered from this parasite is called reinvasion.

Source of invasions are carriers of parasites — invaded animals and human. For example, human who suffer from ascariasis, trichocephaliasis, diphyllobotriasis, or other helminthosis continuously excretes in environment invasional eggs with feces. Humans who have had been ill with amebiasis or lambliasis can disseminate cysts of dysenteric ameba or lamblia with excrements in environment.

The unified nomenclature of invasion diseases has been created. The name of disease consists of the zoological name of parasite plus suffix «asis» or «osis». For example, ameba — amebiasis, leishmania — leishmaniasis, fasciola — fascioliasis, and so on.

Transmissive diseases are diseases which exciters are transferred to human by sanguivorous arthropods. Among them are invasional (malaria, leishmaniasis, trypanosomiasis, filariasis) and also infectional (spotted and relapsing fevers, plague, etc.) diseases. Depending on a transmitter role, distinguish obligate-transmissive and facultative-transmissive diseases.

Obligate-transmissive diseases can be transmited only by sanguivorous arthropods which are carrying out a role of specific transmitters. For example, malaria exciters are transferred by mosquitoes of Anopheles genus, exciters of American trypanosomiasis — by mites of Triatoma genus, and etc.

Facultative-transmissive diseases can be transferred not only by sanguivorous arthropods but also other ways (oral, contact, etc.). So, the plague exciter can be transferred to human by fleas and also through air while contact with ill person.

On the basis of the host-parasite relationships all parasitic diseases can be divided on two groups: zoonoses and anthroponoses.

Zoonoses are diseases which exciters can parasitize both at animals and at human (leishmaniasis, trypanosomiasis, balanthidiasis, taiga encephalitis, plague, etc.).

Anthroponoses are diseases which exciters can parasitize only at human (malaria, amebiasis, ascariasis, enterobiosis, etc.).

5. The concept about natural region of parasitic diseases

Diseases which have natural region are infectional and invasional diseases which can exist long time in certain territory independently of human.

The doctrine about natural region of transmissive diseases of human has been developed by E. N. Pavlovsky on an example of skin leishmaniasis and encephalitis. It has made following definition of natural region: «This phenomenon when the exciter, its specific transmitter and reservoir-animals of the exciter exist in natural conditions for many generations without human influence in preexisting evolution and nowadays».

The natural region of transmissive disease is a territary with particular ecosystem which include: 1) exciter of disease (parasite); 2) host of parasite; 3) transmitter of parasite from the ill individual to healthy one.

Pathogenic viruses, bacteria, protozoa and helminths can be exciters of such diseases. The natural reservoir of the exciter is organism in which exciter

can be preserved for a long time and be transferred directly or indirectly (with help of transmitter) to healthy organism.

Mites, mosquitos, flies, greases, gadflies, louses, and fleas who provide circulation of the parasites in natural region can be transmitters of disease. Distinguish specific (obligate) and facultative transmitters. The exciter passes in an organism of specific transmitter a cycle of the development and reproduces. The transmitter begins capable to infect the host-recipient through rather short term. For example, mosquitoes are specific transmitters for Leishmania, mosquitos of genus Anopheles — for Plasmodium, kissing chinches — for the exciter of the American trypanosomiasis, and etc.

In the organism of facultative transmitter the exciter also can reproduce. For its invasion the exciter high dose is required. The amount of the exciter in transmitter' body is often sufficient for invasion of the host-recipient. For example, mite *Boophylus calcaratus* can be facultative transmitter of encephalitis virus whereas specific transmitters are *Ixodes persulcatus, Ixodes ricinus*.

The natural region of transmissive diseases can be both in unexplored nature and in region of the human activity (the synanthropic regions). Formation of the synanthropic regions is caused by that some species of mammals and birds (goats, sheeps, dogs, mouses, sparrows, swallows, and etc.) are carriers of exciters of transmissive diseases with natural region of distribution and dwell near to human.

From Protozoa, the natural region is established except leishmaniasis, toxoplasmosis, and trypanosomiasis (American, African). There are also helminth diseases which have the natural region: opisthorchosiasis, paragonimiasis, schistosomiasis, diphyllobotriasis, alveococcosis, trichinelliasis, filariases, etc. The natural region is established as well for many virus and bacteria diseases (encephalitis, rabies, relapsing fever, plague, etc.).

E. N. Pavlovsky's doctrine about natural region of diseases has allowed developing new methods of their preventive maintenance. It has supported all over the world and accepted by WHO (World Health Organization).

Theme 8. Medical protozoology

Plan:

1. Unicellular organisms, their characteristic and classification.
2. Class Sarcodina and medical value of representatives.
3. Class Zoomastigota, medical value of representatives.
4. Class Sporozoa, medical value of representatives.
5. Class Ciliata, medical value of representatives.

1. Unicellular organisms, their characteristic and classification

Representatives of Kingdom Monocytozoa (Protozoa) have very small size and body consists of one cell. Therefore their name is unicellular animals. Con-

cept «Protists» is relative for it because it is a whole organism which is carrying out all basic vital functions: movement, metabolism, irritability, and reproduction. Organellas of the Protists carry out the basic functions. Cytoplasm of the Protists is normally sectioned into more dense ectoplasm and on more liquid endoplasm. On an ectoplasm surface there is a thin flexible cuticle (pellicula or plasmolemma) possessing properties of a semipermeable membrane. The further stage of development of ectoplasm is formation of cuticle which morphologically isolated and is strong. The cuticle loses properties of liquid substance. It can exfoliate from cytoplasm of the Protists. Cuticle formations at the Protists play a protection and support (skeleton) role. Organs of movement at the Protists: temporal — pseudopodiums, constant — flagellas and cilia which are outgrowth of cytoplasms.

A feeding of the Protists is carried out either by ingesting of particles including other Protists, or by suction by a body surface. In endoplasm there is a secretory apparatus: contractile vacuoles, organellas of excretion, self-regulation, and breathing - pulsing vacuoles.

Life of the Protists is possible only in the presence of a nucleus and cytoplasm in a cell. Nuclei of the Protists can divide both by mitosis and amitosis.

The Protists reproduce by asexual and sexual way. At asexual reproduction division can be in transversal (Infusoria), longitudinal (Zoomastigota) or in any direction. Division can be uniform, irregular and multiple (schizogony). Sexual reproduction is represented by copulation. Sex individuals of the Protists are called gametes. Isogamy and anisogamy are possible. At a number of the Protists there is alternating of sexual and the asexual reproduction. It is more often related to change of hosts (Plasmodium). At unfavorable conditions at a number of the Protists the encystation is developed. At favorable conditions there is reverse process. Human can excrete long time viable cysts with excrements and be the source of invasion for others.

2. Phylum SARCOMASTIGOPHORA Class SARCODINA, medical value of representatives

DYSENTERIC AMEBA (Entamoeba histolytica) — life cycle of the parasite includes two stages: vegetative (trophozoite) and rest stage (cyst).

In the human intestine, trophozoite passes four stages in development: the tissue form, the big vegetative form or forma magna (infest the large intestine wall, erythrophage), intestinal lumen form or forma minuta (erythrocytes do not swallow by parasite, it is found in recovery), and precyst form (it is found in excrements of ill patients).

The disease caused by a dysenteric ameba is called amebiasis. Human is contaminated orally by cysts with foodstuff and water. Parasite affects on mucous of large intestine. It causes a blood disentery.

The life cycle of Entamoeba hystolytica is complicate. In the lumen of large intestine, cysts loose their resistant shell. Than, the parasite divides into 8

small cells, which are transformed into vegetative forms. They can turn back to the cyst form and come out. They also can be transformed to big vegetative form. These forms enter intestine wall and form ulcers. Getting deeper, they make tissue forms. Tissue forms can enter blood stream and travel throughout the organism. They may cause abscesses in the liver, lungs and in the other organs. In the faeces of patient, it can be found the trophozoites and cysts as well.

The amebiasis is a worldwide disease, but it more often in the countries with a tropical and subtropical climate: in the Northern and the Central Africa, India, China, on the Philippine islands, USA, in countries of Central Asia, Transcaucasia, and Primorsky Territory of Russia.

INTESTINAL AMEBA (Entamoeba coli) is considered nonpathogenic; it meets in forms of trophozoite and cyst.

ORAL AMEBA (Entamoeba gingivalis) is described by Russian scientist Gross in 1949 Parasite lives on teethes surface and in teethes affected by caries. It eats bacteria and leucocytes. Its pathogenic effect is not clear.

3. Phylum SARCOMASTIGOPHORA Class ZOOMASTIGOTA, medical value of representatives

Traits:

— Body has the constant form;
— Parasites has one nucleus;
— has flagella or flagellas;
— has kinetoplast (a basal body);
— has undulate membrane.

All representatives of class Zoomastigota can be divided on:

— Having kinetoplast (trypanosoma, leishmania);
— Not having kinetoplast (lamblia, trichomona).

In life cycles of representatives having kinetoplast distinguish the next stages:

— trypomastigota — has an undulate membrane and a long flagella, kinetoplast is in posterior part of a body;

— epimastigota — the undulate membrane is expressed weakly, flagella is short, kinetoplast is in front of nucleus;

— promastigota — there is only a flagella, kinetoplast is in anterior part of a body;

— amastigota — body has oval shape, flagella is very short, cell has big kinetoplast.

About 10 thousand species is in class Zoomastigota. Many of them are parasites of human.

LEISHMANIAS are exciters of leishmaniases. It is accepted to divide leishmaniases on visceral and cutaneous.

The exciters of cutaneous leishmaniasis are Leishmania tropica (L.tropica major, — rural; L. tropica minor — urban). Life cycle includes two stages: amastigota in a human body; promastigota — in an organism of mosquitoes. It is

characterised by formation of oval, non-healing ulcers on the skin. Way of invasion is transmissive through mosquitoes bite. Laboratory diagnostics: detection amastigotes in a detritus from a bottom of ulcers.

The exciter of visceral leishmaniasis is Leishmania donovani. L. donovani donovani is exciter of Indian leishmaniasis; L. donovani infantum is exciter of Mediterranian leishmaniasis; L. archibaldi is exciter of East African leishmaniasis.

Transmitters of leishmaniases are mosquitoes; natural reservoirs are various species of animals and human. Amastigota stage is in human body, promastigota stage is in organism of mosquitoes. Way of invasion is transmissive through mosquitoes bite. Laboratory diagnostics is based on light microscoping of material taken from bone marrow, lymphatic nodes, spleen and liver.

TRYPANOSOMES are exciters of trypanosomiases. Trypanosomes are parasites of human and animals. Distinguish two types of trypanosomiases — African and American.

Exciters of the African trypanosomiasis are two subspecies of trypanosomes — Trypanosoma brucei gambiense and Trypanosoma brucei rhodesiense.

The first exciter meets in the countries of the West and Central Africa (Zambia, Cameroon, Ghana, Uganda, Nigeria, and Congo). The second exciter is naturally occurs in countries of East and South Africa (Ethiopia, Uganda, Kenya, Tanzania, Zimbabwe and Botswana). Transmitters of T. brucei gambiense are tse-tse flies (Glossina palpalis and G. tachinoides), human is definite host for it, whereas pigs are additional host for it. Transmitters of T. brucei rodesiense are G. morsitans and G. pallidipes, the main host of it is forest antelope, whereas additional hosts are different forest animals, farm animals and human. The patients who suffer from African trypanosomiasis have irregular fever, lymphadenitis, transient local oedema and erythema, psychological and nervous disturbances and overwhelming desire to sleep. Laboratory diagnostics is based on microscoping of material of lymph nodes, spinal fluid, bone marrow, peripheral blood taken during fever period.

Exciter of the American trypanosomiasis (Chagas 's disease) is Trypanosoma cruzi. Disease meets in Brazil, Argentina, Chile, Bolivia, Peru, Paraguay, Uruguay, Ecuador, Colombia, Venezuela, Mexico, and Panama. The acute stage of the disease is accompanied by fever, diarrhea and lymphadenitis. In the chronic stages, a characteristic myocarditis occurs; mega-oesophagitis and megacolon may also be seen. The way of human infection is specific contamination. Trypanosomes on being placed on human skin with bug (Ttriatoma, Panstrongylus genera) faeces are rubbed into the wounded skin in the bite place. It is possible to be infected by trypanosomes while blood transfusion and through placenta. Laboratory diagnostics is based on microscoping of material of spinal fluid, bone marrow, peripheral blood.

TRICHOMONADS. Well known three species of trichomonads which inhabit the human body: Trichomonas hominis (intestinal), T. elongata (oral), and T. vaginalis (urogenital). The urogenital trichomonad is the exciter of urogenital trichomoniasis. It can survive only in human body. The body of parasite is oval or spindle shape, length of body is 10–25 and even 30 micrometers (μm or mcm). The

nucleus is oval; it is situated at the anterior part of the cell. In front of the nucleus, there are place for attachment of four flagella and undulating membrane. A tubular axostyle passes aside from the nucleus and along the entire body of the trichomonad; in the posterior end, it protrudes in the form of a long spindle-like process or a tail. It can get nutrition with help of osmotic diffusion of it also can swallow some bacteria and erythrocytes through barely visible cytostom at the anterior end of the body. It can live only in a form of trophozoite. It is a world-wide parasite. At women, urogenital trichomonad lives in vagina and cervix of uterus; at men — in urethra, urine bladder, and prostate.

Way of invasion of urogenital trichomonad is contact.

Trichomonad affects urogenital epithelia. It causes formation of inflammatory regions and epithelia desquamation. Men recover from disease in a month without treatment, whereas women suffer from it for several years. Laboratory diagnostics is based on detection of trichomonads in smears from vagina, urethra and cervix of uterus.

Preventive maintenance is based on treatment of ill peoples, carrying out educational work concerning safe sex.

The intestinal trichomonad has a bulb-shaped body; it is 5–15 μm long. Five flagellas and nucleus are situated in the anterior part of body. Parasite has undulate membrane.

Intestinal trichomonad reproduces by division. Cysts do not form. Parasite lives in large intestine of human. It can be found in very considerable quantities in liquid excrements. The parasite enters human body through mouth with unclean foodstuffs. Does intestine trichomonad has pathogenic effect or no, is still unclear.

The constitution of oral trichomonad is similar with the intestinal trichomonad. Its pathogenic significance is not proved, though there are data about unfavorable influence of oral trichomonad on development of parodontosis.

LAMBLIA (Lamblia intestinalis) is described in 1859 by D. R. Lamble. Lamblia has the bulb-shaped body; its dimension is 10–18 μm. The vegetative form resembles a split pear and has two symmetrical halves. It meets everywhere. Lamblia intestinalis parasitizes in human intestine. It meets in two forms — vegetative and cyst. Way of invasion by cysts is oral with contaminated vegetables and fruits. In intestine, one cyst formed two trophozoites. Trophozoite has two sucking disks and four pairs of symmetric flagellas. The parasite is attached by disks to cells of epithelium of duodenum and forms excavations on the surface of cells. It reproduces by simple division. Mature cysts have four nuclei.

Diagnostics is based on detection of trophozoits in duodenal fluid and on detection of cysts and trophozoits in faeces.

Preventive measures are directed to follow personal hygiene rules. Social preventive measures are directed to avoid faeces disposal of environment.

4. Phylum APICOMPLEXA. Class SPOROZOA, medical value of representatives

In class SPOROZOA, parasites of human meet in two groups — Coccidia and Haemosporidia. From group Coccidia, Toxoplasma gondii — the toxoplasmosis exciter is well known as parasite of human and animals.

From group Haemosporidia, four species of exciters of malaria are known — Plasmodium vivax (the tertian malaria exciter), Plasmodium ovale (the exciter of malaria like tertian), Plasmodium malaria (the quartan malaria exciter), and Plasmodium falciparum (the exciter of tropical malaria).

The development cycle of malaria exciters is related with two hosts: intermediate (human) and definite (mosquitos of genus Anopheles).

All four exciters have similar life cycles. In the human body, asexual reproduction in liver cells (exo-erythrocytic or tissue schizogony) then erythrocyte schizogony and formation of gametocytes (immatured gametes) are observed. Gametogony and sporogony can be seen in mosquito organism.

Exo-erythrocytic the schizogony begins from the mosquito bite and injections of sporozoites in blood stream (a specific inoculation). After approximately an hour, sporozoites inpour into hepatocytes and develop in tissue trophozoites. The last grow and receive the name of tissue schizonts which contain several hundreds of merozoites. The hepatocytes are ruptured and merozoits are liberated from liver cells and enter blood stream. At P. falciparum of one schizont it can be formed over 30 thousand merozoites, at P. vivax — 10 thousand, and at the other species — 15 thousand. Duration of exo-erythrocytic cycle is for P. vivax — 8 days, for P. falciparum — 5–6 days, for P. malaria — 13–16 days, and for P. ovale — 9 days.

The erythrocytic schyzogony. On the erythrocyte membrane, there are antigens to which tissue merozoits are attached. In this place, erythrocytes membrane engulfs to enable parasite enter erythrocyte. Merozoit, which has entered erythrocyte, called erythrocitic trophozoite. It has four stages of development:

1. Stage of young trophozoite. It starts 2–3 hours after merozoit entering. Parasite develops vacuole which shifts erythrocyte cytoplasm with nucleus to the periphery. Therefore, this stage also called young ring stage.

2. Stage of older trophozoite. The parasite grow in sizes, the nucleus becomes bigger. It expresses pseudopods, which enable it to move. In the erythrocyte cytoplasm, many small granules appear.

3. Stage of young schizont. It continues enlarging in sizes. The granules of red pigment appear in parasite cytoplasm. Nucleus starts to divide into several parts. Chromatin is irregular in shape.

4. Stage of older schizont. The nucleus division is completed that resulting in merozoits formation. They are 1.5 μm in diameter.

After formation of older schizonts there is rupture of erythrocytes and exit of merozoites in a blood stream. Clinically it shows as attack of a malarial fever which occurs repeatedly every 48 hours at P. vivax, P. ovale and P. falciparum

and every 72 hours at P. malaria. The formed merozoites during the fever attack infect new erythrocytes and cycle of erythrocyte schizogony repeats. After several days of erythrocyte schizogony, the part of merozoites is transformed to male and female gamonts. Since this moment human becomes infective. The mature male gamont has the light blue cytoplasm and the large diffuse nucleus. The female gamont has the dark blue cytoplasm and the compact nucleus. Gamonts contain a considerable quantity of pigment. Gamonts mature during 3 days. The exception is P. falciparum at which gamonts mature during 9 days. Gamonts of P. falciparum can be preserved in blood stream of human till 3 weeks; gamonts of other species disappear faster.

Gametogony take place in mosquito's stomach. 15 minutes after swallowing, in mosquito's stomach the male gamont loses an erythrocyte shell and forms 6–8 mobile gametes on periphery of cell. Female gamonts also matured in female gametes. After fusion of male and female gametes the zygote is formed. It becomes elongated in shape and mobile. It called ookinete. Ookinete inpours through epithelial cells of mosquito's stomach and gets under basement membrane. The ookinete loses mobility and forms protective shell. This stage receives the name of oocyst. Oocyst is subjected to the first division by meiosis.

The sporogony begins with the second meiosis division of oocyst. The nucleus and cytoplasm divides into many parts and forms more than 10000 daughter cells (sporozoites). Sporozoites reach mosquito's salivary glad with hemolymph flow, when oocyst shell has been ruptured. Since this moment a mosquito can infect human. Duration of sporogony depends on temperature and species of Plasmodium.

Laboratory diagnostics is based on a blood analysis of the patient in smear or «thick drop» stained with Giemsa.

Toxoplasma gondii is obligate intracellular parasite. It is exciter of toxoplasmosis of animals and human, a protozoal zoonosis. The parasite has been found in 1908 in a rabbit. The life cycle of parasite needs in change of hosts. Definite hosts are domestic cats and some wild cats (ocelot, bobcat, and Bengali tiger). Intermediate hosts are mices, rats, sheep, pigs, rabbits, cattle, some birds, and human also. The form of a body of the exciter depends on a development stage. In a phase trophozoite the parasite has the semilunar form, the dimension 4–7 × 2–4 microns with a large nucleus. One end of the body is sharpened, another — rounded. Cell is covered by shell having internal and external membranes. Cell cytoplasm is homogeneous with small granules; there are mitochondria, endoplasmic reticulum, Golgi complex, ribosomes and so on. Trophozoites reproduce in epithelium of cat's intestine by asexual way (schizogony) with formation 10–16 merozoites. Latter, the part of merozoites will be transformed to sex cells (micro- and macrogametes). After merging of sex cells, the oocyst forms. Oocyst is 20–100 microns of size and concluded in a dense shell. Oocysts through 9 days after invasion of the definite host are excreted with feaces in the environment where can preserve for a long time. Under appropriate conditions, two sporocysts containing 4 sporozoites are formed in each oocyst.

Such oocysts become invasional. In organism of the intermediate host life cycle occurs mostly in a same way. Sporozoites penetrate epithelial cells of intestine. Than, they live and divides in it forming trophozoites. The last can repeatedly divide, reach with blood stream to any tissue of the intermediate host, and form in them tissue cysts. It is latent invasional forms of parasite that localised in brain, heart, muscles, and eyes. Cysts can survive for years. Toxoplasma is found on all mainlands, in the countries with various climate conditions where intermediate and definite hosts of the parasite live.

A human can be infected from animals during flaying animals, while eating rough meat, during contacts with cats even through air. Human also can infect embryo through placenta.

More valuable for diagnostics is serological methods and microscoping of blood smears, spinal fluid, and material from lymph nodes.

5. Phylum INFUSORIA. Class CILIATA, medical value of representatives

Balantidium coli is the balanthidiasis exciter, a zoonosis of human and animals (pigs and rats).

Trophozoites live in large intestine, being attached to its mucosa. Parasite eats bacteria, erythrocytes, and leucocytes. It causes formation of ulcers. Clinical sign of disease is acute diarrhea with blood and pus. Balantidium coli passed through a blood stream can travel in liver, lungs, and other organs. Cysts are formed in intestine lumen.

Invasion way is oral with water and foodstuff contaminated by cysts (more often parasite is found in countries where pigs are involved in agriculture.).

Diagnostics: detection trophozoites and cysts in feaces.

Theme 8. Ecological aspects of parasitism in phylum PLATHELMINTHES, class TREMATODA

Plan:

1. Phylum PLATHELMINTHES, its characteristic and classification.
2. Class TREMATODA, its epidemiological characteristic.
3. Representatives of class Trematoda. Their distribution, localization in human body, morphology characteristics, life cycle, ways of invasion, methods of diagnostics and prevention of diseases.
4. Class CESTOIDEA, its epidemiological characteristic.
5. Representatives of class Cestoidea. Their distribution, localization in human body, morphology characteristics, life cycle, ways of invasion, methods of diagnostics and prevention of diseases.

1. Phylum PLATHELMINTHES (FLAT WORMS)

About 7300 species of flat worms is known. They meet in sea and fresh water, bedrock; many have passed to parasitic way of life. For the animals of phylum PLATHELMINTHES are characteristic:

• They have three layered body and bilateral symmetry of body.

• There is no coelom. Internal organs is suspended parenchyma.

• They have musculo-cutaneus sack.

• Many flatworms have gut with only one opening but tapeworms lack digestive system. They adsorb food through their body walls.

• Flatworms have excretory system.

• Flatworms lack respiratory system. They uptake oxygen through whole body surface.

• Flatworms lack circulatory system.

• Nervous system is presented by two longitudinal nerve cords and two swellings at the anterior end.

• They are hermaphroditic, excluding blood flukes.

From this phylum we will survey representatives having medical and veterinary value from two classes: flukes (Trematodes) and tape worm (Cestoidea).

2. Class Trematoda (Flukes), its epidemiological characteristic

About 3 thousand species of flukes is known. All flukes are parasitic organisms. For flukes complex life cycles are characteristic. Adult stage (marita) inhabit organism of vertebrates. The body of marita is flattened and has a leaf shape. The mouth is on the abdominal side of the anterior part of a body and armed by sucker. Except this sucker there is one more on the abdominal side (latheral sucker) that need for fixation inside the host. Eggs need to be placed into water to continue development. First stage larva, called miracidium, leaves the ovum. It can be ingested by snail. Within the snail, it transforms to sporocyst. Within the sporocyst rediae are produced. This larva continues growing within the snail, giving rise to the several individuals of the tadpole like next larva stage, the cercariae. The cercariae, which are produced within the snail, escape into the water, where they swim about. They look for definite or second intermediate host. If they look for definite host, they can transform to cyst stage — adolescariae. They are located on the pondweed and can be ingested by animals. Second group looks for second intermediate host. Having found it, they bore into the muscles or under the scales, loose their tails and transforms to metacercariae. Intermediate hosts are usually fishes. Having entered final host, invasion stages of flukes travel throughout the body looking for an organ where they will live until the end.

For flukes specialisation and simplification in constitution of some organs caused by a parasitic way of life are characteristic. Specialisation is expressed in availability of suckers, thorns, hooks, and other formations on the body surface, in development of generative organs, in availability of complex life cycles, and in intensive reproduction at various stages of life cycle. Morphological retrogressive evolution (organisation simplification) is expressed in absence of sense organs in the mature forms of endoparasites.

Flukes have originated, obviously, from turbellarian worms passed to parasitic way of life. At human and domestic animals some species of flukes parasitize.

3. Representatives of class Trematoda

LARGE LIVER FLUKE (Fasciola hepatica) — is the fascioliasis exciter.

Localization. This fluke lives in the bile ducts of its hosts, and sometimes in pancreas and other organs.

Distribution. Parasite has world wide distribution.

Morphology characteristics. Marita of large liver fluke is about 3–5 cm in size. The multibranched uterus localized behind an abdominal sucker; behind the uterus the ovary lays; numerous yolk bodies is situated on side of the body, and middle part of the body is occupied by testis. Eggs have yellow color, oval shape, on one of poles the operculum is easily distinguishable; their size are 135×80 microns.

Life cycle. Large liver fluke develops with change of hosts. Its definite hosts are herbivorous mammals (cattle, horses, pigs, rabbits, etc.). Occasionally large liver fluke can be found in human. The intermediate host is pond snails (genera Glabra, Radix, Lymnaea).

Egg of large liver fluke starts to develop in water where it transforms to a larva — miracidium. It can be ingested by snails. In the snail body, miracidium enters into a liver. Further the parasite transforms to the next stage — sporocyst. This stage is capable to reproduction. In the sporocyst, the new larva generation (rediae) forms by parthenogenetic way (i.e. without a fertilization). Inside rediae the next larva generation — cercariae is formed. In a body of cercaria many organs that characteristic for of marita are developed. It has suckers, intestine, nervous and excretory systems but unlike the adult form it has a long tail which provides movement. Cercaria leaves the snail and actively swims in water. Further cercariae are attached to plants and become covered by a shell. In this stage, called adolescaria, parasite has the spherical shape. If adolescaria is ingested by animals, it leave defence shall in small intestine of the host and parasite burrow through intestine wall. Then worm migrates through peritoneal cavity into the liver and finally into the bile duct.

The way of invasion is oral with pond water and water plants.

Pathogenic value and diagnostics.

Worm can plug up bile ducts, causing mechanical jaundice. Parasite antigens are strong. They may cause acute allergic reactions. They affect bile ducts; they also make wound on their walls. Massive invasion can result in liver cirrhosis.

The laboratory diagnosis is based on feaces examination for the eggs of large liver fluke. Eggs can be found in excrements of healthy people after eating of liver of animals sick of fascioliasis (transit eggs). As a result the inspection on fascioliasis is necessary to exclude a liver from a food of the patients.

Preventive maintenance. The knowledge of biological characteristics and life cycle is necessary for the organisation of the parasite control and developing of rational preventive actions. Personal preventive measures are directed to avoid using pond water for drinking, to wash vegetables before eating and so on. Social preventive measures are treating ill animals and people, pastures interchange, and health care eduction.

SMALLER LIVER FLUKE (Dicrocoelium lanceolatum) — is the dicroceliosis exciter.

Localization. Smaller liver fluke parasitizes in bile duct of farm animals, and very rare can be found in human.

Geographical distribution — world wide.

Morphology. Length of smaller liver fluke is about 10 mm, the body has lancet shape. The digestive canal has two unbranched tubes. There are two oval testicles. They are located behind ventral sucker. There is ovarium behind them, surrounded by yolk bodies, uterus and sperm accepting chamber. Eggs of the worm have oval shape, a thin yellow membrane, an operculum on one end. Egg measures are 38–45 by 25–30 μm.

Life cycle. Smaller liver fluke develops with change of hosts. Definite hosts are herbivorous mammals. The first intermediate host — the mollusk from Zebrina or Helicera genera, the additional host — ants from Formica genus. Eggs are escaped from final host with faeces. Within the snail liver, it transforms to first range sporocyst. Than, it transforms to a second range sporocyst. This stage continues growing within the snail, giving rise to the several individuals of the tadpolelike next larva stage, the cercariae. The cercariae travel to mollusk's lungs. There they congregate and make congregated cysts. Those cysts escape onto plants. Here, they can be ingested by additional host. In ants, cercariae leave defense shell and transform to metacercariae. Human and animal invasion occurs with occasional swallowing of ants with weed.

Invasion of human and animals occur at accidental swallowing of ants.

Pathogenic value and diagnostics. Clinical picture of dicrocoeliosis is similar to fascioliasis. Diagnostics is based on examination of faeces for the eggs.

Preventive maintenance. Measures of preventive maintenance of dicroceliosis are developed insufficiently. Personal preventive measures are directed to avoid eating of ants with weed. Social preventive measures are to care about health, education in affected regions, treating of ill animals, and pastures interchange.

CAT LIVER FLUKE (Opisthorchis felineus) — the exciter of opisthorchosiasis. This disease was described in Siberia by K. N. Vinogradov in 1891.

Localization. The cat liver fluke parasitize in liver, bile ducts or pancreatic duct of human, cats, dogs and other mammal eats raw fish.

Geographical distribution. The regions of opisthorchosiasis are West Siberia, especially along Ob and Irtysh rivers; and East Europe, along Volga, Don, Dnepr, Dnestr, North Donets, Pripiat, Neman rivers.

Morphological features. Parasite body has 13 mm long; digestive canal has two unbranched tubes. In the centre of the body, there is branched uterus. There is oval ovarium behind it. Two rosette-shaped testicles are at the terminal part of the body. Eggs measure 26–30 by 10–15 μm, they are slightly elongated, asymmetrical in shape and have smooth thin light yellow membrane. On the anterior pole of the egg there is a hardly noticealble knob.

Life cycle. Human and carnivorous mammals can be definite hosts of the cat liver fluke. Eggs are escaped from final host with feces. In the mollusk intestine, miracidium leave the egg, travel to liver and transform to sporocyst. Last one give rise to rediae. Rediae divide and transform to cercariae. The cercariae escape into the water. Then they bore into the muscles of fishes lose their tails, and transform into metacercariae within the cysts. If a human or other mammal eats raw infected fish, the cysts dissolve in the intestine and young flukes migrate to the bile ducts or pancreatic duct, where the mature.

Pathogenic value and diagnostics. Opisthorchosiasis is serious disease. At the big number of parasites in host body it can have death in result. Facts are known when in human liver was found 25000 and more flukes. The acute stage of opisthorchosiasis is witnessed by signs of acute allergosis with high pyrexia and eosionophilic leucocytosis. In the chronic stage, the symptoms of pancreatitis, cholecystitis, and hepatitis are common. The laboratory diagnosis is based on detection of eggs in excrements and duodenal fluid.

Preventive maintenance. Personal preventive measures are directed to exclude uncooked or improperly cooked fish in ration. The social preventive measures are directed to health care education and checking out fish which is for sale.

BLOOD FLUKES from genus Schistosoma are exciters of schistosomiasis.

Localization. All Schistosomas live in human veins.

Geographical distribution. Schistosomas can be found in the countries with a tropical and subtropical climate.

Morphology characteristics. In this group, there are organisms of both sexes. Males have flat body, whereas females have tread-like body. Matured females are in ginecoform canal on ventral side of male organism. Suckers are small. They are on anterior end of parasite.

Life cycle. For some schistosomas the definite host is only human, for others — human and various mammals. Intermediate hosts — some species of tropical limnetic snails. Miracidium leaves egg in the water. Than miracidium enters a snail where it transforms to sporocyst of first and second range. Finally, sporocyst transforms to cercariae. Cercariae escape intermediate host and swim in the water. Swimming in the water, they bore under the human skin. It is possible when people swim, work in rice field or on irrigative system. Wearing cannot prevent parasite invasion. On the invasion site, there are skin eruptions, rashes, itching. It is cercariosis. Entered schistosomas travel with lymph and blood to right part of heart, lungs, mesenteric veins, urinary veins.

Three species of blood flukes parasitizing at human are known. They differ in number of biological features, localization in human body, and geographical distribution.

Schistosoma haematobium — the exciter of urogenital schistosomiasis; parasitize in large veins of intestine and urogenital system. This disease occurs in Egypt, Southern Africa, Australia, Iran and other countries. Definite hosts are

human and monkeys. Eggs bore ureter or urinary bladder wall and escape body with urine. The further development and ways of invasion are mentioned above. The diagnosis is based on microscopic examination of parasite eggs in urine.

In biology urogenital Schistosomas thin acclimatisation to maintenance of existence of the species shows. Eggs of the parasite get to urine only during hot time of days when the probability of their escape in water is more, as it is necessary for their further development. It should be considered at diagnostics because schistosoma eggs are not found in morning urine.

Schistosoma mansoni — the exciter of intestinal schistosomiasis; parasitizes in mesenteric and portal veins. It is extended in Africa, Indonesia, and the South America. Definite hosts are human, farm animals, and dogs. Eggs bore intestine wall and escape host with feaces. Laboratory diagnostics is based on detection of eggs in excrements.

Schistosoma japonicum — the exciter Japanese schistosomiasis; parasitizes in large veins of intestine. It distributed in South Japan, South China, and Philippines. Definite hosts are human, domestic and wild mammals. Eggs bore intestine wall and escape host with feaces. Laboratory diagnostics is based on detection of eggs in excrements.

Preventive maintenance. Personal preventive measures are to avoid swimming in ponds contaminated by cercariae of schistosomas. Social preventive measures are directed on treating ill people, elimination ponds disposal by human faeces, and health care education.

LUNG FLUKE (Paragonimus westermani) — the exciter of paragonimiasis.

Localization. Lung fluke parasitizes in lungs of human, carnivorous, domestic and farm animals which can eat fresh crabs and shrimps.

Geographical distribution. Paragonimiasis distributed in the countries of East Asia including south of the Russian Far East.

Morphology. Paragonhmis westermani is reddish-brown and resembles a coffee bean. It size is about 7.5–16 mm. Eggs are golden-brown and have an operculum.

Life cycle. Lung fluke develops with change of two intermediate hosts. The first – is freshwater mollusc of genus Oncomelania, the second — is freshwater crabs and shrimps. Marita is located in lungs. Eggs together with sputum escape an external environment.

Miracidium escape egg and actively burrow into mollusc where passes through stages sporocyst, rediae and cercaria. Cercariae escape the first intermediate host and burrow into crabs and shrimps where transform in metacercariae which are invasive stage for definite hosts.

Pathogenic value and diagnostics. Course of paragonimiasis look like tuberculosis. The brown sputum with fluke eggs is abundantly excreted. Eggs with a blood flow can get to various organs including brain that is especially hazardous. Diagnostics is based on examination of sputum and faeces for the eggs.

Preventive maintenance. Personal — awoid eating uncooked crabs and shrimps, social — health care education.

4. Class Cestoidea (Tapeworms), its epidemiological characteristic

It is known about 1800 species of tapeworms. All of them are obligate endoparasites, in a mature stage parasitizing in intestines. They have tape-like structure (strobila). The strobila is divided into many proglotides. On the anterior end situated scolex with attachment organs (suckers, attachment grooves (bothria), and hooks). Body is covered by tegument. They lack respiratory system. Excretory system is presented by protonephridia. Nervous system is presented by scolex ganglion and two nervous cords, which extend throughout the body. Reprodactive system is well developed in mature proglottids. They have cross insemination.

Cycle of development starts from eggs passing out of the human body with the faeces. It contains embryos (oncosphere), which can start to develop in intermediate host digestive system. It has hooks. It burrows the walls of the intestine and ultimately reaches the muscles, liver, and lungs by the way of blood and lymph vessels. There, it transforms to larva. Entered final host, larva matures with help of digestive enzymes. The head pulls out and attaches to the intestine wall. Definite hosts can be infected through eating meat of intermediate hosts with larvae. Distinguish next type of larvae: 1) Cysticercus. It has shape of the bladder filled with fluid in which the head with suckers pushed inside. The head can turn out; 2) Cenur. It has shape of the bladder with the several heads pushed inside; 3) Cysticercoid. It has a sphere shape with a head pushed inside and tail coming out of sphere; 4) Echinococcus. It has shape of the big maternal bladder with many daughter spheres inside. In which the scolexes develop. The bladder is filled by the fluid containing products of life activity of a parasite; 5) Plerocercoid. It has the worm-like shape. On the anterior part of its body there are two bothria.

5. Representatives of class Cestoidea

PORK TAPEWORM (Taenia solium) — the exciter of teniasis.

Localization. In mature stage the parasite localized in small intestine, in larva stage the parasite localized in muscles. In human it also can be found in eyes and brain.

Geographical distribution — world wide.

Morphological features. Strobila length of mature forms can be 2–3 m. There are four suckers and a crown of hooks on the scolex. In hermaphroditic proglottids, the ovarium has three lobes. In mature proglottids, the uterus branches into 7–12 side branches. Eggs are oval and have three shells. Eggs measure 20–44 by 28–38 μm.

Life cycle. The definite host is human. The intermediate host is pig, occasionally human. Invasion of pigs occurs at eating of food with proglottids of

pork tapeworm. In the stomach, onchospheres leaves proglottids and travel to muscles. Two month later, they transform to cysticercus. In cysticercuse there is a pushed inside scolex. In pork the cysticercus having size of rice grain are well visible. Invasion of human occurs at the eating of uncooked or bad thermally treated pork. In human intestine, under the influence of digestive juices the cysticercus pulls out scolex and attaches to intestine wall. Than, cysticercus begins to produce proglottids. It becomes mature after 2–3 months after invasion.

Pathogenic value and diagnostics. Pathogenic influence is caused by mechanical injury, use of the digested nutriment of the host, and toxic effect of products of life activity. At teniasis the digestive disturbance, anaemia, and fatigue occur. Disease is hazardous also because human can be the intermediate host for this helminth. Having vomiting, patients with teniasis may swallow tapeworm proglottids. Thus, they release oncosperes, which can burrow stomach wall and travel to muscles, brain and eyes by the way of blood and lymph vessels. Therefore, they may cause cysticercosis of brain and eyes — the severe disease of human. Cysticercosis of brain causes a death, cysticercosis of eyes causes' loss of sight. Treatment of cysticercosis is only surgical.

Diagnostics is based on examination of faeces for the mature proglottids. It is important to count number of side branches of uterus.

Preventive maintenance. Personal preventive measure is escape of uncooked pork eating; social — veterinary and sanitary inspection of suspicious meat in butchery and the markets and treatment of ill patients.

BEEF TAPEWORM (Taeniarhynchus saginatus) — the exciter of teniarhynchiasis.

Localization. Worm in a mature stage parasitizes in human intestine.

Geographical distribution — world wide.

Morphological features. Strobila length of mature forms can be 4–7 m. There are four suckers are on the scolex; hooks are not present, therefore tapeworm is called as unaided. In hermaphroditic proglottids, the ovarium has two lobes and uterus does not branch. In mature proglottids, the uterus has 17–34 side branches. They are extremely long. Eggs are similar to Taenia soleum. In one mature proglottid, it can be more than 175 thousands of eggs. One mature Taeniarhynhus saginatus can deliver about 2500 proglottids per year.

Life cycle. Human is the definite host, cows are the intermediate host. Last is invaded by eating proglottids with human excrements which can be on a grass, hay, or other foodstuff. The development cycle is similar to Taenia soleum. Invasion of human occurs at the eating of uncooked or bad thermally treated beef.

Pathogenic value and diagnostics. Teniarhynchiasis is similar with teniasis. The diagnosis is based on finding of proglottids which can be found not only in excrements. Proglottids can pass out and actively crawl over the body and on the linen. It may attract the patient attention. Larva stage in the human body does not develop.

Preventive maintenance. Personal preventive measure is escape of uncooked beef eating. Measures of social preventive maintenance are similar to that at teniasis.

DWARF TAPEWORM (Hymenolepis nana) — is the hymenolepiasis exciter.

Localization — in small intestine of human.

Geographical distribution — worldwide especially in countries with arid climate. Children are always more infected than adults.

Morphological features. Mature organism is about 1–5 cm long. Strobila has 200 and more segments. There are four suckers and proboscis with crown of hooklets on the scolex. Eggs are elongated with transparent membranes. Eggs measure 45 by 37 μm.

Life cycle. For dwarf tapeworm human is the definite and intermediate host, as well. Eggs of this parasite escape from human intestine with feaces. If eggs are swallowed, they release onchospheres. The onchospheres borrow intestine wall and attach to it. Here, the cystecercoids are developed. Several days after, the intestinal vilia is destroyed by parasite and cysticercoids fall into an intestine lumen. Within about 2 to 3 weeks, it becomes matured worm. Up to 1500 parasite can be in the intestine at the same time. Life span of parasite is 1–2 months. Eggs can be preserved in the intestine. Sometimes eggs turn to mature forms without an exit from a human body (autoinvasion). In this way a very heavy infection may be aquired, especially in children. However, most of the eggs pass out of the organism.

Pathogenic value and diagnostics. Pathogenic action is expressed in destruction of the big number of intestine villi and toxic effect of products of helminth metabolism. At hymenolepiasis there are headache, abdominal pains, disturbances of digestive and nervous systems, stomachache, and fatigue. Children become peevish and irritable. Way of invasion is contact. There are no eggs on vegetables, fruits and in water. So, none can be infected by eating these food and drinking water. The diagnosis is based on microscopic detection of eggs in feaces.

Preventive maintenance. Washing of child hands before meal, sanitary-educational work among parents and workers of child care centres, careful sweeping of child care centres, sterilisation of toys, following personal hygiene rules.

ECHINOCOCCUS (Echinococcus granulosus) — the echinococcosis exciter.

Localization. Parasite localized in various organs of human during larva stage: liver, lungs, brain, tubular bones.

Geographical distribution — world wide.

Morphological features. Mature form of echinococcus is about 2–6 mm long; strobila has 3–4 segments. There are four suckers and proboscis with two crowns of booklets on the scolex. Next-to-last segment is hermaphroditic. Last segment is mature. Uterus contains to 5000 eggs with developed onchospheres. Eggs look like Tenia soleum eggs.

Life cycle. Definite hosts are dogs, wolfs, jackals. Intermediate hosts are human, cows, pigs, camels, rabbits and many other mammals. In excrements of the definite hosts invaded by echinococcus, there are eggs of parasites. Furthermore, mature segments can crawl out of intestine and leave eggs on the hair. A human is infected by swallowed eggs. In the intestine, onchospheres leave egg. It burrows the walls of the intestine and reaches the muscles, liver, and lungs by the way of blood and lymph vessels. There it transforms to larva. Human is a deadlock branch for Echinococcus granulosus. Final hosts eat affected organs of animals and become infected.

Pathogenic value and diagnostics. Pathogenic value is related to disturbance of tissues and difficulty of functioning of organs where the echinococcus parasitizes, and also with the general intoxication. Treatment is only the surgical. The diagnosis is based on immunologic reactions and X-ray examination.

Preventive maintenance. Personal preventive measure is following personal hygiene rules that are washing of arms before meal, after contact to dogs and cattle. Social preventive measures are based on treating of ill dogs, veterinary control of meat for dogs.

ALVEOCOCCUS (Alveococcus multilocularis) is the exciter of alveolar echinococcosis.

Localization — the same as echinococcus.

Geographical distribution. The alveococcosis registers much less often than an echinococcosis. The disease was found in Europe, Asia, the North America. In Russia, alveococcosis meets mainly in Siberia, but events in Central Asia, Bashkiria and other places are known.

The morphology. The mature stages of echinococcosis and alveococcosis exciters are very similar. Distinguishable features are number of hooklets and uterus of sphere shape in Alveococcus multilocularis.

Life cycle. Definite hosts for Alveococcus are foxes, dogs, and cats; intermediate hosts are mice and human, occasionally. Human is a deadlock branch for it.

Pathogenic value and diagnostics. Alveococcus occurs in liver and lungs, sometimes meets in other organs. Larva stage is rough vesicle with smaller vesicles inside. They are without fluid. Each vesicle has small parasite scolex. It can grow outside to surrounding tissue and destroys surrounding tissue. The metastases to brain and lymph nodes may occur. It is more malignant than echinococciasis. Diagnosis has to be proved by serological tests. Treatment only surgical, but diagnosis is possible only at older stages when the operative measure is complicated in use.

Preventive maintenance. Following the personal hygiene rules (washing hands after contact with dog and before meal). Social preventive measures are based on treating of ill dogs, veterinary control of meat for dogs, sanitary control of butchery.

FISH TAPEWORM (Diphyllobothrium latum) — is the diphyllobotriasis exciter.

Localization. Mature stage parasitizes in small intestine of human.

Geographical distribution. It can be found in regions with many rivers, lakes and ponds. In Europe countries it is most distributed in Kareliya, Leningrad region, Baltic countries. The separate cases of diphyllobotriasis are noted on shores of Volga, Dnestr and other large rivers.

Morphological features. Mature worm have strobila 7–10 meters in length. There are bothria on the scolex. They help to attach to intestine vilia. Strobila has about 4000 of proglotides. Immature proglotides are short. Mature proglottid is more wide than tall. Uterus has rosette shape. It opens on anterior side of proglottid. Eggs are oval, brown in color, with openculum on the one pole.

Life cycle is related to change of two intermediate hosts. Definite hosts are human and carnivorous mammals (cats, foxes, dogs, bears, etc.). The first intermediate host is copepod (Copepoda genus), the second host is fish (perch). If eggs reach water with host's feaces, they hatch into coracidium. Coracidium is ciliated larva. It has three hooks pairs. Coracidium need to be ingested by copepods. In its intestine, the coracidium lose cilia and transforms to procercoid. The procercoid is elongated larva with six hooks on the posterior part of the body. If copepod is ingested by fish, the procercoid travels to muscles and transforms to plerocercoid. In the organism of big predatory fishes, plerocercoids can accumulate. That means that they are reservoir hosts.

Pathogenic value and diagnostics. Bothria can restrain intestine mucosa that leads to tissue necrosis. Worm can selectively adsorb vitamin B12 causing B12 deficiency anemia. Diagnosis is based on detection of eggs in feaces.

Preventive maintenance. Personal — awoid eating uncooked fish, social — health care education.

Theme 10: Ecological aspects of parasitism in phylum NEMATHELMINTHES (Roundworms). Pathogenic action on human organism

Plan:

1.General characteristics of phylum Nemathelminthes.

2.The main representatives of class Nematoda — disease exciters of human (large intestinal roundworm, whipworm, Ancylostoma, Necator, dwarf treadworm, pinworm, and trichina worm).

1. General characteristics of phylum Nemathelminthes

It is described more than 500 thousand species of the roundworms dwelling in various environments. Many of roundworms have adapted to a parasitic form of life. A number of species have medical interest being parasites of human.

The general traits of representatives of phylum Nemathelminthes:

1. Body bilaterally symmetrical, cylindrical, unsegmented;
2. Develop from three embryonic layers;
3. Have primary body cavity;
4. Have external cuticle with underlying muscles;
5. Have organs systems (digestive, excretory, nervous, reproductive);
6. Have two sexes;
7. Digestive system is terminated by anus;
8. Have partial reduction of a skin-muscular bag or full its absence at some groups; usually it is submitted only by the longitudinal muscles divided into 4 longitudinal tapes;
9. Absence of respiratory and blood systems.

Nematodes are divided into geohelminthes (Ascaris lumbricoides, Trichocephalus trichiurus, Ancylostoma duodenale, Necator americanus, and Strongyloides stercoralis), biohelminthes (Trichinella spiralis, Dracunculus medinensis, and representatives of Filariidae family), and contact helminthes (Enterobius vermicularis).

2. The main representatives of class Nematoda

LARGE INTESTINAL ROUNDWORM (Ascaris lumbricoides) — the ascariasis exciter.

Localization — in small intestine.

Geographical distribution — worldwide.

Morphology characteristics. Mature female of large intestinal roundworms is about 40 cm long, male — 15–25 cm long. Body is cylindrical, narrowed to the ends. The posterior end of male worms is curved ventrally. Fertilized eggs have oval shape and have a thick multi-layer membrane. The external membrane of the egg is yellow-brown in color and covered with large trabecules.

Life cycle. The large intestinal roundworm is geohelminth which parasitizes only in human. Large intestinal roundworm eggs escape from human organism with feaces. Free oxygen is necessary for their development. Eggs develop about 24 days in the soil at optimum temperature 24–25ºC. Depending on fluctuations of temperature and humidity terms can differ.

Human swallows eggs with contaminated vegetables or fruits. In human intestine, larva escapes from egg and migrates in human body. It bores the intestine wall and with a blood travels into lungs. Oxygen is necessary for the further development of larva. From lungs the larva travels in a pharynx and with saliva can be again swallowed. Migration lasts about two weeks. Repeatedly entered intestine, the larva becomes mature. It takes 2-2.5 months. The female of large intestinal roundworm delivers up to 240 thousand eggs every day. The worm lives about one year. Several hundreds of large intestinal roundworm individuals can simultaneously parasitize in intestines of human.

Pathogenic value and diagnostics. Products of life activity of Ascaris lumbricoides are toxic for human. Symptoms of ascariasis are following: headache, fatigue, dizziness. Ascaris can cause intestinal congregation and mechanical jaundice. Migration of large intestinal roundworms into bile duct can cause jaundice; mi-

gration into liver — abscesses. Migrating larvae are the cause of allergic reactions, especially in lungs, referred as pneumonia. The diagnosis is based on detection of eggs in feaces.

Early diagnostics can be made at stage of migrated larvae (sputum examination and immunologic methods).

Preventive maintenance. Measures of personal preventive maintenance: following to personal hygiene rules, careful clearing and washing of vegetables, fruit and berries before the use as foodstuff. Measures of social preventive maintenance: treatment of ill people and health care education.

PIN WORM (Enterobius vermicularis) is the enterobiasis exciter.

Localization. Parasitizes in the lower section of small intestine.

Geographical distribution — worldwide.

Morphology characteristics. Pinworm is a small worm of white colour. Female is about 10 mm long, male — 2–5 mm. The posterior end of female is curved spirally. Eggs pinworms are asymmetrically oval. Pinworms eat intestine contents.

Life cycle. Pinworms are parasite only human. Changes of hosts are not present. The female with mature eggs is travel to anus mainly at night when the tonus of its sphincter weakens, pass out anus and lay their eggs in peryanal region. They may lay about 10–12 thousands of eggs. Crawling pinworms on a skin causes perianal itch.

Eggs become mature during 6–7 hour. Eggs can get to the hand while scratching. The eggs also can be transferred to the toys, linen and other staff. If eggs are swallowed, they quickly give a rise to mature organism. The life span of mature pinworm is about a month. Children are especially affected. They usually have autoinvasion.

Pathogenic value and diagnostics. The patients with enterobiasis have troubled sleep, tiredness. Pupils lose ability to study well. Sometimes, Enterobius vermicularis can cause appendicitis. Laboratory diagnostics is based on anal folds scrape or adhesive tape smear examination for eggs and revealing living pinworms. In feaces of ill people the pinworm eggs are absent more often.

Preventive maintenance. Measures of personal preventive maintenance: following to personal hygiene rules, careful clearing of fingernails. Regular wet sweeping of rooms is necessary. Measures of social preventive maintenance: treatment of ill people, health care education, separation of ill and health children in child care centers.

WHIPWORM (Trichocephalus trichiurus) is the exciter of trichocephaliasis.

Localization. In caecum and the upper sections of large intestine.

Geographical distribution — worldwide.

Morphology characteristics. Whipworm is about 3–5 cm long. Trichocephalus trichirus has the tread-like anterior end, which is longer than the posterior end. The posterior end of male is curved spirally. Eggs have barrel shape with thick cuticle of brown color. There are two colorless «plugs» on the poles. One mature female can deliver about 60000 eggs per day.

Life cycle. Whipworm is the parasite only human. Changes of hosts are not present. Eggs of whipworm with feaces escape in environment and develop in the soil during 20–25 days with temperature about 25–30ºC. If invasional egg comes into human intestine, it loses its shells and mature. Development of whipworm occurs without migration. Invasion occurs mainly at the use of the vegetables, fruits, and berries contaminated by eggs. Life span of Trichocephalus trichirus is about 5–6 years.

Pathogenic value and diagnostics. Pathogenic action of Trichocephalus trichirus is anemia and acute stomach ache. They may cause peritonitis and appendicitis. Diagnostics is based on faeces examination for eggs.

Preventive maintenance — the same, as at the ascariasis.

HOOKWORM (Ancylostoma duodenale) is the ancylostomiasis exciter.

Localization — in the duodenum and proximal parts of small intestine.

Geographical distribution. The ancylostomiasis is extended mainly in the countries with a subtropical and tropical climate. In the temperate climate the ancylostomiasis can arise in mines.

Morphology characteristics. Body of Ancylostoma is red colour. Length of female is 10–18 mm; male is 8–10 mm long. The anterior part of body is curved on the spinal side. Worm parasitizes in the duodenum of human. On the anterior end of the worm has buccal capsule with 4 teeth. The parasite catch small region of intestine by buccal capsule and suck the blood. Eggs of Ancylostoma are oval shape with the dull poles, are covered by thin transparent shell. Lifetime of the parasite is 4–5 years.

Life cycle. Hookworm is the geohelminth and parasitizes only at human. Eggs with feaces escape in an external environment. At appropriate temperature for more than a day, they can divide and form larvae, called rabditiform larvae. They are not invasional. The anterior end of intestine of larvae in this stage has long esophagus and ball-shaped bulbus with cutting plates. Rabditiform larvae in an external environment eat rotted organic substances. Larvae moult twice. At the second moulting the cuticle exfoliates but not comes off, so the larva preserves like in shell.

At the same time there is a rebuilt of the anterior part of intestine to cylindrical form. At this stage the larva becomes invasional (filariform). They can get in the human body by two ways:

1. Orally with the contaminated food and water;
2. Through undamaged skin.

Larvae do not migrate at oral invasion. They just catch intestine wall and start maturing. It takes 4–5 weeks to mature. Adult worms live about 1–3 years.

Transdermal invasion is possible when larvae bore the intact skin at contact of human to soil or plants. Larvae migrated in the human body. Through veins they travel into heart, then in lungs, respiratory tracts, and pharynx, then are swallowed with saliva and get into esophagus, stomach, and then in the duodenum. As invasion occurs at contact with soil, those who constantly walking on the land (workers of tea plantations, truck farmers, miners etc.) are infected mainly.

Pathogenic value and diagnostics. Patients suffer from stomachache, digestion disturbances, fatigue, headache, emaciation, and memory shortening. Children development becomes slower. All of these are due to blood lost. Laboratory diagnostics is based on faeces examination for eggs and larvae.

Preventive maintenance. Personal preventive maintenance consists in following personal hygiene and walking on the soil only in footwear in the ancylostomiasis regions; public — in revealing and treatment of ill patients, construction of toilets in towns and villages, health care education. Hookworm larvae can be destroyed in soil by potassium chloride.

In mining and a coal industry following actions are regularly carried out:

a. Inspection of all employed miners;

b. Give released time for sick miners;

c. Inspection of all miners on helminthoses;

d. Construction of underground sewage disposal and water supply systems;

e. Supply of miners by individual flasks with boiled water.

Necator americanus is the necatoriasis exciter. The disease is clinically indistinguishable from the ancylostomiasis.

The necatoriasis is extended in tropical and subtropical countries, mainly in Asia and the South America. Necator is similar in structure with hookworm. They cause same clinical symptoms. In general, they are called ancylostomids. In buccal capsule of Necator americanus there is two crescentic cutting plates that differ from Ancylostoma duodenale. Eggs are indistinguishable from hookworm eggs.

The diagnostics is the same, as at the ancylostomiasis.

Preventive maintenance — the same, as at the ancylostomiasis.

DWARF TREADWORM (Strongyloides stercoralis) is the strongyloidosis exciter.

Localization — in small intestine.

Geographical distribution. The disease occurs in the regions with moderate climate (Caucasus, Central Asia, Moldova, Ukraine, and in a number of Russian districts) but extremely often in tropics and subtropics.

Morphology characteristics. Dwarf treadworm is a very small worm. The female of parasitic generation is 2–3 mm long, male — 0.7 mm.

Life cycle is a very complicated and related to existence of free living and parasitic generations. Dwarf treadworm parasitizes only at human.

The fertilised females produce eggs from which rabditiform larvae are develop in the human intestine. They may have two ways of development:

1. Direct development.

1. The rabditiform larvae escape the human organism with feaces. The larvae live in the soil, grow, molt twice and become the infective (filariform larvae). They can enter human body with contaminated food or through undamaged skin. If they have entered transdermaly, they migrate as Ancylostoma duodenale larvae. When they have got to the intestine, they start to mature. It takes about two weeks. Then, mature organism copulates. After copulation, females enter intestine wall and start to produce eggs.

2. Indirect development:

1) The rabditiform larvae escape the human organism with feaces. The rabditiform larvae in the soil develop to male and female worms of the free living generation. Free living females are fertilized and produced eggs from which rabditiform larvae are develop. Depending on environment conditions, larva can develops in mature forms of the next free living generation or in filariform larvae which are infective for human;

2) The rabditiform larvae do not escape the human organism and after moulting develop in the filariform larvae which bore intestine wall and migrate through the human body as Ancylostoma duodenale larvae. Then they mature in the human intestine lumen. This way of development is called autoinvasion.

Pathogenic value and diagnostics. Patients suffer from digestion disturbances, emaciation. On the early stage, the allergic reactions are observed. Laboratory diagnostics is based on faeces examination for larvae.

Preventive measures — same as for ancylostomiasis.

TRICHINA WORM (Trichinella spiralis) is the trichinelliasis exciter.

Localization. Larvae of trichina worm live in striated muscles, and mature trichina worm — between villi of small intestine of human and animals.

Geographical distribution. The trichinelliasis has casual worldwide distribution.

Morphology characteristics. Trichina worm is a very small helminth. The female is 2.6–3.6 mm long, the male — 1.4–1.6 mm.

Life cycle. The trichinelliasis is zoonosis disease. Except human trichina worm parasitize at pigs, rats, dogs, cats, bears, foxes and many other mammals. Any animal organism, in which trichina worm lives, is simultaneously definite and intermediate host. Mature worm lives in small intestine of host about 1.5–2 months. Males are die after copulation, but females produce about 1500–2000 of larvae during the life. Larvae travel into lymphatic system and then are spread by the blood flow on all parts of organism but enter only in striated muscles (diaphragm, tongue muscles, masseter, deltoideus, gastrocnemius, intercostal muscles and other). The migration period lasts from 2 to 6 weeks. Entering muscles, the larva is curved spirally and covered by calcium shell. In calcinated capsule, the larvae can survive for years.

To mature, the larvae should enter intestine of the other host. For example, infected rat can be eaten by pigs, dogs, foxes. The capsules are digested by digestive enzymes. The larvae are released and they mature in 2–3 day. Human can be infected by eating infected pork or meat of wild animals (bears, wild boar and etc.). Heat treatment of meat does not kill the trichina worms.

Pathogenic value and diagnostics. The human clinical signs of the trichinelliasis are various: from asymptomatic forms to death. It depends from a number of the swallowed larvae. The incubation interval lasts from 5 to 45 days. The diagnosis is based on clinical signs (fever, headache and muscle ache, oedemata, marked eosinophilia, fatigue, and digestive disturbances) and muscle biopsy results. Immunobiological reactions are applied also.

The preventive measures include microscoping of muscles of killed animals for larvae. The veterinary inspection of pork and wild meat should be made on farms, meatpacking plants, and markets.

MEDINA WORM (Dracunculus medinensis) is the dracunculiasis exciter.

Localization — in skin derma layer near joints mainly in lower limbs.

Geographical distribution — Iraq, India, Pakistan, tropical Africa and other countries with tropic and subtropic climate.

Morphology characteristics. The thread-like female is from 30 to 150 cm long; male — 12–29 mm long.

Life cycle is related to change of hosts. The definite host is human, sometimes dog; intermediate — small Crustacean (Copepoda). The development cycle of the medina worm is studied by the Russian zoologist A. P. Fedchenko.

Being in the skin derma layer of the definite host, the medina worm forms thread-like roller. Near anterior end of the roller, the dracunculema (vesicle filled by serum fluid) is formed. In case itching in the water, the vesicle can be ruptured; the female parasite pushes out the head and releases the larvae. Larvae are swallowed by intermediate host — Copepoda. Within it, they transforms to microfilaria (invasional stage). The small crustacean can be swallowed with the water. In the intestine, microfilaria bores the intestine wall and enters the blood vessels and travel to the skin derma. In the derma they mature for a year.

Pathogenic value and diagnostics. The clinical symptoms are itching, allergic reactions on migrating larvae, tissue ulcers, which can be accompanied by secondary infection. Diagnostics is based on visual skin examination for parasite.

Preventive maintenance. In the regions of the dracunculiasis, it is necessary to boil or filter water before drinking. Social preventive measures are to provide clean, fresh water supply in the dracunculiasis regions and to treat ill people.

FILARIAS (roundworms of family Filariidae) — are exciters of filariasis.

Filariases are biohelminthoses with transmissive way of invasion. All parasites of this family are common in tropics. The final hosts for these parasites are human and some other mammalian species. The intermediate hosts are sanguivorous insects (mosquitoes, gadflies, greases).

Wuchereria bancrofti — is the exciter of wuchereriasis. The size of female is about 80–100 mm; male - about 40 mm. The definite host is human, intermediate host is mosquitos of genera Anopheles, Culex, Aedes, and etc. Adult filarias in the human body live about 20 years and localised in the lymph nodes and vessels. The veins and lymphatic vessels are dilated by them and elephantiasis is developed. Wuchereriasis is spread in West and Central Africa, South-East Asia, on Caribbean islands.

Brugia malayi — is the exciter of brugiasis. Life cycle and symptoms of disease is similar with wuchereriasis. The size of female is about 55 mm; male — about 22 mm. The definite hosts are human and animals: cats, dogs, and monkeys. Intermediate hosts are mosquitos of genera Anopheles, Aedes, and etc. It is spreaded in a number of countries of Asia.

Loa loa — is the loasis exciter. The size of female is about 150 cm, male — 3 cm. The definite hosts are human and some monkeys. The intermediate host is gadflies of genus Chrysops. The loasis is spreaded in the regions with wet tropical forests of the Western and Central Africa.

The pathogenic action is due to allergic reaction on helminth antigens and due to mechanical wounding of tissue by crawling parasites. If they have come to the eye, they can cause conjunctivitis, edema of optic disc, paresis of eye moving muscles.

Onchocerca volvulus — is the onchocercosis exciter. The size of female is about 33–34 mm, male — from 19 to 42 mm. The definite host is human; intermediate host is gnats of genus Simulium. The onchocercosis is spread in Africa and in the tropical America.

Symptoms of onchocercasis are skin itching resulting in dermatitis and formation of dense connective nodes (onchocercoma). Like the loasis, onchocercosis can cause eye affections.

Preventive measures of filariosises are revealing and treatment of ill patients, combating with mosquitos, gadflies, gnats.

Theme 11. Medical arachnoenthomology

Plan:

1. Arachnids as exciters and vectors of transmissive diseases of human.
2. Insects as exciters and vectors of transmissive diseases of human.

Medical arachnoenthomology — is the section of medical parasitology studying value of arthropods as ectoparasites, exciters and transmitters of disease exciters of human.

1. Arachnids as exciters and vectors of transmissive diseases of human

In Arachnidea class, the important medical value has mites. It is a broad group of animals; many of species are blood-sucking, parasitizing on birds, mammal and human, and play role of transmitters of disease exciters. The major families are Ixodidae, Argasidae, Tpombiculidae, Demodicidae, Gamasoidae, and Tyroglyphidae.

Representatives of class Arachnidea, order Acarina (Acari), family Ixodidae as vectors of transmissive diseases

The Ixodidae family includes the following genera: Ixodes, Dermatocentor, Hyalomma and others. The typical representatives of Ixodes genus are dog and taiga mite. The typical representative of Dermatocentor genus is pasture mites.

The dog mite (Ixodes ricinus) live in forests of Europe. It supports rabbit fever and West-European encephalitis virus circulations. The taiga mite (Ixodes persulcatus) is morphologically similar with the dog mite. It occurs in the forests of Europe and Asia. It lives as parasite on many species of birds and mammals. It supports circulation of taiga encephalitis virus.

The mites of Dermatocentor genus have dorsal shield with enamel picture. It occurs in Siberia, and European part of Russia. The larvae and nymphs attack

only small animals, whereas mature mites can attack big animals and human. The Dermatocentor pictus and Dermatocentor marginatus are vectors of rabbit fever exciter. The Dermatocentor nuttali is vector of Omsk's hemorrhagic fever virus and spotted Rocky Mountains fever virus.

The mites of Hyalomma genus differ from other mites of family by very thick and long legs. They live in steppe regions and in tropical mountains of South Europe. They can be vectors for Crimean-Congo fever virus.

Family Argasidae as vectors of transmissive diseases

The village mite (Ornithodorus papillipes) — is typical representative of Argasidae. It is vector of relapsing fever exciter. They occur in West China, India, Iran, Iraq, Syria, south states of USA, Venezuela, Columbia, and other countries.

Family Trombiculidae as vectors of transmissive diseases.

The representatives of Trombiculidae family are spread worldwide. The larvae need blood to development. The larvae of Trombicula acamushi can transmitte rickettsia of tsutsugamushi fever, which occurs in Far East, Japan, India, Pakistan, China and other countries.

The mites as parasites of human skin

The exciter of human scabies is Sarcoptes scabiei. It is spread worldwide. The oral apparatus is adapted to gnawing in human skin. They gnaw 2-3 mm canal every day. Way of infection is contact.

Demodex folliculorum is the small mites with worm-like body. They inhabit oil-bags and hair follicles of human and mammalians. It is spread worldwide.

The mites as inhabitant of human dwelling

The representatives of Tyroglyphidae family — are small eyeless mites. They eat food storage. The food infected by such mites can cause irritation in digestive tract. It also can be allergic. The mites can cause dermatitis when bite human. They can cause also acariosis of respiratory system. The representatives of this family are Tyroglyphus farinae and Tyroglyphus siro.

The mites of Dermatophagoides genus live in pillows, mattress, carpet, and so on. They can cause allergic reactions.

2. Insects as exciters and vectors of transmissive diseases of human

Order Blattoidea

The Blatta orientalis (black cockroach), Blatta germanica (red cockroach), Polyphaga saussurei (Egypt's cockroach), Periplaneta Americana (American cockroach) occur in the human dwelling. They are mechanical vectors of different infections and invasions. They can transmit on their legs the exciters of diphtheria, typhoid, and cholera, cysts of protozoa, and helminthes eggs.

Order Hemiptera

Bed-chinch (Cimex lectularis) is representative of this order. It is most adapted to parasite mode of life. The body is flat. The wings are reduced. They can fast for several months. They attack human at night and suck the blood.

In tropics, the C. rotundatus inhabit the human dwelling. The role in transmitting exciters of diseases was not proved.

The kissing chinches are spread in South and Central America. They are sanguivorous insects. They are vectors of Chagas's disease exciters. The chinches of Triatoma infestans and Panstrongylus megistus transmit the trypanosomiasis.

Order Anoplura

Two species parasitize on the human body: Pediculus humanus (human louse) and Phtirus pubis (pubic louse). The species Pediculus humanus has two subspecies: P. humanus capitis — the head louse, P. humanus humanus — body louse.

Biting, the louses put saliva on the wound that causes inching and skin pigmentation. The louses living on human body was called pediculiasis. The disease caused by pubic louse is called phtiriasis.

The head and body louse can transmit the exciter of spotted fever (Rickettsia provaczeka). The head and body louse can transmit the exciter of louse relapsing fever.

Order Aphaniptera

The representatives are Pulex irritans (human flea), Xenopsilla cheopis, Ceratophyllus fasciatus and others. The fleas suck blood of human, rats, and other animals. The human flea lives in floor splits, under wallpapers. The fleas can transmit plague, tularemia, endemic rat typhus, and brucelliasis.

Order Diptera

Family Culicidae (mosquitoes)

The mosquitoes of Anopheles genus are definite hosts and transmitter for malaria exciters. In tropics, the Anopheles mosquitoes are transmitter for exciters of brugiasis and wuchereriasis.

The Culex mosquitoes are specific vectors for exciter of Japanese encephalitis, West Nil encephalitis, wuchereriasis and brugiasis.

The Aedes mosquitoes maintain circulation of yellow fever virus, Japanese encephalitis virus, exciters of brugiasis and wuchereriasis.

Family Simuliidae (gnats)

They are small (2–5 mm long) ectoparasites of animals and human. Attacking them, the gnats are very troublesome (crawl over the body and under the clothes, enter the nose and ears). They can transmit exciters of tularemia and onchocercosis in tropical Africa and America.

Family Phlebotomidae (mosquitoes)

They are small (1.2–3.7 mm long) sanguivorous insects. It causes itching with inflammatory reaction. Human can have troubled sleep, high temperature, and fatigue after repeated bite by the insects. They are specific vectors for exciters of leishmaniasis and phlebotomic fever.

Family Ceratopogonidae (greases)

Insects of this family can be found worldwide except Arctic zone. The acute inflammatory reaction with severe itching develops after greases biting. In tropics of America and Africa, the greases can be transmitters of filiariases (Mansonella ozardi). In China, the greases can be transmitters of the Japanese encephalitis virus. In Russia, the virus of lymphocyte choriomeningitis and bacteria of tularemia were found in greases.

Family Tabanidae (gadflies)

Insects of this family are ectoparasites of human and animals. Their saliva is toxic. It causes inflammatory reaction of host. The gadflies are transmitters of tularemia bacteria, anthrax bacteria, and loasis exciters.

Family Muscidae (real flies)

The typical representatives of family are house fly (Musca domestica), market fly (Musca sorbens), biting fly (Stomoxys calcitrans) and tsetse flies (Glossina palpalis, Glossina morsitans). The flies are nonspecific, mechanical vectors for exciters of infections (dysentery, typhoid, cholera), of tuberculosis, diphtheria and also of helminthes eggs and protozoa cysts. The biting fly and tsetse fly are sanguivorous. The biting fly can participate in spreading of zoonosis infections (tularemia, plague, anthrax, brucilliasis). The tsetse flies are specific transmitters for exciters of African trypanosomiasis.

Family Sarcophagidae (grey meat flies)

Family is presented by grey meat fly, Wolfart's fly, and others species which deliver larvae. The larvae of Wolfart's fly develop in wounds, in lumen of animals and human. They cause severe damage of internal organs. The grey meat flies can be transmitters for exciters of alimentary infections.

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Гаврилова Лариса Петровна
Фомченко Наталья Евгеньевна
Потенко Владимир Владимирович

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(на английском языке)

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