***PUBLIC HEALTH MINISTRY OF UKRAINE***
KHARKIV NATIONAL MEDICAL UNIVERSITY

# *WORKBOOK FOR PRACTICAL CLASSES IN MEDICAL BIOLOGY*

## *Semester II*

*OF THE FIRST-YEAR STUDENT*

*OF* _____ *FACULTY*

_____ *(name, surname)*

*GROUP №* _____

*TUTOR* _____

**KHARKIV 2017**

*Workbook for practical classes in Medical Biology* for the first-year students of 6th faculty for foreign students (General Medicine). *Semester II* / Authors: Valeriy V. Myasoyedov, Ludmila G. Dugel, Helena S. Mangeley, Olga E. Fedorchenko, Boris V. Kulachenko, Irene P. Meshcheryakova, Olga B. Khromenkova, Yuriy A. Sadovnychenko. — Kharkiv, 2017. — 80 pp.

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## *Unit 3: Population, holocoenotic and biospheric levels of life organisation*

| № | Date | Theme | Mark |
|---|---|---|---|
| ***20*** | | Introduction to Medical Parasitology. Medical Protozoology. Subkingdom Protozoa. Phylum Sarcomastigophora. Class Lobosea | |
| ***21*** | | Phylum Sarcomastigophora. Class Zoomastigophora (Flagellata) I: causative agents of human diseases | |
| ***22*** | | Phylum Sarcomastigophora. Class Zoomastigophora (Flagellata) II: causative agents of human diseases | |
| ***23*** | | Phylum Apicomplexa. Class Sporozoa: causative agents of human diseases. Phylum Ciliophora. Class Litostomatea: causative agents of human diseases | |
| ***24*** | | **Lab Practical Exam 3: Medical Protozoology** | |
| ***25*** | | Medical Helminthology. Phylum Flatworms (Plathelminthes). Class Flukes (Trematoda) I: causative agents of human diseases | |
| ***26*** | | Phylum Flatworms (Plathelminthes). Class Flukes (Trematoda) II: causative agents of human diseases | |
| ***27*** | | Phylum Flatworms (Plathelminthes). Class Tapeworms (Cestoidea) I: causative agents of human diseases | |
| ***28*** | | Phylum Flatworms (Plathelminthes). Class Tapeworms (Cestoidea) II: causative agents of human diseases | |
| ***29*** | | Phylum Roundworms (Nemathelminthes). Class True Roundworms (Nematoda) I: causative agents of human diseases. Geohelminthes | |
| ***30*** | | Phylum Roundworms (Nemathelminthes). Class True Roundworms (Nematoda) II: causative agents of human diseases. Biohelminthes | |
| ***31*** | | **Lab Practical Exam 4: Medical Helminthology** | |
| ***32*** | | Medical Arachnoentomology. Phylum Arthropoda. Class Crustacea. Class Arachnoidea. Ticks and mites: causative agents and vectors of human diseases | |
| ***33*** | | Phylum Arthropoda. Class Insecta: causative agents and vectors of human diseases | |
| ***34*** | | The biosphere as a system that provides existence of human being. Human ecology | |
| ***35*** | | **Lab Practical Exam 5: Medical Arachnoentomology** | |

## SHORT SYLLABUS FOR MEDICAL PARASITOLOGY

All rules and requirements described in *Medical Biology Syllabus* (see the notebook for Semester I) are true for Semester II

There is more precise below.

**I. Purpose of the Course:** to learn principles of parasitism and many aspects of parasite biology. Parasites causing human diseases will be studied, with emphasis on their occurrence, transmission, reservoirs and methods of control. The course includes 16 Themes in Medical Parasitology and Human Ecology.

**II. Classes**

Classes are practical works to teach students the major types of medically important parasites (protozoans, helminthes and arthropods). The list of themes is on page 3.

***Attendance:*** Attendance of all classes and lectures is mandatory. Disruptive behavior (i.e. coming to class late, talking during the classes and lectures that is not part of the discussion, and leaving class before the end of lecture) could result in the student being asked to leave class and an absence being recorded. If the student has missed lecture(s) (regardless of reason) he/she must work off it/them **verbally** before the Lab Practical Exam 5.

**III. Tests and Exams**

Knowledge will be estimated by multiple-choice tests in each theme and three Lab Practical Exams given throughout the semester. Exams include the control of the practical skills to identify common parasites of humans and MCT of shared base of License Exam "Krok 1".

**Lab Practical Exam 3** includes the identification of the pictures and permanently preserved specimens of protozoans and respective MCT of shared base of License Exam "Krok 1".

**Lab Practical Exam 4** includes the identification of the pictures and permanently preserved specimens of helminthes (flukes, tapeworms and roundworms) and respective MCT of shared base of License Exam "Krok 1".

**Lab Practical Exam 5** includes the identification of the pictures and specimens of arthropods and respective MCT of shared base of License Exam "Krok 1".

The students have to pass *both* all tests *and* exams before Final Exam!!!

A charge of **$20.00** will be made for each slide that is lost, broken or damaged sufficiently to be useless of teaching purposes, although many of these slides cannot be replaced at any price. All broken slides must be accounted for. Failure to do so will result in your grade being withheld from the Dean Office.

We regret having to take such drastic steps to insure the survival of our slide collection, but we are sure that you will come to appreciate its unique value and will cooperate fully with us in this matter.

***Additionally:*** your filled notebook must be signed by your tutor.

**IV. Evaluation**

The results of MCT and Lab Practical Exams are evaluated by *"5", "4", "3", "2"* marks. At the end of semester, a student's marks are converted into points according to current grading scale.

*Final Grade in Medical Biology* is a **SUM** of arithmetical mean of both *Semester's Current Scores* and Final Exam. It ranges from 122 to 200 pts.

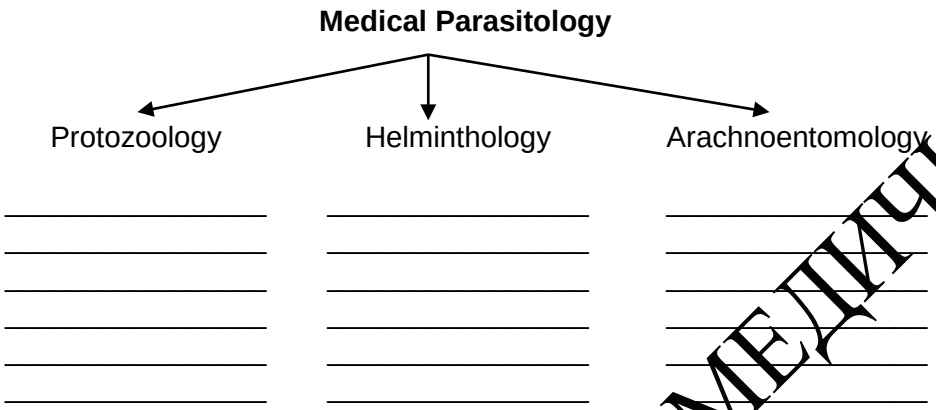
$$\text{Final Grade} = \overline{\text{Current Score}} + \text{Exam Result}$$

**Theme 20: Introduction to Medical Parasitology. Medical Protozoology. Subkingdom Protozoa. Phylum Sarcomastigophora. Class Lobosea**

**Task 1.** Give the definition *Medical Parasitology*?

***Medical Parasitology*** - _____

**Task 2.** What do the special branches of Medical Parasitology study?




**Task 3.** Inter-specific associations. Give the definitions and examples.

**No effect**

**1**. ***Commensalism*** – _____

*Examples*: _____

Synoecious commensalism – _____

**Benefit effects**

**2**. ***Mutualism*** – _____

*Examples*: _____

**Harm effects**

**3**. ***Parasitism*** – _____

*Examples*: _____

**Task 4.** Characterize the components of "*parasite – host*" system.

**Parasite**

– obligate parasite _____

– facultative parasite _____

– false parasite _____

**Host**

– definitive host _____

– intermediate host _____

– reservoir host _____

**Vector –** _____

**Task 5.** Write the routes of parasite transmission:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

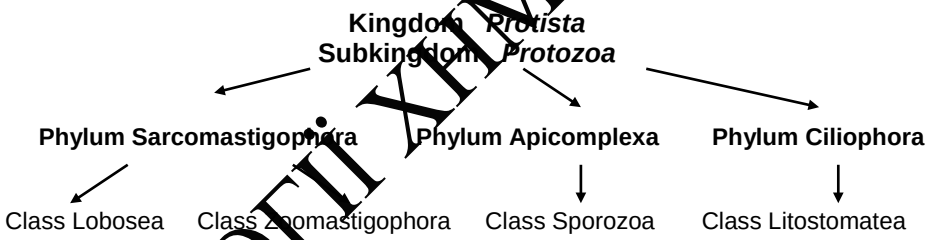
**Task 6.** Study the effects of a parasite on a host and write them down.

1._____
2. _____
3._____
4._____
5. _____
6. _____
7._____
8._____
9. _____

**Task 7**. You must know about every parasite organism the following:

1. Classification (Taxonomy)
2. Latin name
3. Disease
4. Geographic distribution
5. Morphological features
6. Localization inside human body
7. Invasive stage for a human
8. Route and factors of transmission
9. Source of invasion
10. Life cycle
11. Pathogenicity
12. Laboratory diagnosis
13. Prophylaxis (Prevention)

**Task 8**. Study the modern classification of *Protozoa* that is based on the structure of locomotory organelles and nuclear apparatus.




***Class* Lobosea – *Amoebae***

**Order** Amoebida
**Family** Amoebidae
**Genus** *Amoeba*
**Species** *Amoeba proteus*

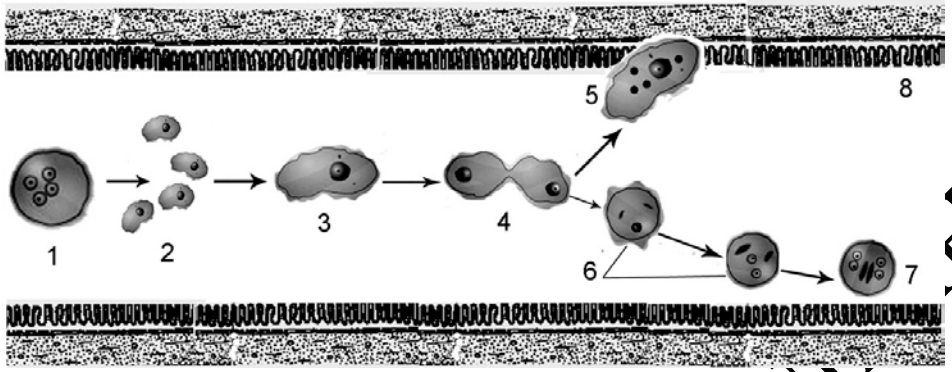
**Task 9.** Examine the mount of free-living species – *Amoeba proteus* under low and high magnification of the microscope. Pay attention to the body shape, presence of vacuoles. Sketch the mount in the notebook, make the following designations: nucleus, pseudopodia, ectoplasm, endoplasm, food and contractile vacuoles.

**1.**_____
**2.**_____
**3.**_____
**4.**_____
**5.**_____
**6.**_____

**Order** Amoebida
**Family** Entamoebidae
**Genus** *Entamoeba*
**Species** *Entamoeba histolytica*
*Entamoeba coli*
*Entamoeba gingivalis*

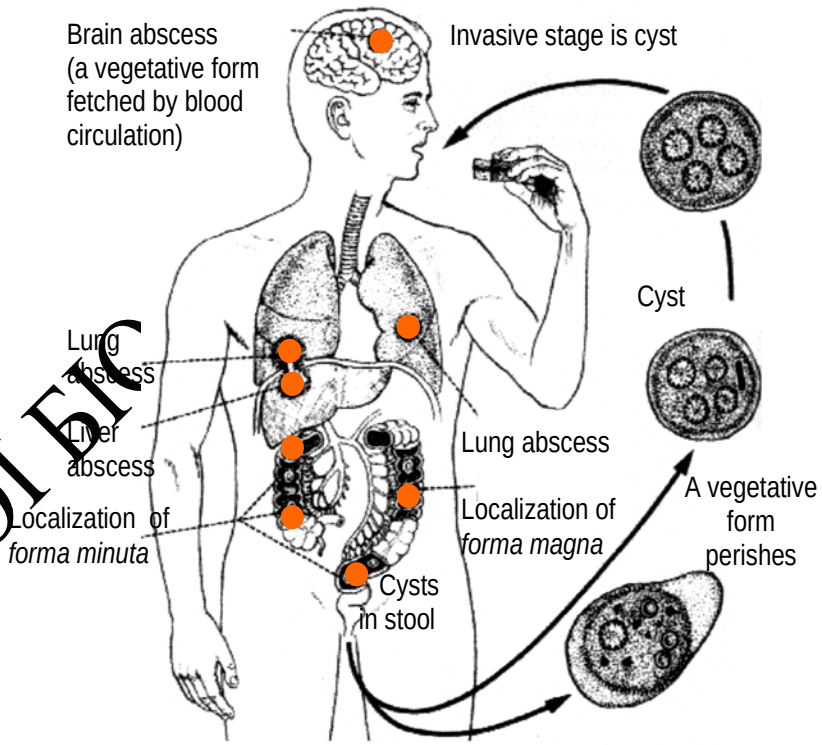
**Task 10.** Study the life-cycle of *Entamoeba histolytica*. Make the designations

**Scheme of *Entamoeba histolytica* life-cycle**




1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

**Life-cycle of *Entamoeba histolytica***




**WHO: *Amoebiasis***

Worldwide, approximately 50 mln cases of invasive *E histolytica* disease occur each year, resulting in as many as 100,000 deaths. This represents the tip of the iceberg because only 10%-20% of infected individuals become symptomatic. The incidence of amebiasis is higher in developing countries.

The prevalence of *Entamoeba* infection is as high as 50% in areas of Central and South America, Africa, and Asia.

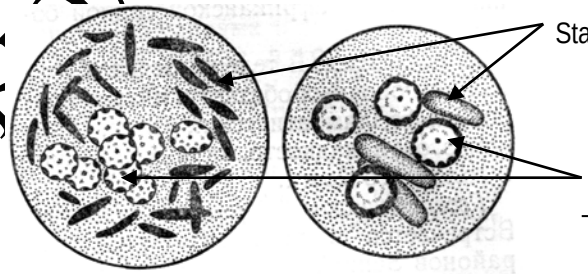
**Task 11.** Fill in the table.

**Comparison of *Entamoebae* species**

| Characteristics | Species of *Entamoebae* | | |
|---|---|---|---|
| | *E. histolytica* | *E. coli* | *E. gingivalis* |
| Localization inside human body | | | |
| Nutrition | | | |
| Cyst morphology | | | |
| Vegetative form (trophozoite) | *forma minuta* | | |
| | *forma magna* | | |
| Pathogenicity | | | |
| Laboratory diagnosis | | | |

***Entamoeba histolytica***
Microphotograph of a vegetative form (*forma magna*) in the faeces specimen

**Task 12.** Study a figure below; make the designations of inner components.




_____ _____ _____

**Family** Vahlkampfiidae
**Genus** Naegleria
**Species** *Naegleria fowleri*

**Family** *Acanthamoebidae*
**Genus** *Acanthamoeba*
**Species** *Acanthamoeba spp*

} *facultative parasites of human*

**Task 13.** Fill in the table.

**Comparison of *Naegleria* and *Acanthamoeba* species**

| Characteristics | *Naegleria* | *Acanthamoeba* |
|---|---|---|
| Disease(s) | | |
| Morphology<br>- size<br>- pseudopodia | | |
| Localization inside human body | | |
| Route and factors of transmission | | |
| Pathogenicity | | |
| Laboratory diagnosis | | |



**Test questions:**

**1**. In protozoans, the function of contractile vacuoles is
A. participation in photosynthesis
B. participation in movement
C. osmoregulation
D. food digestion
E. gamete production

**2**. A non-pathogenic free-living species is
A. *Naegleria fowleri*
B. *Entamoeba coli*
C. *Entamoeba gingivalis*
D. *Entamoeba histolytica*
E. *Amoeba proteus*

**3**. The most commonly involved area in amoebiasis is
A. duodenum
B. liver
C. cecum
D. brain
E. spleen

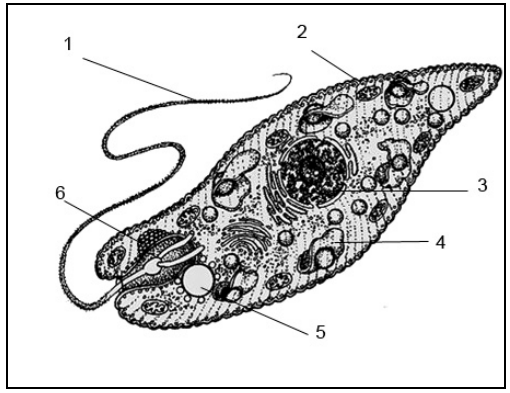
| Date | Signature |
|---|---|
| | |

## Theme 21: Phylum Sarcomastigophora. Class Zoomastigophora (Flagellata) I: causative agents of human diseases

**Order** Euglenales
**Family** Euglenaceae
**Genus** *Euglena*
**Species** *Euglena viridis**

*(Taxonomic position of *E.viridis* is still questionable)

**Task 1.** Examine the mount of *Euglena viridis* under low and high magnifications of a microscope. Pay attention to the shape of its body, presence of chloroplasts. At the figure below, make the designations: flagella, pellicle, nucleus, chloroplast, contractile vacuole, and stigma.




**1.** _____
**2.** _____
**3.** _____
**4.** _____
**5.** _____
_____
**6.** _____

Medical significance of *E. viridis* _____
_____
_____
_____

**Order** Diplomonadida
**Family** Hexamitidae
**Genus** *Giardia*
**Species** *Giardia lamblia (Lamblia intestinalis)*

**Task 2.** Examine the vegetative forms of *Giardia lamblia (Lamblia intestinalis)* under high magnification of the microscope. Sketch a *Lamblia* trophozoite and make the designations of organelles: two symmetrically placed nuclei, axostyle, flagella and disk-like sucker (adhesive disk). Sketch a *Lamblia* cyst.

Vegetative form of *Lamblia intestinalis*

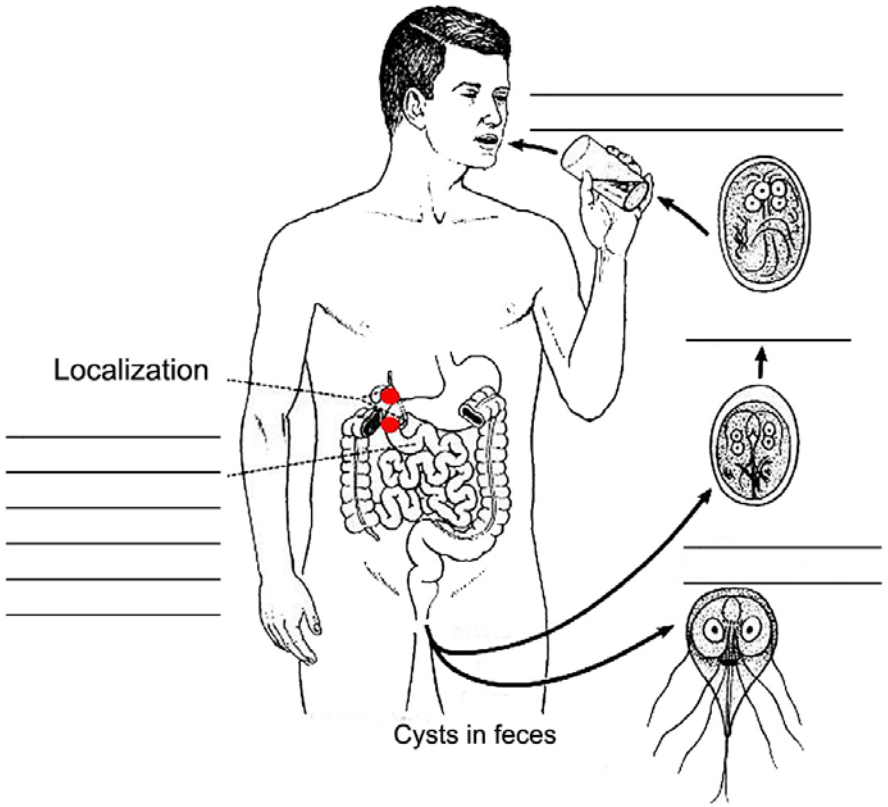
**1.** _____
**2.** _____
**3.** _____
**4.** _____

*Lamblia* cyst

_____
_____
_____
_____
_____
_____

**Task 3.** Study the life-cycle of *Lamblia intestinalis*. Make the designations.

**Life-cycle of *Lamblia intestinalis***




**WHO: *Lambliasis***

Lambliasis is worldwide distributed illness.

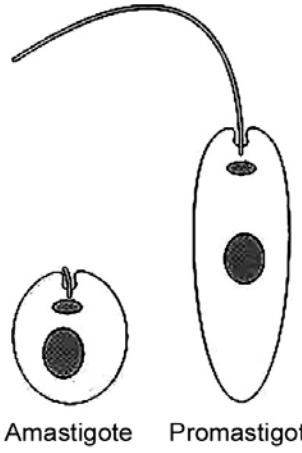
There is a significant risk for travelers in contact with recreational waters used by wildlife, with unfiltered water in swimming pools or with contaminated municipal water supplies.

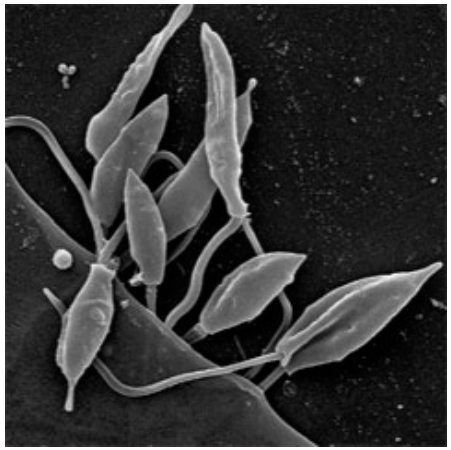
**Order** Kinetoplastida
**Family** Trypanosomatidae
**Genus** *Leishmania*
**Species** *Leishmania* spp

***Leishmania*** species

| Dermatotropic group | Viscerotropic group |
|---|---|
| ***Leishmania tropica minor*** | ***Leishmania donovani*** |
| ***Leishmania tropica major*** | ***Leishmania infantum*** |
| ***Leishmania tropica mexicana*** | |
| ***Leishmania braziliensis*** | |

***Vital stages of Leishmania***



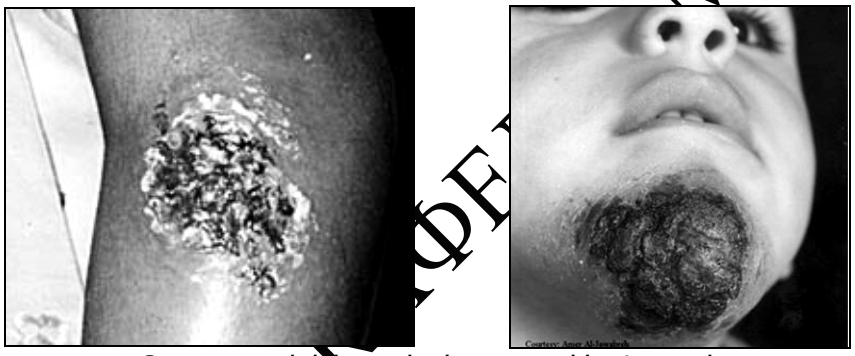
Scanning electron microphotograph of *Leishmania* promastigotes

## Dermatotropic group of *Leishmania*

**Task 4.** Examine the specimen of dermatotropic *Leishmania* parasites under high magnification of the microscope. Sketch the parasites and make the designations.

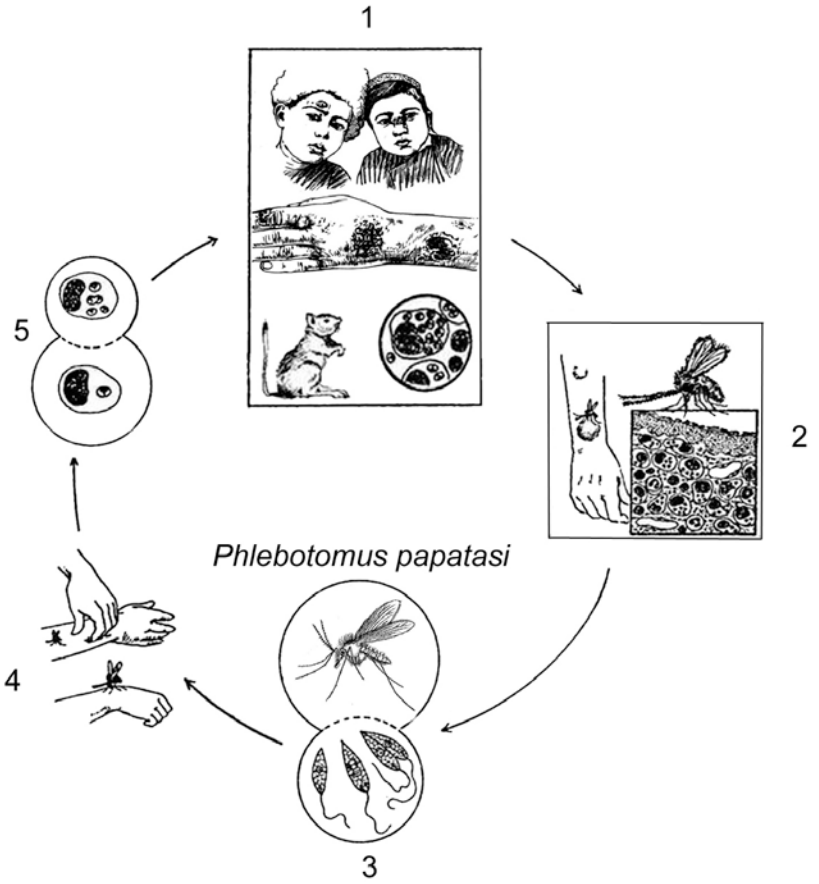
**WHO: *Cutaneous leishmaniasis***

Cutaneous leishmaniasis (CL) is the most common form of leishmaniasis. About 95% of CL cases occur in the Americas, the Mediterranean basin, and the Middle East and Central Asia. Over two-third of CL new cases occur in six countries: Afghanistan, Algeria, Brazil, Colombia, Islamic Republic of Iran and the Syrian Arab Republic. An estimated 0.7 million to 1.3 million new cases occur worldwide annually.



*Cutaneous leishmaniasis, caused by L. tropica*

**Task 5**. Study the life-cycle of *Leishmania tropica major* using a table. Make the designations.




1. _____
2. _____
3. _____
4. _____
5. _____

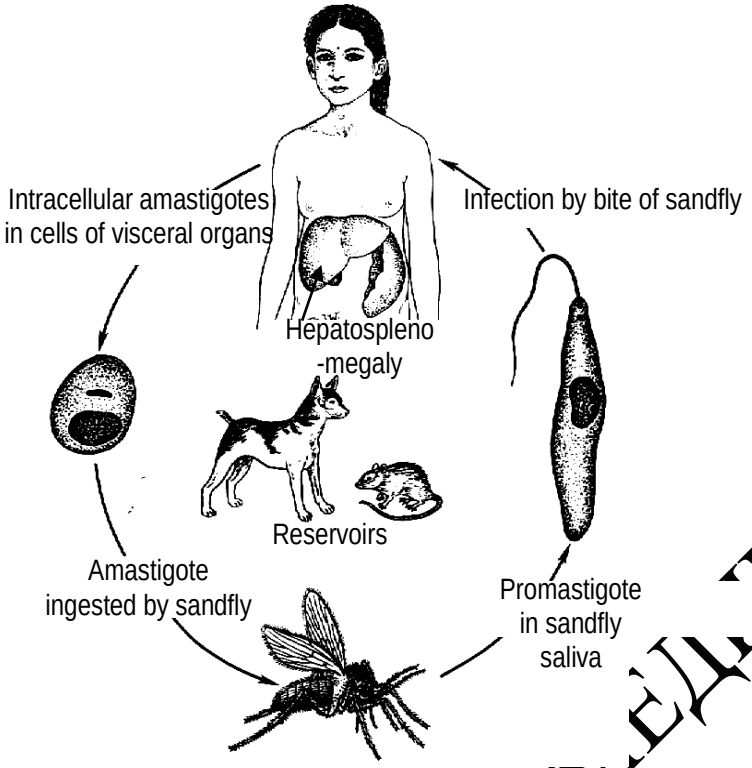
**Task 6.** Fill in the table.

**Comparison of dermatotropic *Leishmania* species**

| Characteristic | *L. tropica minor* | *L. tropica major* | *L. braziliensis* |
|---|---|---|---|
| Disease | | | |
| Vital forms | | | |
| Source of invasion | | | |
| Invasive stage for a human | | | |
| Route and factors of transmission | | | |
| Localization inside human body | | | |
| Pathogenicity | | | |
| Laboratory diagnosis | | | |
| Prophylaxis | | | |

## Viscerotropic group of *Leishmania*

**Task 7.** Study the life-cycle of *Leishmania donovani*.




**WHO: *Visceral leishmaniasis***

Visceral leishmaniasis (VL), also known as kala-azar, is fatal if left untreated. It is characterized by irregular bouts of fever, weight loss, enlargement of the spleen and liver, and anaemia. It is highly endemic in the Indian subcontinent and in East Africa. An estimated 200 000 to 400 000 new cases of VL occur worldwide each year. Over 90% of new cases occur in six countries: Bangladesh, Brazil, Ethiopia, India, South Sudan, and Sudan.

**Task 8.** Fill in the scheme below. Give the definitions and examples.

**Invasive diseases**

| **Anthroponosis** | **Zoonosis** | **Anthropozoonosis** |
|---|---|---|
| | | |
| Examples: | Examples: | Examples: |

**Task 9.** Fill in the table.

**Comparison of viscerotropic *Leishmania* species**

| Characteristics | *Leishmania donovani* | *Leishmania infantum* |
|---|---|---|
| Disease | | |
| Vital forms | | |
| Source of invasion | | |
| Invasive stage for a human | | |
| Route and factors of transmission | | |
| Localization inside human body | | |
| Pathogenicity | | |
| Laboratory diagnosis | | |
| Prophylaxis | | |

**Test questions:**

**1.** Which of the following is ***not*** true of *Euglena*?

A. It contains chloroplasts
B. It absorbs nutrients such as vitamins from its environment in a heterotrophic manner
C. It moves by pseudopodia
D. Its cell body is not surrounded by a cell wall
E. none of these; all statements are true

**2**. The stool of a patient infected with what parasite is described as steatorrheic?

A. *Entamoeba histolytica*
B. *Leishmania donovani*
C. *Amoeba proteus*
D. *Lamblia intestinalis*
E. *Entamoeba gingivalis*

**3.** An U.N. military officer returned from a tour of duty in the Middle East. He has served in a desert area where sand flies were abundant. He had several painless ulcers on his forearms. What diagnosis is most likely to be?

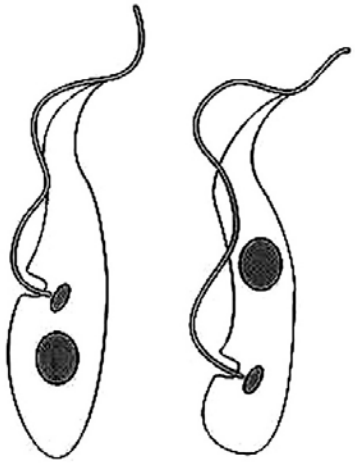
A. Lambliasis
B. Visceral leishmaniasis
C. Cutaneous leishmanisis
D. Amoebiasis
E. Kala-azar

| Date | Signature |
|---|---|
| | |

**Theme 22: Phylum Sarcomastigophora. Class Zoomastigophora (Flagellata) II: causative agents of human diseases**

**Order** Kinetoplastida
**Family** Trypanosomatidae
**Genus** *Trypanosoma*
**Species** *Trypanosoma brucei gambiense*
*Trypanosoma brucei rhodesiense*
*Trypanosoma cruzi*

***Vital forms of Trypanosomes***



Epimastigote Trypomastigote


*Scanning electron micrograph of Trypanosomes*

**Task 1.** Examine the trypanosomes in blood smear of a patient. Sketch some trypanosomes in the blood plasma. Make the designations of trypanosomes, erythrocytes and organelles of *Trypanosoma* body: nucleus, flagella, undulating membrane, blepharoplast.

_____
_____
_____
_____
_____
_____

**WHO:** ***Human African trypanosomiasis, or African sleeping sickness***

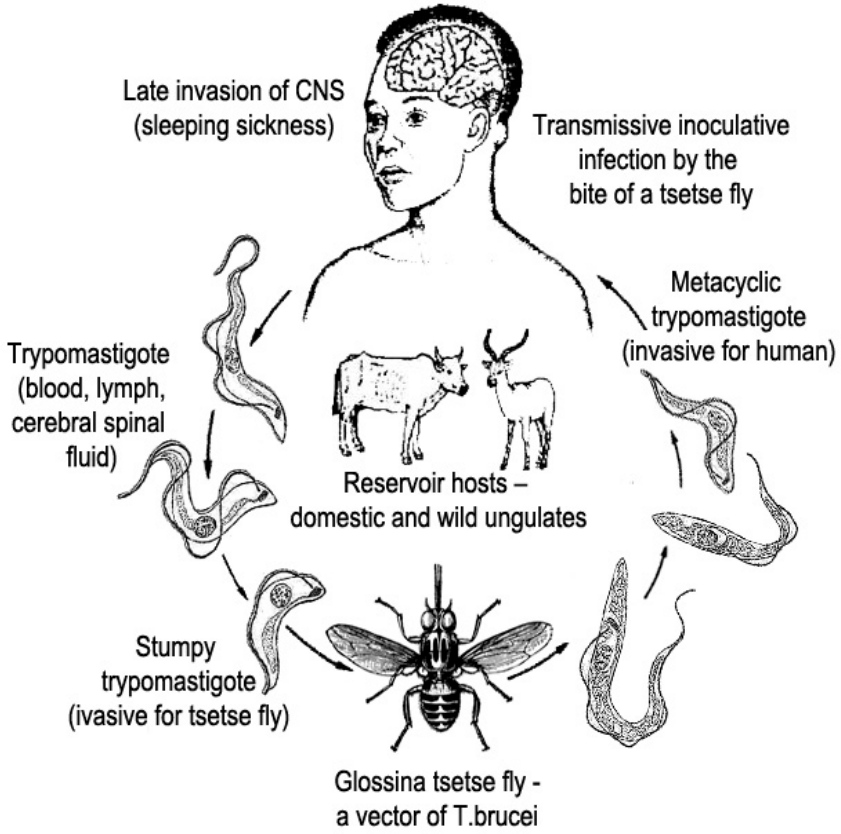
African sleeping sickness occurs only in 36 sub-Saharan Africa countries where there are tsetse flies that transmit the disease.

*Trypanosoma brucei gambiense* is found in 24 countries in West and Central Africa. This form currently accounts for over 98% of reported cases of sleeping sickness and causes a chronic infection. *T.b. rhodesiense* is found in 13 countries of Eastern and Southern Africa. Nowadays, this form represents under 2% of reported cases and causes an acute infection. Only Uganda presents both forms of the disease.

Sustained control efforts have lowered the number of new cases. The estimated number of actual cases is currently 30 000.

Other parasite species and sub-species of the *Trypanosoma* genus are pathogenic to animals and cause animal trypanosomiasis in wild and domestic animals. In cattle the disease is called *Nagana*.

**Task 2.** Study the life-cycle of *Trypanosoma brucei*. Make the designations.



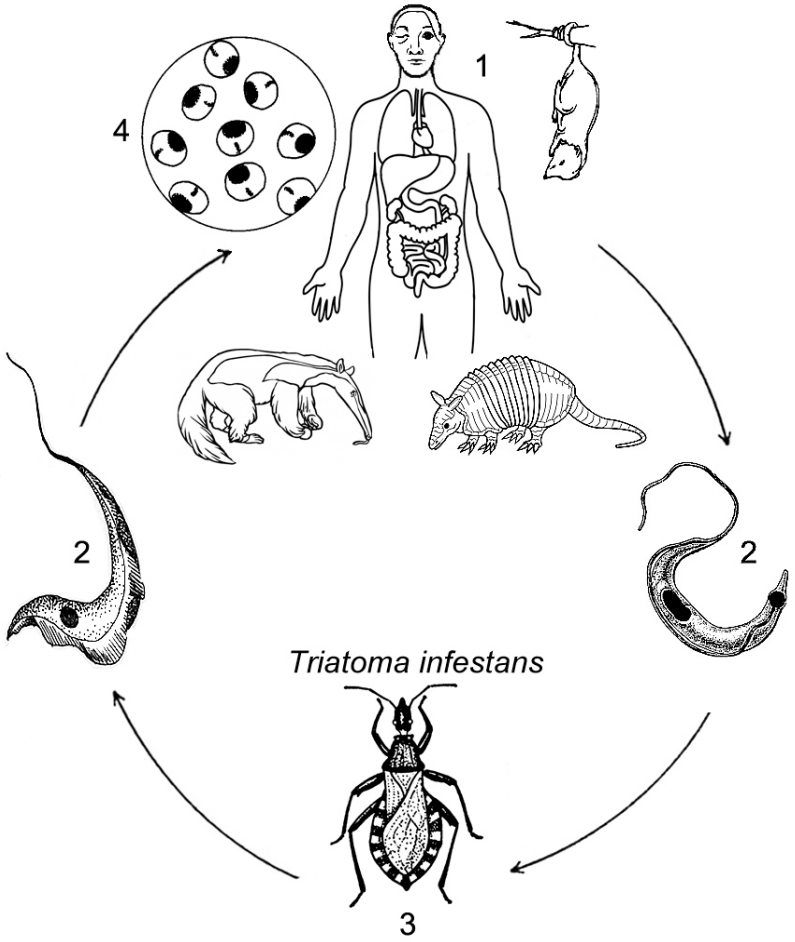

Invasive stage for human _____

Invasive stage for vector_____

Route and factors of transmission _____

_____

**Task 3.** Study the life-cycle of *Trypanosoma cruzi*. Make the designations.




1. _____
2. _____
3. _____
4. _____

**Task 4.** Fill in the table.

**Comparison of *Trypanosoma* species**

| Characteristics | *T. b. gambiense* | *T. b. rhodesiense* | *T. cruzi* |
|---|---|---|---|
| Disease | | | |
| Vector | | | |
| Natural reservoir hosts | | | |
| Invasive stage for human | | | |
| Route and factors of transmission | | | |
| Localization inside human body | | | |
| Pathogenicity | | | |
| Laboratory diagnosis | | | |
| Prophylaxis | | | |

**WHO:** ***American trypanosomiasis***

American trypanosomiasis, also known as *Chagas disease*, is a potentially life-threatening illness.

About 7-8 mln people are estimated to be infected worldwide and about 100 mln people are at risk of infection, with 56 000 new cases annually for all forms of transmission, causing 12 000 deaths annually.

It is found mainly in endemic areas of 21 Latin American countries, where vector-borne transmission is main form of transmission. However, in the past decades it has been increasingly detected in the USA, Canada, many European and some Western Pacific countries. This is due mainly to population mobility between Latin America and the rest of the world.

The disease is curable if treatment is initiated soon after infection.

Up to 30% of chronically infected people develop cardiac alterations and up to 10% develop digestive, neurological or mixed alterations which may require specific treatment.

**Task 5.** Give a definition of *focal disease*.

***Focal disease –*** _____

_____

_____

_____

**Components of focal disease:**

**1.** _____

_____

**2.** _____

_____

**3.** _____

_____

**Order** Trichomonadida

**Genus** Trichomonas

**Species** *Trichomonas vaginalis*

*Trichomonas hominis*

*Trichomonas tenax*

**Task 6.** Sketch a trophozoite of *Trichomonas vaginalis*, using a table. Designate a nucleus, axostyle, flagella and undulating membrane.

_____

_____

_____

_____

_____

_____

**WHO:** ***Sexually Transmitted Infections***

More than 1 mln people acquire a sexually transmitted infection (STI) every day. Each year, an estimated 500 million people become ill with one of 4 STIs: chlamydia, gonorrhoea, syphilis and trichomoniasis. These four are currently curable.

A person can have an STI without having obvious symptoms of disease. Therefore, the term “sexually transmitted infection” is a broader term than “sexually transmitted disease” (STD).

STIs can have serious consequences beyond the immediate impact of the infection itself, through mother-to-child transmission of infections and chronic diseases.

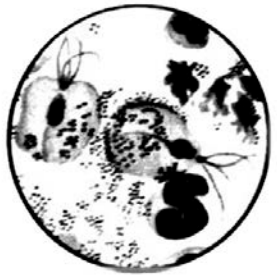
**Task 7**. Fill in the table.

**Comparison of *Trichomonas* species**

| | *Trichomonas vaginalis* | *Trichomonas hominis* | *Trichomonas tenax* |
|---|---|---|---|
| Disease | | | |
| Morphological features | | | |
| Route of transmission | | | |
| Localization inside human body | | | |
| Pathogenicity | | | |
| Laboratory diagnosis | | | |
| Prophylaxis | | | |

**Task 8**. Have a look at the pictures below and recognize what species are there. What biological material was used for laboratory diagnosis?





**Test questions:**

**1.** A vector of *Trypanosoma brucei gambiense* is:
- A. a mosquito *Anopheles*
- B. a tse-tse fly *Glossina palpalis*
- C. a tse-tse fly *Glossina morsitans*
- D. a bug *Triatoma infestans*
- E. a sand fly *Phlebotomus papatasi*

**2.** What organ is targeted during an infection with *Trypanosoma cruzi*?
- A. Heart
- B. Brain
- C. Lungs
- D. Kidneys
- E. Spleen

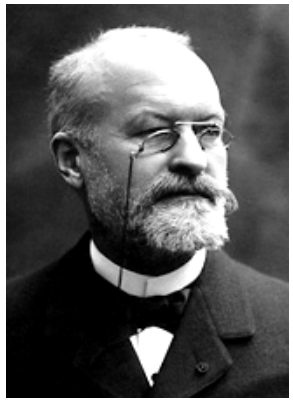
**3.** A species associated with *Entamoeba gingivalis* is
- A. *Trichomonas hominis*
- B. *Trichomonas vaginalis*
- C. *Trichomonas tenax*
- D. *Trypanosoma brucei gambiense*
- E. *Trypanosoma brucei rhodesiense*

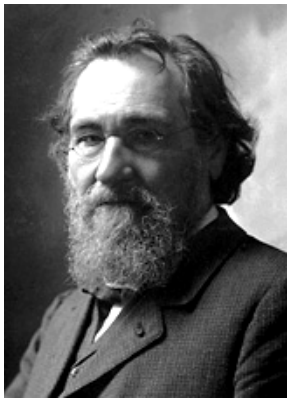
| Date | Signature |
|---|---|
| | |

**<u>Theme 23</u>: Phylum Apicomplexa. Class Sporozoa: causative agents of human diseases. Phylum Ciliophora. Class Litostomatea: causative agents of human diseases**

**Order** Haemosporida
**Family** Plasmodiidae
**Genus** *Plasmodium*
**Species**
***Plasmodium vivax*** is a causative agent of **tertian malaria**
***P. malariae*** is a causative agent of **quartan malaria**
***P. falciparum*** is a causative agent of **tropical malaria**
***P. ovale*** is a causative agent of **tertian malaria,** or **ovale-malaria**

***The great scientists contributed to malaria discoveries***


***C.L.A. Laveran***


***I. Mechnikov***


***R.Ross***

In 1880, C.L.A. Laveran, a French army surgeon, discovered the causative agent of malaria. In 1907, he was awarded with Nobel Prize "in recognition of his work on the role played by protozoa in causing diseases".

In 1884, a Russian physiologist and protistologist, professor of Kharkov University, V. Danilevsky described the causative agent of avian malaria.

In 1887, a Russian scientist I. Mechnikov defined a belonging of a malarial plasmodium to phylum *Protozoa*, class *Sporozoa*.

In 1890, Italian zoologists G.B. Grassi and R. Feletti found the causative agent of tertian malaria. They first introduced the names *Plasmodium vivax* and *P. malariae* for two of the malaria parasites that affect humans.

In 1891, a Russian physician D.L. Romanovsky elaborated a special staining method for the study of the malarial plasmodium structure.

In 1895, a British officer in the Indian Medical Service, R. Ross proved the role of mosquitoes of Genus *Anopheles* in the epidemiology of malaria. In 1902 he was awarded with Nobel Prize "for his work on malaria, by which he has shown how it enters the organism and thereby has laid the foundation for successful research on this disease and methods of combating it".

In 1897, an American physician W.H. Welch discovered the causative agent of tropical malaria, *Plasmodium falciparum*.

In 1922, a British scientist J.W. Stephens described the fourth human malaria parasite, *P. ovale*.

**WHO: *Malaria***

Malaria is a life-threatening disease. According to the latest estimates (December, 2013), there were about 207 mln cases of malaria in 2012 (with an uncertainty range of 135 mln to 287 mln) and an estimated 627 000 deaths (with an uncertainty range of 473 000 to 789 000). Malaria mortality rates have fallen by 42% globally since 2000, and by 49% in the WHO African Region.

Most deaths occur among children living in Africa where a child dies every minute from malaria. Malaria mortality rates among children in Africa have been reduced by an estimated 54% since 2000.

**<u>Task 1.</u>** Write the possible routes of transmission in malaria.

**1.** _____
_____
**2.** _____
_____
**3.** _____
_____

**Life cycle of *Plasmodium***

**EXOERYTHROCYTIC STAGE.** In the liver cells the sporozoites become rounded and grow to a definite size. In all species the parasites initiate a round of intracellular asexual multiplication (schizogony). The products of the liver stage (the exoerythrocytic merozoites) are liberated in their thousands from each parenchymal cell into the bloodstream. Merozoite is spherical or oval and small in size (1-2 mcm). They consist of cytoplasm and a nucleus. The Romanowsky – Giemsa stain colours the cytoplasm light-blue and the nucleus red. *P. falciparum* undergoes one cycle of tissue schizogony and *P. vivax* – two cycles. There are no clinical manifestations of the disease in infected individuals during the tissue developmental cycles of the parasites.

**ENDOERYTHROCITIC STAGE.** In the bloodstream merozoites attach to and invade circulating erythrocytes. Having gained entrance into the erythrocyte, the young schizont (ring-form stage) grows larger and a vacuole appears in its cytoplasm. At this stage the malarial parasite has irregular contours and resembles a ring with a ruby.

The semiimmature schizont is capable of amoeboid movement. As it grows, a pigment appears within it (a product of hemoglobin break down) in the form of dark-brow spots. The mature schizont becomes rounded and pulls in its pseudopodia by the time of complete maturation, occupying almost the entire erythrocyte. Merulation takes place at this stage, i.e. the nucleus and cytoplasm divide forming from 4 to 32 merozoites, depending on the species of the parasite. The pigment accumulates in the centre in a compact clump. On the completion of merulation the erythrocytes are destroyed and the merozoites are released into the blood plasma. Some of them again penetrate into erythrocytes, while others (the majority) are killed by the immune factors of the body. At a certain stage the merozoites transform into the sexual forms: female (macrogamonts) and male (microgamonts) cells. The gametocytes are ingested by mosquitoes with their blood meal and continue their sexual cycle in the mosquito midgut.

**GAMETOGONY.** In the female mosquito's stomach the microgamonts fertilize the macrogamonts and as a result of this a mobile form, the ookinete, is produced. The latter penetrates into the stomach wall where it transforms into an oocyst. The time needed for the devolopment of the malarial plasmodium in the mosquito body depends on the species of the parasite and on the environmental temperature, but averages 7-9 days, although it sometimes ranges from 7 to 45 days. The mature oocyst may be up to 60 mcm in diameter and is filled with sporozoites. It bursts and the sporozoites are released into the mosquito body cavity. They accumulate in the cells of the salivary glands and are introduced into the human body through a bite.

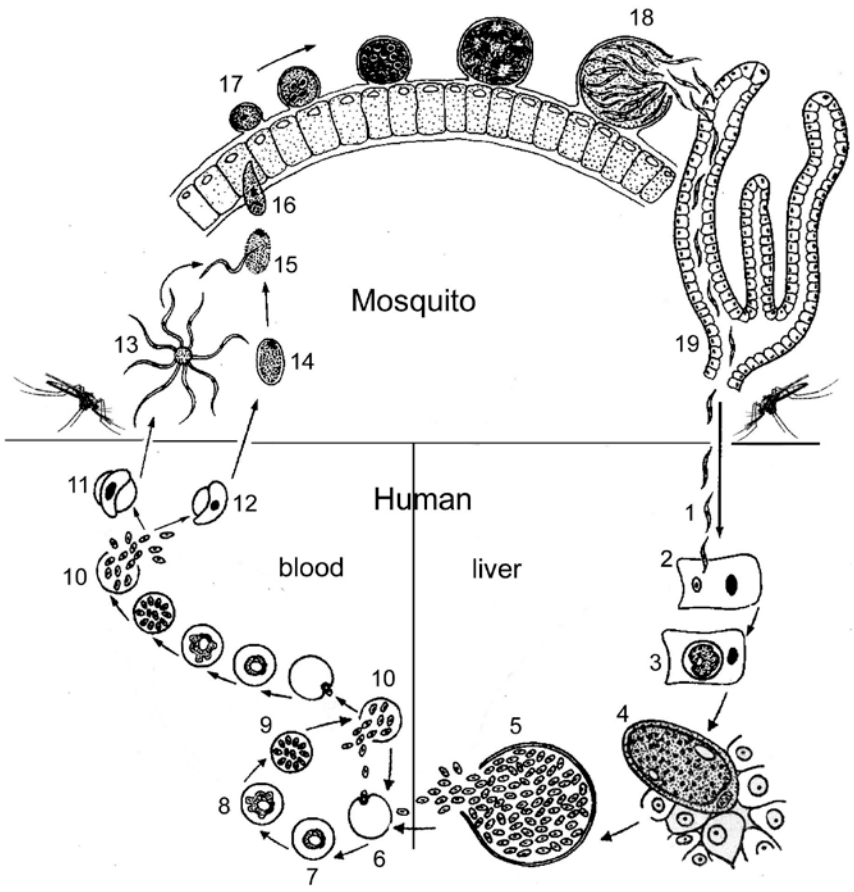
**Task 2.** Study the life-cycle of malarial plasmodium. Make the designations of developmental stages of the parasite.

**I – exoerythrocytic schizogony:**

**1** – _____
_____
**2** – _____
_____
**3** – _____
_____
**4** – _____
_____
**5** – _____
_____

**II – endoerythrocytic schizogony:**

**6** – _____
**7** – _____
**8** – _____
**9** – _____
**10** – _____
_____
**11** – _____
**12** – _____




**III – gametogony:**

**13** – _____

**14** – _____

**15** – _____

**16** – _____

**17** – _____

_____

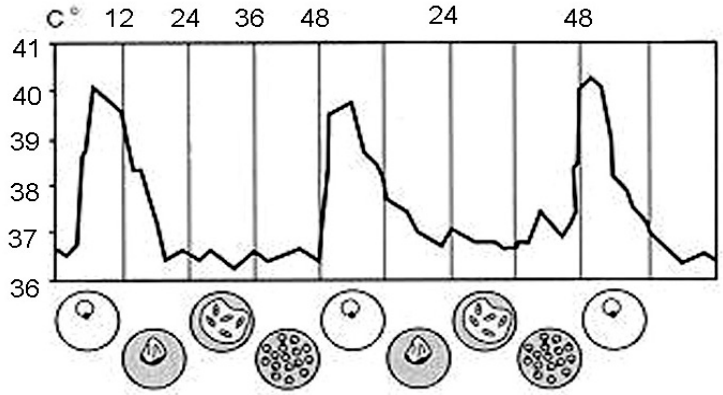
**18** – _____

_____

**19** – _____

**Task 3**. Analyze the temperature chart of patient infected with malaria and characterize three stages of malaria paroxysm (attack).

Typical temperature chart of *Plasmodium vivax* showing tertian periodicity




| ***Stage*** | ***Features*** |
|---|---|
| Cold | |
| Hot | |
| Sweating | |

**Task 4**. Note the features of the diseases caused by different species of *Plasmodium.*

**Developmental characteristics of human malaria parasites**

| Species | *P.vivax* | *P. malariae* | *P.falciparum* | *P. ovale* |
|---|---|---|---|---|
| Name of disease | | | | |
| Prepatent period * | 8-27 days | 15-30 days | 8-25 days | 9-17 days |
| Duration of asexual erythrocytic cycle | 48 h | 72 h | 48 h | 48 h |
| Red blood cells parasitized | Reticulocytes | Mature erythrocytes | All | Reticulocytes |
| Number of merozoites per a schizont | 12-24 | 6-12 | 8-32 | 4-16 |
| Relapse from persistent liver infection | Yes | No, but persistent red-cell infection up to 30 years | No | Yes |
| Drug resistance | Yes | No | Yes | No |
| Features of clinical course | | | | |
| Laboratory diagnosis | | | | |
| Prophylaxis:<br>- personal | | | | |
| - public | | | | |

***** - Time from an infective mosquito's bite to appearance of parasites in blood.

**Task 5.** Note the differences between developmental stages of malarial plasmodia in human erythrocytes. Sketch the erythrocytes infected by malarial plasmodia.

| Species / Stage | *Plasmodium vivax* | *Plasmodium malariae* | *Plasmodium falciparum* | *Plasmodium ovale* |
|---|---|---|---|---|
| Triphosoite (ring stage) | | | | |
| Amoeboid schizont | | | | |
| Morula | | | | |
| female gametocytes (micro-gamonts) | | | | |
| male gametocytes (macro-gamonts) | | | | |

**_Plasmodium knowlesi_ – fifth malarial parasite**

*P. knowlesi* occurs in nature in long-tailed and pig-tailed macaques that are commonly found in forested areas of south-east Asia. The species was first described in 1931 in a macaque imported from Singapore to India; in 1932, *P. knowlesi* was experimentally shown to be infectious to humans. The first natural infection of *P. knowlesi* in humans was reported in 1965 in a man returning to the United States after a visit to Peninsular Malaysia.

Until a few years ago, infection with *P. knowlesi* was regarded as a rare disease, occurring only sporadically in humans. The recent findings of a large number of infected patients in Malaysia, Thailand, Myanmar, the Philippines and Singapore, have changed that perception of *P. knowlesi*.

This infection is considered to be a new zoonosis. In 2006, *J. Vythilingam et al* reported for the first time the incrimination of *Anopheles latens* as the vector of *P. knowlesi* among humans and monkeys in Sarawak, Malaysia. The infection is due to the transmission of the malarial parasite from the monkey via the vector, *Anopheles spp* mosquito, to human beings. Human to human transmission is still questionable.

*P. knowlesi* malaria has characteristics similar to those seen in other types of malaria, and particularly a high fever with chills in infected cases. This parasite has the shortest erythrocytic cycle among the primate malarias, (only 24 hours), and high parasitaemias with fatal outcome in humans can occur. Morphologically the early ring forms of *P. knowlesi* resemble those of *P. falciparum*. The late and mature trophozoites, schizonts and gametocytes appear very similar to those of *P. malariae* although some minor morphological differences exist between *P. knowlesi* and *P. malariae*.

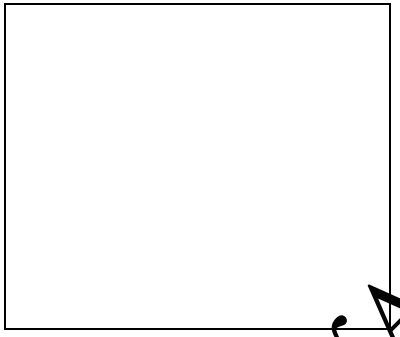
Human *P. knowlesi* infections resolve rapidly following treatment with chloroquine and mefloquine is also effective. However, due to the rapid rate at which P. *knowlesi* can multiply, in severely ill knowlesi malaria patients with high parasitaemias, management and treatment as for severe tropical (falciparum) malaria is being recommended.

**Malaria transmission in non-endemic areas**

Transmission of malaria in a non-endemic area (e.g., in the European Union,) is an extremely unusual event, but is possible under certain conditions and various circumstances including: (i) *"airport/port" malaria* resulting from infective bites of mosquitoes, which travelled aboard an airplane and has occurred in a number of instances around major airports throughout Europe, and (ii) *"baggage" malaria* due to possibility of carrying infective mosquitoes within pieces of baggage to non-endemic areas or to areas far from international airports, (iii) *nosocomial (hospital) transmission* in which blood or parasite-containing fluids from a parasitaemic patient enter the bloodstream of a secondary patient (There is also evidence of transmission through contaminated surfaces. This has been implicated in cases of malaria following re-use of catheters for contrast media or handling of intravenous lines with contaminated gloves) and (iv) transmission *by local competent vectors*.

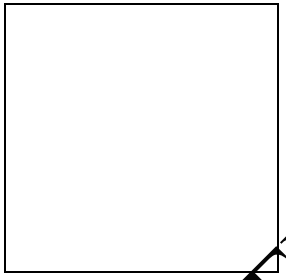
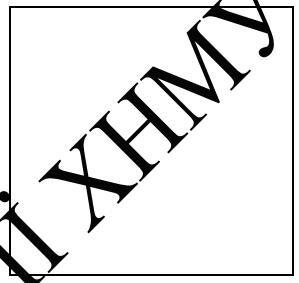
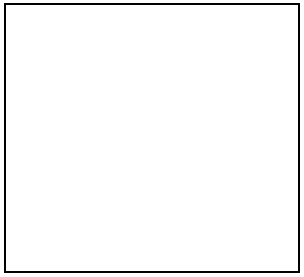
**Class** Sporozoa
**Order** Eucoccidorida
**Family** Sarcocystidae
**Genus** *Toxoplasma*
**Species** *Toxoplasma gondii*

**Task 6.** Examine the fixed specimen of *Toxoplasma gondii* under high magnification of a microscope. Sketch an endozoide of *T. gondii* in the notebook. Designate the cytoplasm and nucleus.



_____
_____
_____
_____
_____

**Task 7.** Sketch the vital forms of *T. gondii*: pseudocyst, cyst, oocyst.

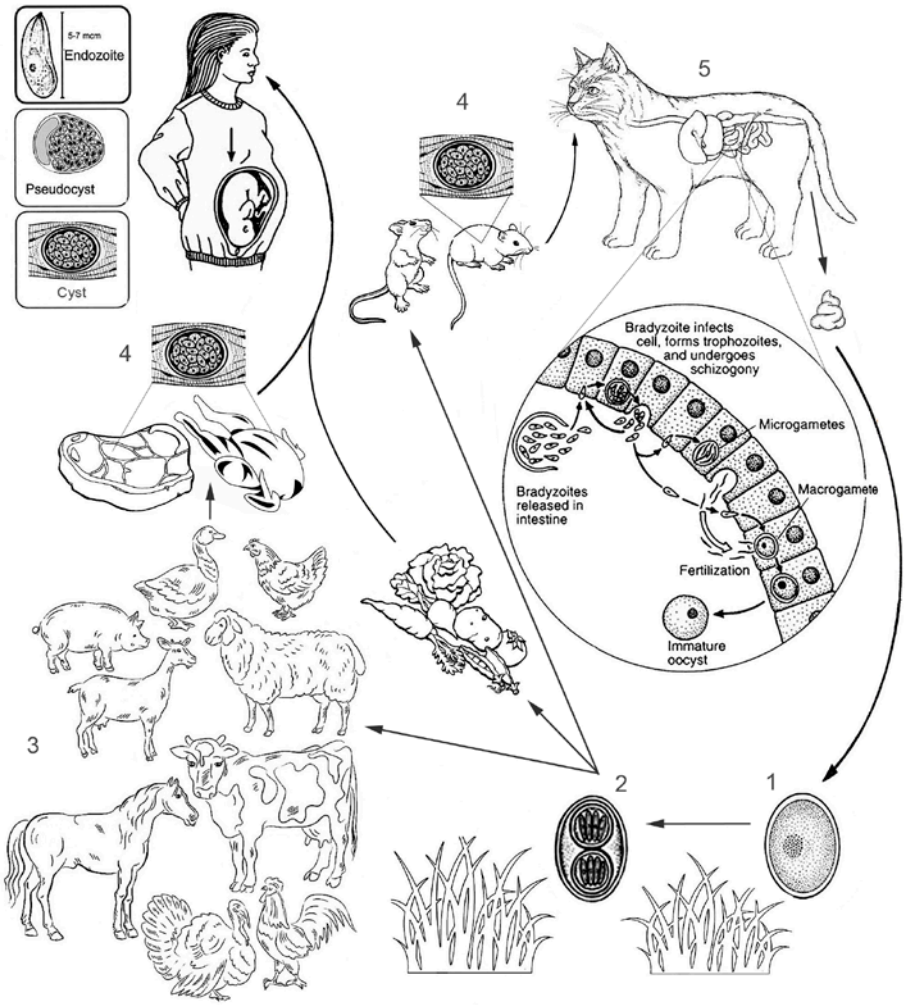




_____ _____ _____

**Task 8.** Give the characteristic of *Toxoplasma gondii*.

Disease _____
Source of invasion _____
Invasive stage for a human _____
_____
Route and factors of transmission _____
_____
_____
_____
Localization inside human body _____
_____
_____
Pathogenicity _____
_____
_____
_____
Laboratory diagnosis _____
_____
Prophylaxis: _____
_____
_____
_____

**Task 9.** Study the life-cycle of *Toxoplasma gondii*. Make the designations to the life cycle.



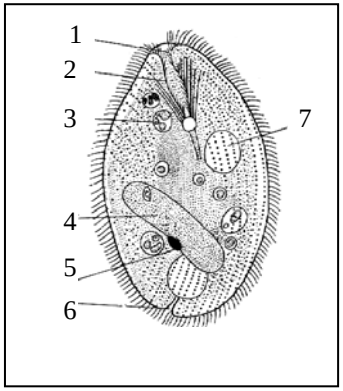

1 - _____
2 - _____
3 - _____
4 - _____
5 - _____

**WHO:** ***Toxoplasmosis***

Toxoplasmosis is present in every country and seropositivity rates range from less than 10% to over 90%. Seroprevalence rates vary according to geographical distribution, sample size and diagnostic methods. Based on epidemiological surveillance in general populations, approximately 30% in USA and the United Kingdom, 50–80% in Europe, 30% in Asia, 60% in South Africa, and 70% in South America are seropositive for *Toxoplasma* infection. The prevalence of toxoplasmosis appears to be higher in less developed countries, in humid environment and plains, in adults and in persons in close contact with soil and animals.

**Order** Vestibuliferida
**Family** Balantiididae
**Genus** *Balantidium*
**Species** *Balantidium coli*

**Task 10**. Study the vital forms of *Balantidium coli* parasite. Make the designations: cilia, cytostome, macronucleus, micronucleus, food vacuole and contractile vacuole, cytopyge (posteriorly the minute "anal" aperture).




1 - _____
2 - _____
3 - _____
4 - _____
5 - _____
6 - _____
7 - _____

_____ _____

**Task 11.** Give the characteristics of *Balantidium coli.*

Disease _____
Source of invasion _____
Invasive stage for a human_____
_____
Route and factors of transmission _____
_____
Localization inside human body_____
_____
Pathogenicity _____
_____
_____
_____
_____
Laboratory diagnosis _____
_____
_____
Prophylaxis: _____
_____
_____
_____
_____

**Test questions:**

**1.** The members of Phylum *Apicomplexa* share two features, which are
A. endoparasitism and flagella
B. flagella and cyst formation
C. cyst formation and an apical complex
D. an apical complex and endoparasitism
E. cilia and cyst formation

**2.** The product of fertilization in body of *Anopheles* mosquito is
A. sporozoite
B. merozoite
C. trophozoite
D. schizont
E. ookinete

**3.** What species produces the more severe type of malaria?
A. *Plasmodium ovale*
B. *Plasmodium falciparum*
C. *Plasmodium malariae*
D. *Plasmodium vivax*
E. *Plasmodium knowlesi*

**4.** Which of the following is ***not*** a form of asexual reproduction used by species of Kingdom Protista?
A. longitudinal binary fission
B. trasversal binary fission
C. budding
D. conjugation
E. schizogony

**5.** The most common opportunistic CNS infection in patients with AIDS is caused by
A. *Plasmodium falciparum*
B. *Trichomonas hominis*
C. *Toxoplasma gondii*
D. *Entamoeba gingivalis*
E. *Balantidium coli*

**6.** What is the reservoir for *Balantidium coli*?
A. the human gastrointestinal tract
B. cats
C. snails
D. the large intestines of pigs
E. mosquitoes

| Date | Signature |
|---|---|
| | |

**<u>Theme 24</u>: Lab Practical Exam 3: Medical Protozoology**

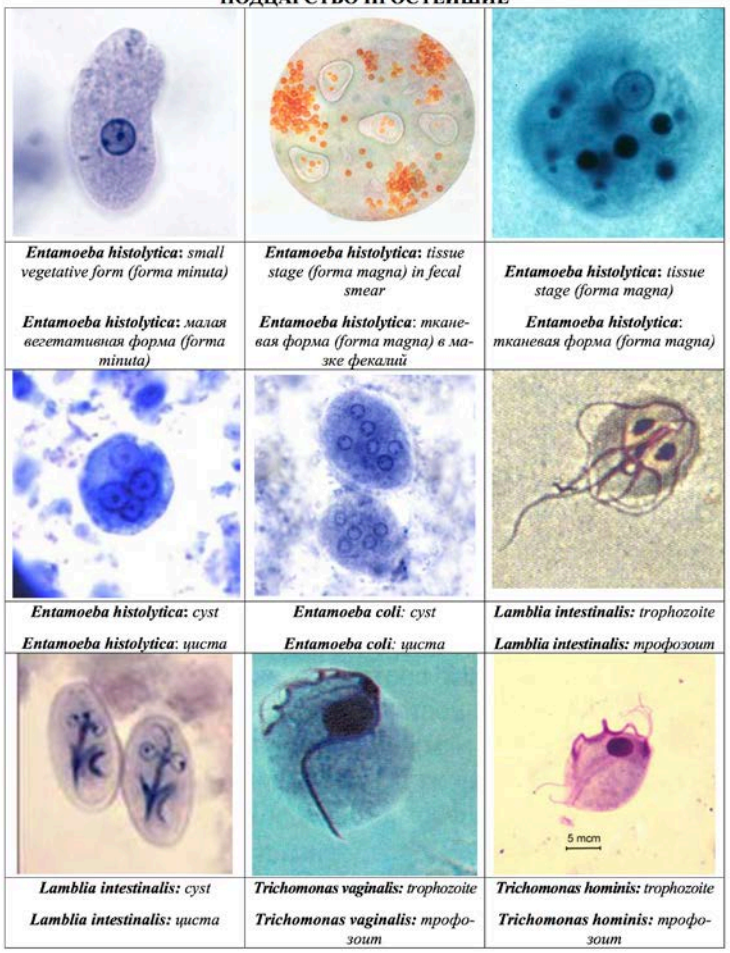
At the class, the students shall be able to identify the common infectious agents of Subkingdom Protozoa. It includes the identification of photographs, slides, and specimens.

**Link:**

**http://repo.knmu.edu.ua/bitstream/123456789/12558/1/Exam I Protozoans 2016.pdf**

**SUBKINGDOM PROTOZOA**

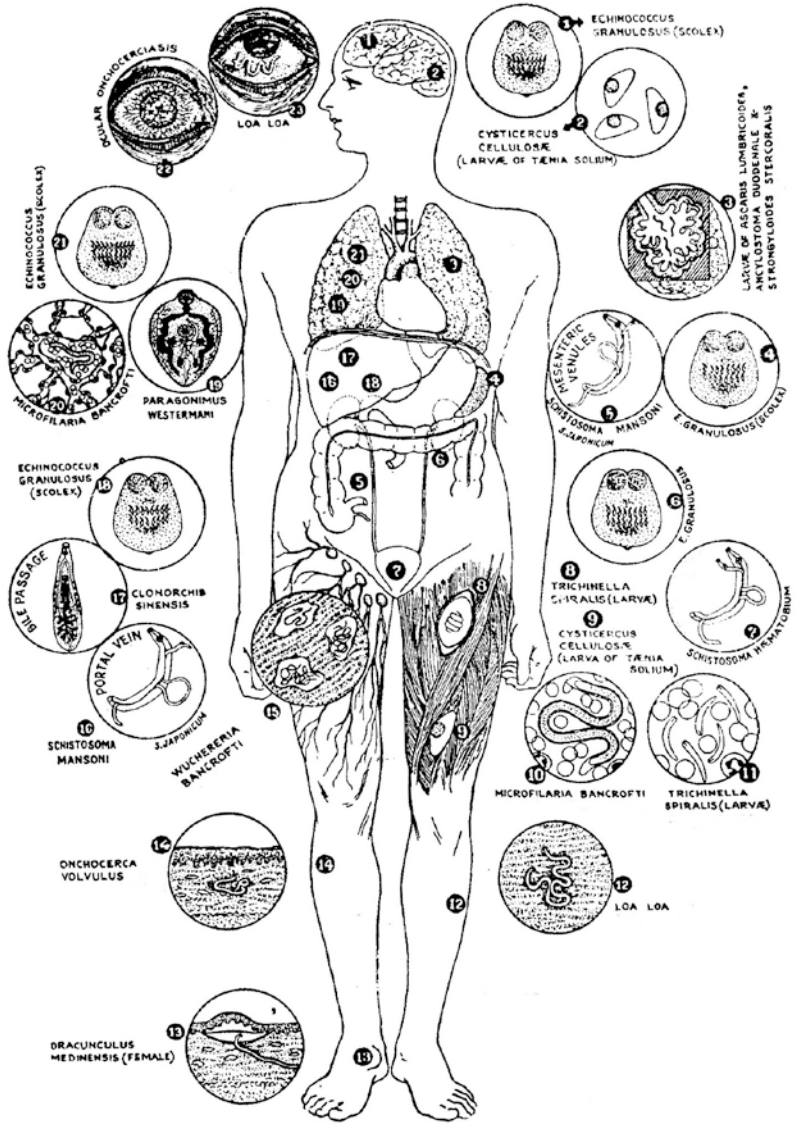
**ПОДЦАРСТВО ПРОСТЕЙШИЕ**




| | | |
|---|---|---|
| ***Entamoeba histolytica***: *small vegetative form (forma minuta)*<br>***Entamoeba histolytica***: *малая вегетативная форма (forma minuta)* | ***Entamoeba histolytica***: *tissue stage (forma magna) in fecal smear*<br>***Entamoeba histolytica***: *тканевая форма (forma magna) в мазке фекалий* | ***Entamoeba histolytica***: *tissue stage (forma magna)*<br>***Entamoeba histolytica***: *тканевая форма (forma magna)* |
| ***Entamoeba histolytica***: *cyst*<br>***Entamoeba histolytica***: *циста* | ***Entamoeba coli***: *cyst*<br>***Entamoeba coli***: *циста* | ***Lamblia intestinalis***: *trophozoite*<br>***Lamblia intestinalis***: *трофозоит* |
| ***Lamblia intestinalis***: *cyst*<br>***Lamblia intestinalis***: *циста* | ***Trichomonas vaginalis***: *trophozoite*<br>***Trichomonas vaginalis***: *трофозоит* | ***Trichomonas hominis***: *trophozoite*<br>***Trichomonas hominis***: *трофозоит* |

**Theme 25: Medical Helminthology. Phylum Flatworms (Plathelminthes). Class Flukes (Trematoda) I: causative agents of human diseases**

**HELMINTHS ARE PARASITIC WORMS**



**Helminthes**

**Phylum Plathelminthes**

**- Class Trematoda**
**- Class Cestoidea**

**Phylum Nemathelminthes**

**- Class Nematoda**

**Helminth infections**

**Medical Helminthology**

- **300 species of helminths can parasitize in human organism!!**

**by Taxonomic Group**

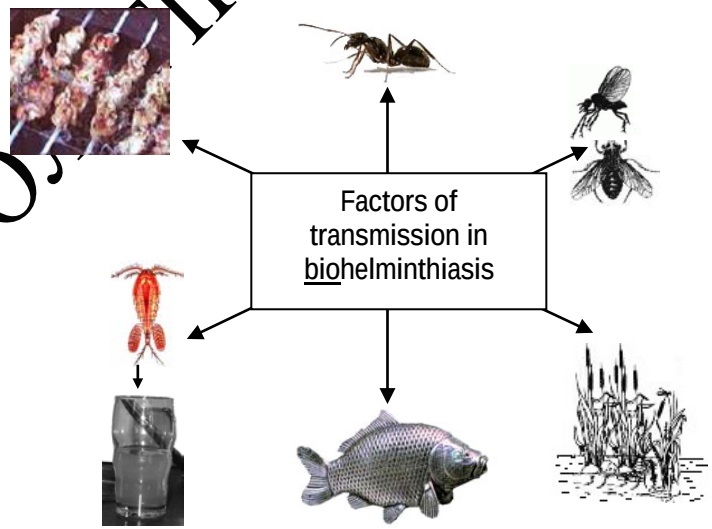
| | |
|---|---|
| Platyhelminthes | 173 species |
| Nemathelminthes | 38 species |

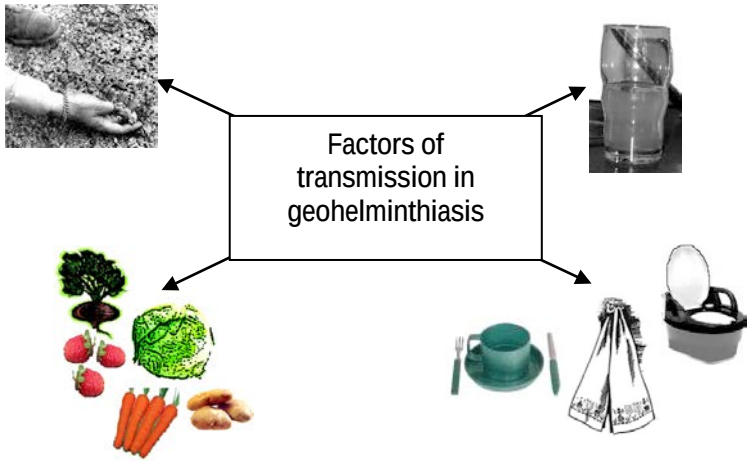
**by Location within the Host**

| | |
|---|---|
| Alimentary tract | 197 species |
| Cavities, organs, and tissues | 107 species |
| Circulatory system | 21 species |
| Skin and tissues | 56 species |

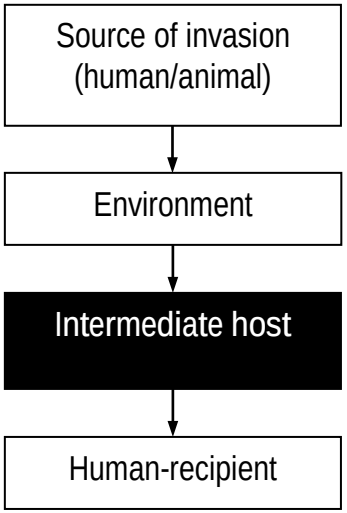
In humans, helminthic parasites are divided into three groups according to their life cycles:

- **Biohelminthes** develop with alternation of hosts.
- **Geohelminthes** develop without alternation of hosts and the part of life cycle passes in soil.
- **Contact helminthes.** All stages of development occur in human organism.

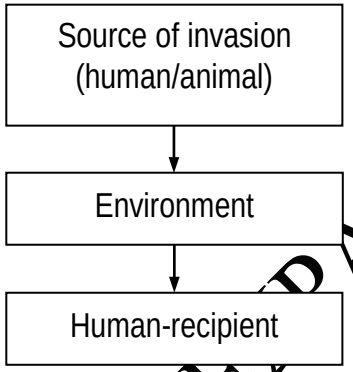


**Scheme of pathogen transmission in <u>bio</u>helminthiasis**




**Scheme of pathogen transmission in <u>geo</u>helminthiasis**




**<u>Task 1.</u>** Study the progressive features and the evolutionary adaptations of Phylum *Platyhelminthes*

| *Progressive features* | *Adaptive features* |
|---|---|
| - triploblastic organization of embryos<br>- body wall is covered by syncytial tegument<br>- bilateral symmetry<br>- presence of organ systems | - complex life-cycle<br>- well developed reproductive system<br>- enormous fertility<br>- presence of holdfast organs<br>- anaerobic respiration<br>- functions of respiratory or circulatory system take place by absorption through the body wall |

**<u>Task 2.</u>** Write the characteristics of Class *Trematoda* and the features of organ systems

**1.** _____

_____

**2.** _____

_____

**3.** _____

_____

**4.** _____

_____

**5.** _____

_____

**6.** Presence of organ systems:

Digestive system _____

_____

_____

_____

Excretory system _____

_____

_____

_____

Nervous system _____

_____

_____

_____

Reproductive system _____

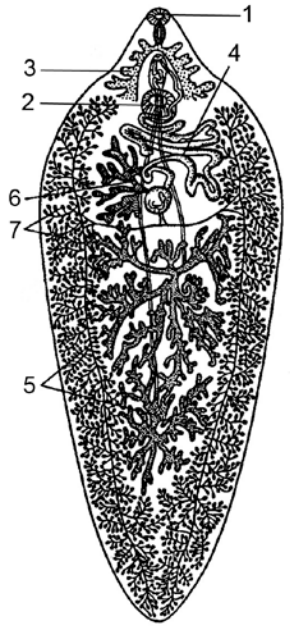
_____

_____

_____

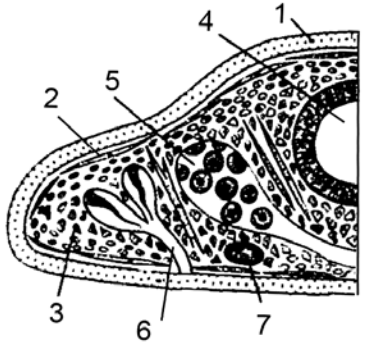
**Class** Trematoda
**Order** Echinostomida
**Suborder** Echinostomata
**Family** Fasciolidae
**Genus** *Fasciola*
**Species** *Fasciola hepatica* – **liver fluke**

**Task 3.** Examine the fixed preparation of *Fasciola hepatica* under low magnification of the microscope. On the picture below make the designations: anterior and ventral suckers, branched digestive tract (intestine), uterus, testes, ovary, vitelline glands.




1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

**Task 4.** Examine the cross-section of *Fasciola hepatica* under low magnification of the microscope. Pay attention to the absence of body cavity (space between the body wall and internal organs is occupied by parenchyma). Find the cross-section of intestine, testes, vitelline glands. On the picture below, make the designations: tegument, muscles, parenchyma, gonads, intestine, and excretory canals, nerves.




1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

**WHO: *Fascioliasis***

Fascioliasis is a global disease caused by two species of Genus *Fasciola*: *F. hepatica* and *F.gigantica*. (Adult *F. gigantica* measure 25–75 mm × 12 mm). The disease they both cause is similar.

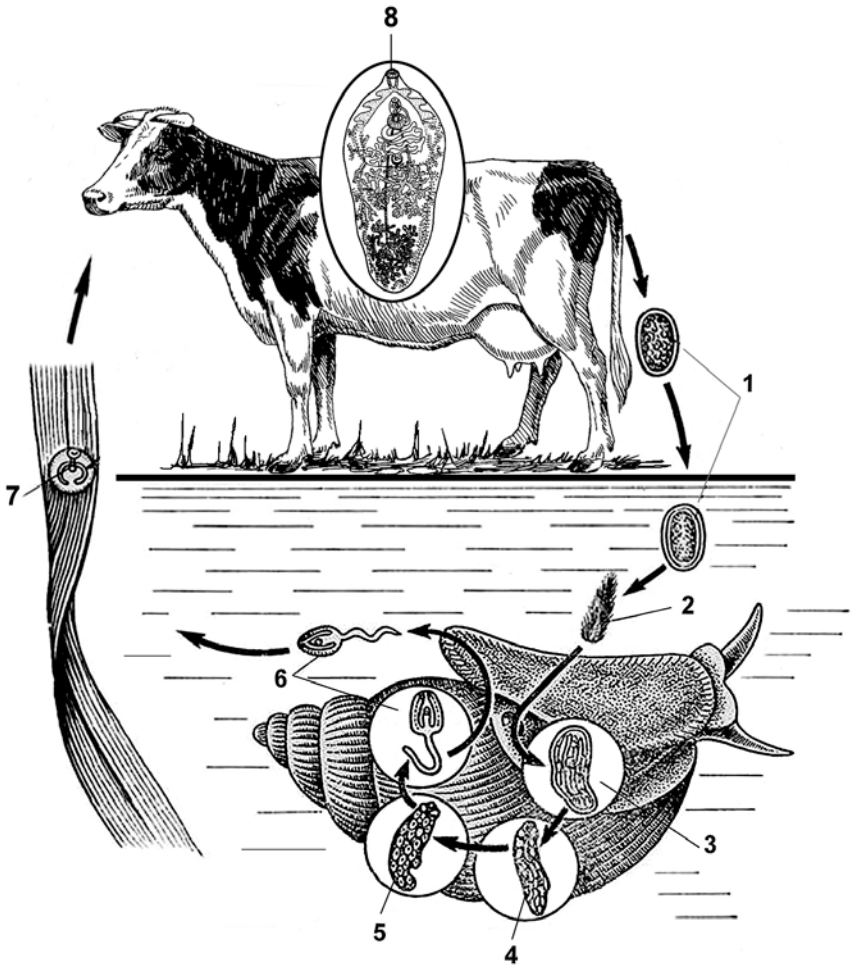
Until recently, human cases occurred occasionally but are now increasingly reported from Europe, the Americas and Oceania (where only *F. hepatica* is transmitted) and from Africa and Asia (where the two species overlap). At least 2.4 mln people are infected in more than 75 countries worldwide, with several million at risk. No continent is free from fascioliasis, and it is likely that where animal cases are reported, human cases also exist.

Recognized areas of high transmission are the highlands of South America, the Nile valley, the Caspian sea basin, as well as east Asia and South-East Asia.

**Task 5.** Study the life-cycle of *Fasciola hepatica*. Note the stages of parasite development and their habitat.

| | ***Developmental stage*** | ***Habitat*** |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |






**Task 6.** Give the characteristics of *Fasciola hepatica*.

Disease _____

Morphological features _____

_____

_____

_____

The source of invasion _____

_____

Invasive stage for a human _____
Route and factors of transmission _____
_____
Localization inside human body _____
_____
Pathogenicity _____
_____
_____
_____
Laboratory diagnosis _____
_____
Prophylaxis _____
_____
_____

**Order** Plagiorchidae
**Suborder** Plagiorchiata
**Family** Dicrocoeliidae
**Genus** *Dicrocoelium*
**Species** *Dicrocoelium lanceolatum* **– lanceolate fluke**

Dicrocoeliasis is an unusual zoonotic trematode infection caused by the lancet fluke *Dicrocoelium: D. lanceolatum* or *D. dendriticum*.

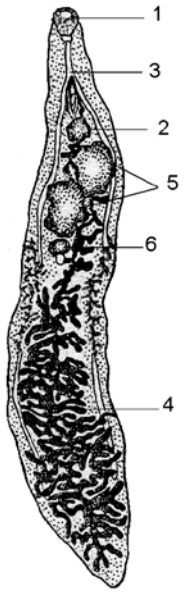
Grazing herbivores (usually sheep or cattle) are the definitive hosts. The life cycle proceeds through two intermediate hosts: a land snail (genera *Helicella* or *Zebrina*) and a field ant (e.g., genus *Formica*). Human infection is acquired by accidental ingestion the field ant, infected by the larval parasites – metacercariae (invasive stage).

Symptoms of human dicrocoeliasis are mild. In severe infections, vague biliary and gastrointestinal disturbances including abdominal distress, flatulence, biliary colic, vomiting, diarrhea, or constipation have been reported. The liver may be enlarged. Spurious human infection is common and results from the consumption of raw infected liver. Laboratory diagnosis is performed by finding the characteristic ova in faeces, bile, or duodenal fluid. In order to avoid infection, raw vegetables should not be eaten in the endemic area.

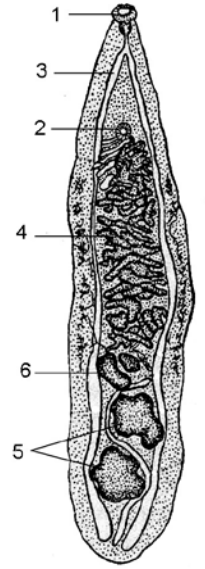
**Order** Opisthorchiida
**Suborder** Opisthorchiata
**Family** Opisthorchiidae
**Genus** *Clonorchis*
**Species** *Clonorchis sinensis* - **Chinese liver fluke**
**Genus** *Opisthorchis*
**Species** *Opistorchis felineus* **– cat fluke**
*Opisthorchis viverrini* – **Southeast Asian liver fluke**

**Task 7**. Examine the fixed specimens of *Dicrocoelium lanceolatum* and *Opisthorchis felineus* under low magnification of a microscope. Compare their interior structures. At the picture, make the designations: anterior and ventral suckers, the branched digestive tract (intestine), uterus, the testes, and the ovary.

_____ _____
_____ _____

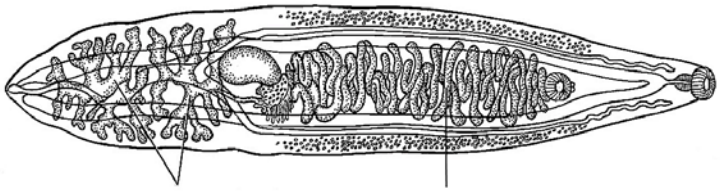



1. _____
_____
2. _____
_____
3. _____
_____
4. _____
5. _____
6. _____



**Chinese liver fluke** – ***Clonorchis sinensis***

**Task 8**. Look at the picture of Chinese liver fluke. Pay attention to the characteristic features: flattened cigar-shaped body is 10-20 mm long and 3-5 mm wide. Much of the anterior half of body is filled with a looping uterus (**1**). A small, slightly lobed ovary follows with two large branching testes (**2**) located in the posterior half of the body. The ventral sucker is circular and located slightly behind the oral sucker.



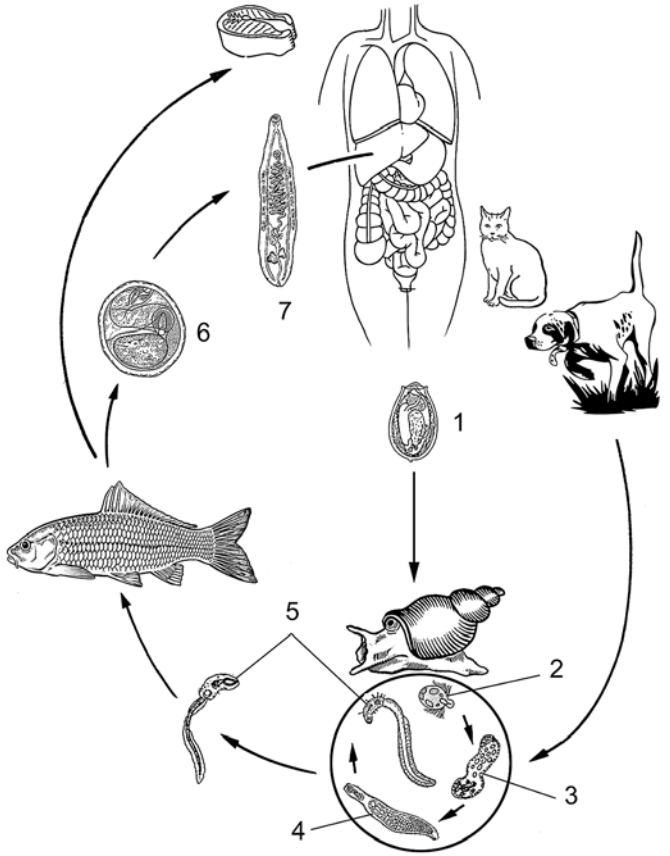
**WHO: *Clonorchiasis***

Clonorchiasis, or Chinese liver fluke disease, is caused by infection with *Clonorchis sinensis.* It is a common infection of humans, dogs and other fish-eating carnivores (reservoir final hosts) in China, Koreas and Viet Nam. 12.5 mln people are estimated to be infected in China alone.

Chronic chlonorchiasis is strongly associated with *cholangiocarcinoma*, a severe and often fatal form of bile duct cancer. *C. sinensis* (and also *O. viverrini*, but not *O. felineus*) as a carcinogenic agent.

**Task 9.** Study the life-cycle of *Opisthorchis felineus* as typical life cycle of parasitic trematodes of Order *Opisthorchiida*. Note the stages of parasite development and their habitat.

| ***Developmental stage*** | | ***Habitat*** |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |



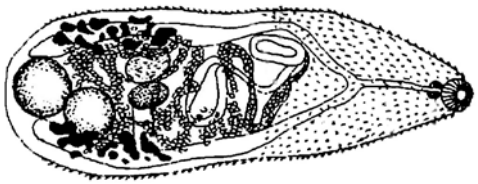
**Order** *Opisthorchiida*

**Suborder** *Opisthorchiata*

**Family** *Heterophyidae*

**Genus** *Metagonimus*

**Species** *Metagonimus yokogawai* – **minute intestinal fluke**



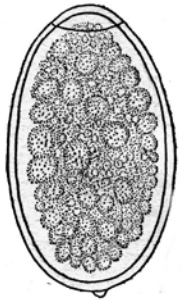
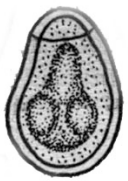
**WHO: *Foodborne trematodiases***

In 2005, more than 56 million people worldwide were infected with one or more foodborne trematodiases and over 7000 people died. Foodborn trematodiases are caused by flukes, of which the most common species affecting humans are *Clonorchis, Opisthorchis, Fasciola* and *Paragonimus*.

Cases have been reported from over 70 countries worldwide; however South-East Asia and South America are the most affected areas. In these regions, infections with foodborne trematodes represent a significant public health problem.

**Task 10.** Fill in the table (*see the next page*) writing the differences between some pathogenic species of Class *Trematoda*.

**Task 11.** Examine the ova of the different species of trematodes under low and high powers of microscope. Study their characteristic features.

| | |
|---|---|
|  | The egg of _____ is oval, yellowish brown, thin-shelled with an *operculum* (top) (125-150 × 70-90 mcm). It contains yolk cell mass. Ova are not found in the stool until the second phase of the illness when the mature flukes are established in the biliary tract. |
|  | The egg of _____ is yellowish brown and oval with an operculum (26-30×10-15 mcm). It has a thin, transparent smooth shell. Prominence resides in either pole of egg, which contains a miracidium. |
|  | The egg of _____ is ovoid, yellowish colored (26-30 × 15-17 mcm) with an operculum at one end, small knob at opposite end. The operculum covers the anterior end with a conspicuous rim that protrudes from the sides of the egg. |
|  | The egg of _____ is dark brown (38-45×25-30 mcm), slightly flattened on one side, thick-shelled with a large operculum, and contains a miracidia and two yolk cells. |

**Comparison of trematode species**

| *Characteristics* | *Clonorchis sinensis* | *Opistorchis felineus* | *Metagonimus yokogawai* |
|---|---|---|---|
| Disease | | | |
| Geographic distribution | | | |
| Morphological features (body shape, intestinal branches, location of uterus, shape and location of testes) | | | |
| Localization inside human body | | | |
| Definitive host | | | |
| Invasive stage for definitive host | | | |
| Intermediate host | | | |
| Invasive stage for intermediate host | | | |
| Route and factors of transmission | | | |
| Pathogenicity | | | |
| Laboratory diagnosis | | | |
| Prophylaxis | | | |

**Test questions:**

**1.** The *Platyhelminthes* are characterized by which of the following?
A. Bilateral symmetry
B. Triploblastic embryonic germ layers
C. Organ-level systems
D. Most are hermaphroditic
E. All of the above are correct

**2.** One of the intermediate hosts of liver fluke belongs to Class _____
A. *Trematoda*
B. *Gastropoda*
C. *Annelida*
D. *Porifera*
E. None of the above is correct

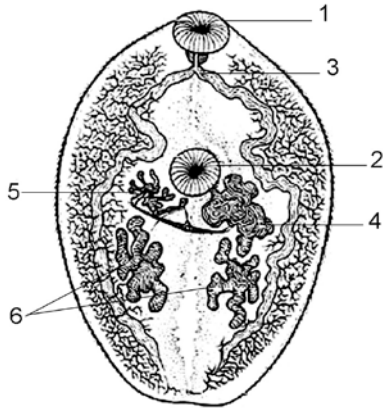
**3.** In human body, localization of cat fluke is
A. small intestine
B. large intestine
C. lungs
D. bile ducts
E. heart

| Date | Signature |
|---|---|
| | |

## Theme 26: Phylum Flatworms (Plathelminthes). Class Flukes (Trematoda) II: causative agents of human diseases

**Class** Trematoda
**Order** Plagiorchida
**Suborder** Troglotremata
**Family** Paragonimidae
**Genus** *Paragonimus*
**Species** *Paragonimus westermani* (*P. ringeri*)

**Task 1.** Study the internal structure of *Paragonimus westermani* on the picture below. Make the designations: anterior and ventral suckers, the branched digestive tract (intestine), the uterus, the testes, and the ovary.

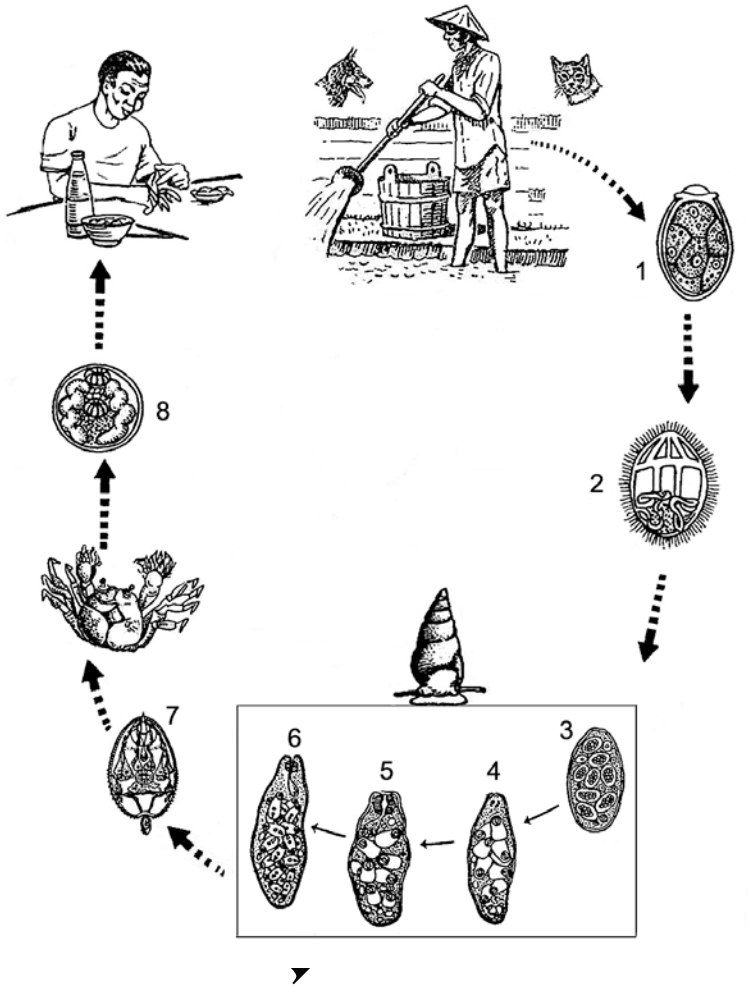



1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

**Task 2.** Study the life-cycle of *Paragonimus westermani*. Note the stages of parasite development and their habitat.

| ***Developmental stage*** | | ***Habitat*** |
|---|---|---|
| 1 | | |
| 2 | | |

| | | |
|---|---|---|
| 3-6 | | |
| 7 | | |
| 8 | | |




**Task 3.** Give the characteristics of *Paragonimus westermani*.

Disease _____

Morphological features _____

_____

_____

_____

The source of invasion _____

_____

Invasive stage for a human _____

Route and factors of transmission _____

_____

_____

Localization inside human body _____

_____

Pathogenicity _____

_____

_____

_____

_____

Laboratory diagnosis _____

_____

_____

Prophylaxis _____

_____

_____

_____

**Order** Strigeatida

**Family** Schistosomatidae

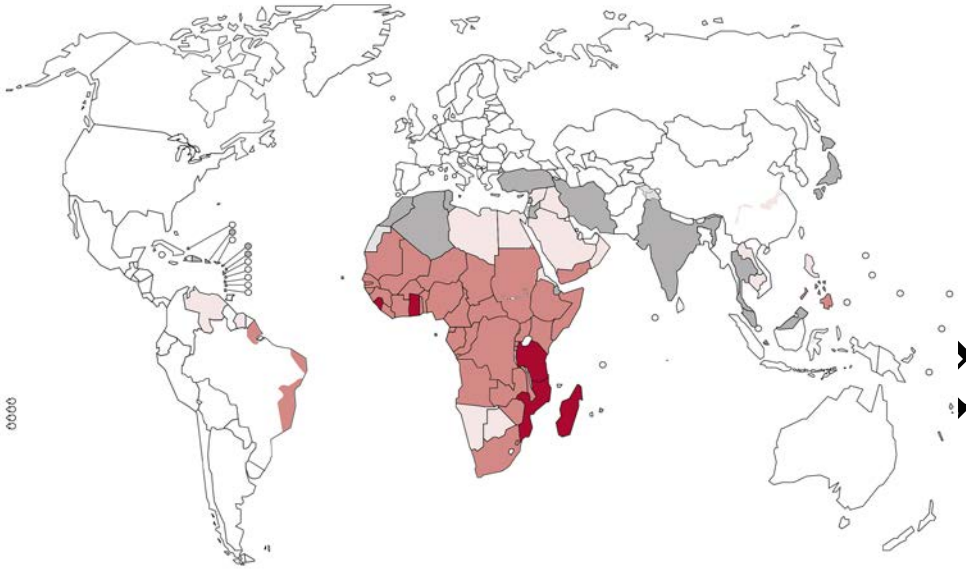
**Genus** *Schistosoma*

**Species** *Schistosoma haematobium*

*Schistosoma mansoni*

*Schistosoma japonicum*

**Geographic distribution of Schistosomiasis, 2012 (WHO)**



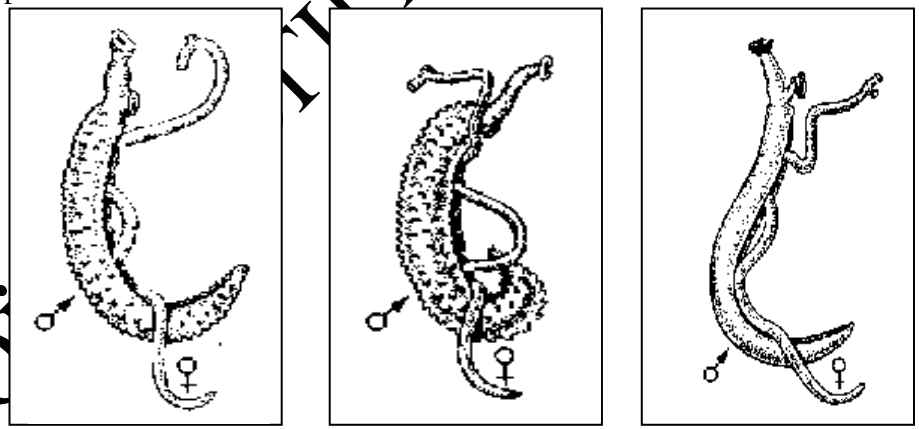
**WHO: *Schistosomiasis***

Schistosomiasis is an acute and chronic disease caused by blood flukes of the Genus *Schistosoma*. It is prevalent in tropical and sub-tropical areas, especially in poor communities without access to safe drinking water and adequate sanitation. In 2012 at least 249 mln people required preventive treatment for schistosomiasis and at least 90% of those requiring treatment for schistosomiasis live in Africa.

The number of people reported to have been treated for schistosomiasis in 2012 was 42.1 million. Preventive treatment, which should be repeated over a number of years, will reduce and prevent morbidity.

Schistosomiasis transmission has been reported from 78 countries. However, preventive chemotherapy for schistosomiasis, where people and communities are targeted for large scale treatment, is only required in 52 endemic countries with moderate to high transmission.

**Task 4.** Study the figures and write down the names of *Schistosoma* parasites.

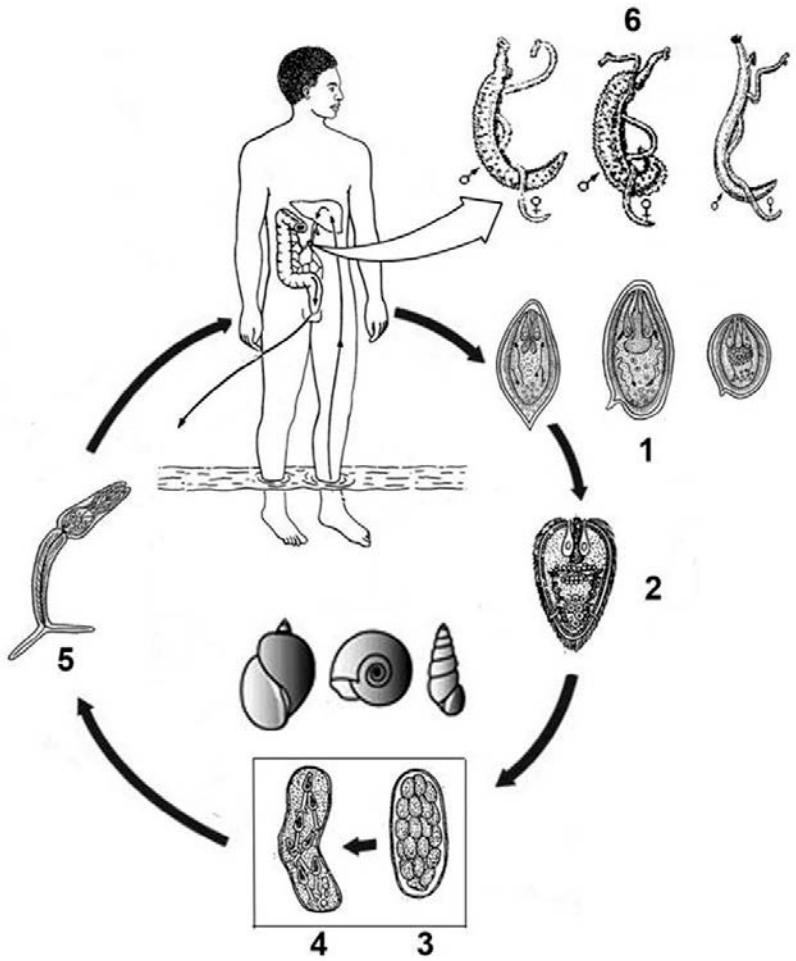


_____ _____ _____

_____ _____ _____

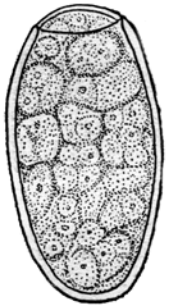
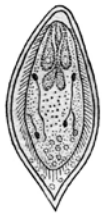
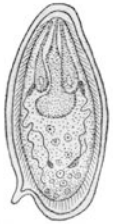
**Task 5.** Study the generalized life-cycle of *Schistosoma* species. Note the stages of parasites' development and their habitat.

| | ***Developmental stage*** | ***Habitat*** |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |




**Task 6.** Give the characteristics of the different species of genus *Schistosoma* (*see the next page*).

**Task 7.** Study the structure of *Paragonimus westermani* eggs and different species of *Schistosoma*. Read the description.

| | |
|---|---|
|  | The eggs of *Paragonimus westermani* are golden brown and ovoid in shape with a thick, but transparent shell. An operculum resides in either pole of egg. The eggs are 80-120 × 50-60 μm. The yolk cells are inside of egg. Ova are expelled the bronchi and expectorated with sputum or swallowed and passed with faeces. |
|  | Egg of *S. haematobium* (120-160 × 50-70 μm) is ellipsoid and has a sharp terminal spine. |
|  | Egg of *S. mansoni* (130-180 × 60-80 μm) is ellipsoid and has a distinctive lateral spine. |
|  | The egg of *S. japonicum* (70-100 × 50-65 μm) is more spherical with a small reduced spine (knob). The eggs can pass out through the intestinal or bladder wall into the lumen, from where they are released in the excreta to the environment. The egg contains a miracidium. |

**Comparison of *Schistosoma* species**

| *Characteristics* | *Schistosoma haematobium* | *Schistosoma mansoni* | *Schistosoma japonicum* |
|---|---|---|---|
| Disease | | | |
| Intermediate host | | | |
| Source of invasion | | | |
| Invasive stage for human | | | |
| Route of transmission | | | |
| Factors of transmission | | | |
| Localization inside human body | | | |
| Pathogenicity | | | |
| Laboratory diagnosis | | | |
| Prophylaxis | | | |

**Test questions:**

**1.** What organisms are blood flukes?
A. Worms of the genus *Fasciola*
B. Worms of the genus *Opisthorchis*
C. Worms of the genus *Clonorchis*
D. Worms of the genus *Schistosoma*
E. Worms of the genus *Paragonimus*

**2.** Bilharziasis is causes by:
A. *Metagonimus yokogawai*
B. *Clonorchis sinensis*
C. *Opisthorchis viverrini*
D. *Paragonimus westermani*
E. *Schistosoma haematobium*

**3.** Prevention of paragonimiasis includes:
A. To avoid ingestion of raw or undercooked crustaceans
B. To prevent faecal contamination of freshwater
C. To control snail population by molluscicides
D. Health education and changes in customs and food preparation practices
E. All of the above

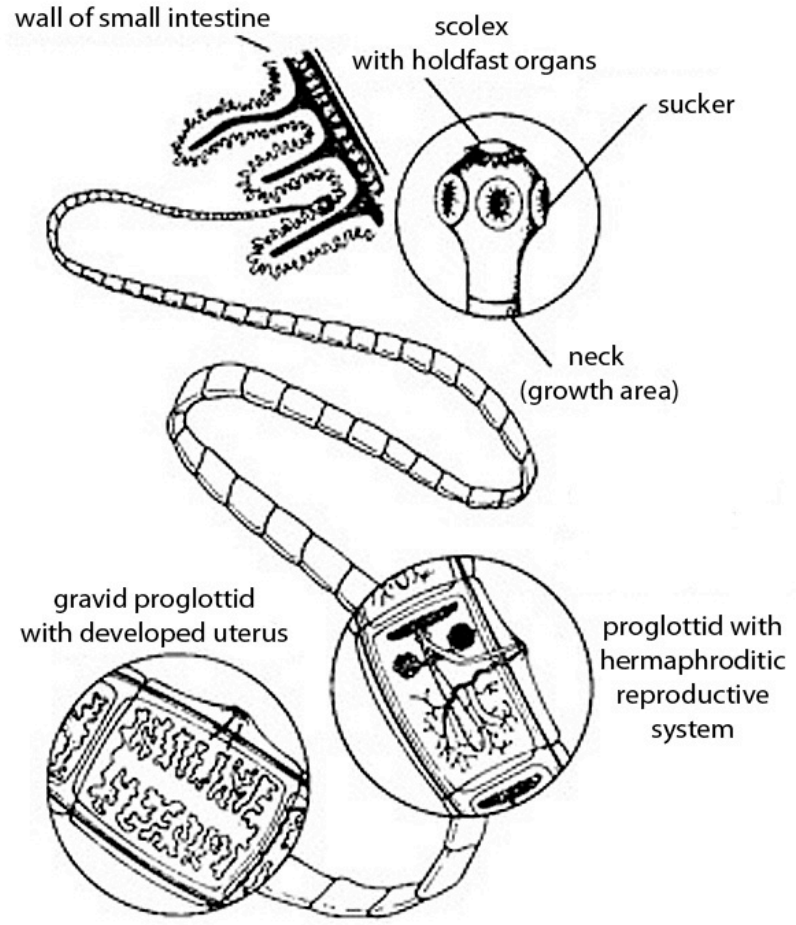


| Date | Signature |
|---|---|
| | |

**<u>Theme 27</u>: Phylum Flatworms (Plathelminthes). Class Tapeworms (Cestoidea) I: causative agents of human diseases**

**<u>Task 1.</u>** Study morphological features of tapeworms. Write the main features of Class *Cestoidea*.






1. _____

_____

2. _____
_____
3. _____
_____
4. _____
_____
5. _____
_____
6. _____
_____

**Task 2.** Examine the scoleci (heads) of pathogenic gut tapeworms under low magnification of the microscope. Pay attention to the holdfast organs (hooks, sucking discs, and sucking grooves). Sketch the scoleci of Cestodes, designate the holdfast organs.

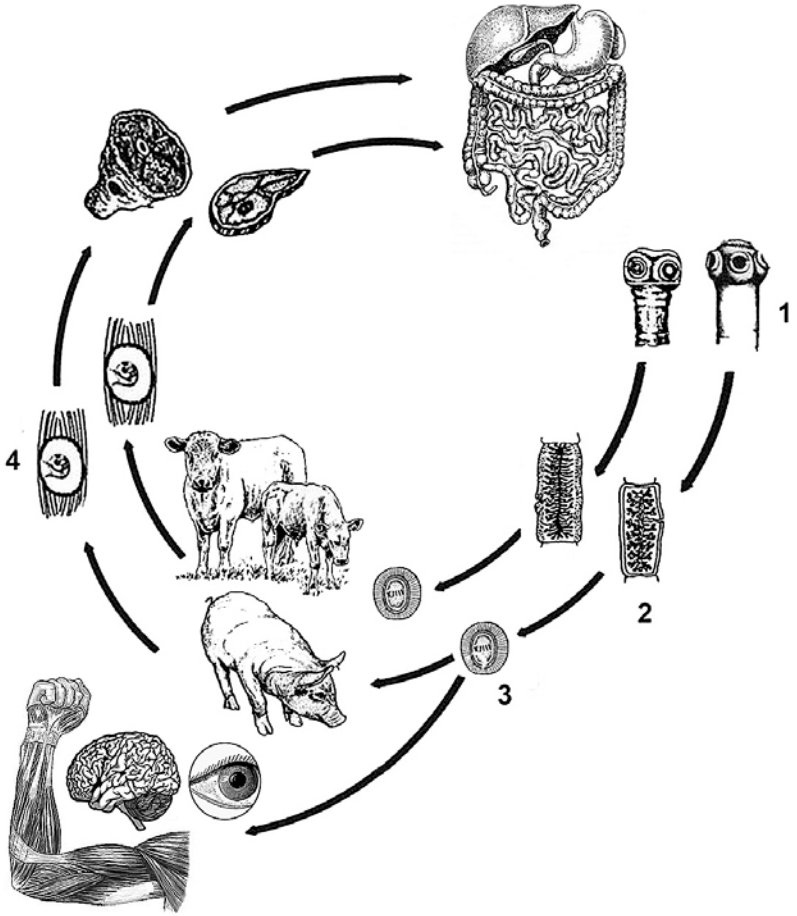
| | | |
|---|---|---|
| | | |
| 1._____<br>2._____ | 1._____<br>2._____ | 1._____<br>2._____ |

**Task 3.** Examine the gravid proglottids of pathogenic gut tapeworms under low power of microscope. Sketch the gravid proglottids of Cestodes, note a number of lateral branches of uterus.

| | | |
|---|---|---|
| | | |
| 1._____<br>2._____ | 1._____<br>2._____ | 1._____<br>2._____ |

**Order** Cyclophyllidea
**Family** Taeniidae
**Genus** *Taenia*
**Species** *Taenia solium* – **pork tapeworm**
**Genus** *Taeniarhynchus*
**Species** *Taeniarhynchus saginatus* **– beef tapeworm**

**Task 4.** Study the generalized life-cycle of species of Family *Taeniidae: Taenia solium* and *Taeniarhynchus saginatus*. Note the stages of parasite development and their habitat.




| *Developmental stage* | | *Habitat* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |

***WHO: Cysticercosis***

*Cysticercosis* is the infection of tissues caused by larvae *cystercerci* as a result of ingesting *Taenia eggs.* Cysticerci of *T. solium*, but not *T. saginata*, can infect humans.

Cysticercosis mainly affects the health and livelihoods of subsistence farmers in developing countries of Africa, Asia and Latin America. In fact, besides leading to epilepsy and death in humans, cysticercosis also reduces the market value of pigs and makes pork unsafe to eat.

Cysticerci larvae that develop in the CNS cause *neurocysticercosis* – the most severe form of the disease and one of the main preventable causes of epilepsy (seizures) in many developing countries.

More than 80% of the world's 50 million people who are affected by epilepsy live in developing countries, many of which are endemic for *T. solium* infections in people and pigs. About 29 % of people with epilepsy in endemic countries had neurocysticercosis. High distribution is in countries with free-roaming pigs, poor sanitation and informal animal slaughter.

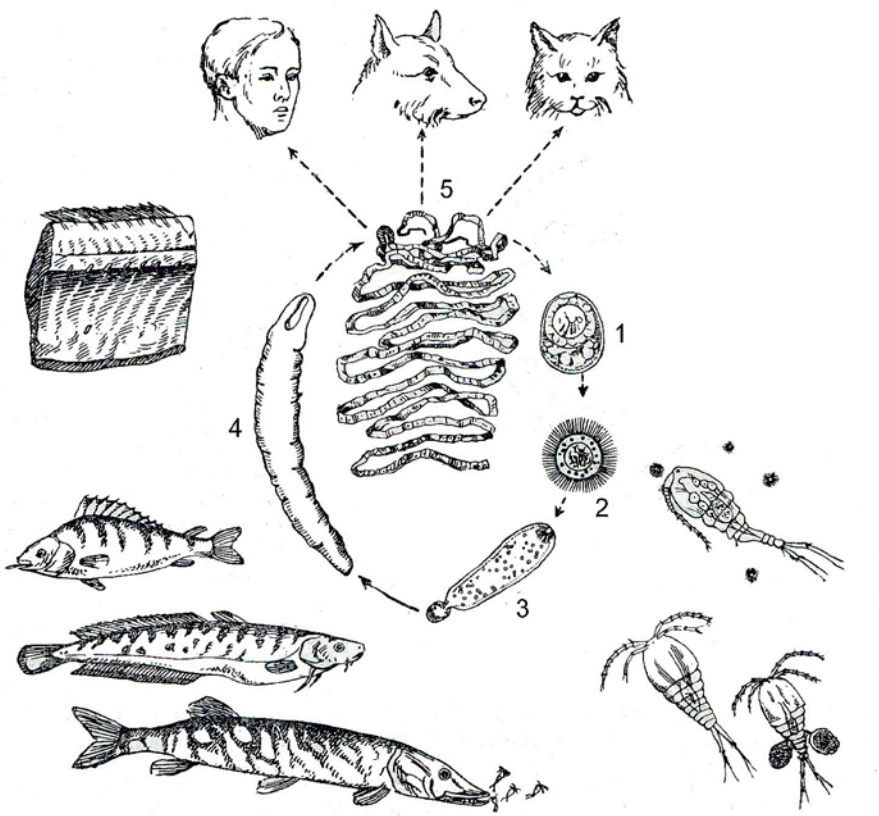
**Task 5**. Give the characteristics of *Taenia solium* and *Taeniarhynchus saginatus* and the diseases caused by them (*see the next page*).

**Comparison of *Taenia solium* and *Taeniarhynchus saginatus* and the diseases caused by them**

| *Characteristics* | *Taenia solium* | | *Taeniarhynchus saginatus* |
|---|---|---|---|
| Disease(s) | | | |
| Morphological features | | | |
| Definitive host | | | |
| Intermediate host | | | |
| The source of invasion | | | |
| Invasive stage for a human | | | |
| Route and factors of transmission | | | |
| Localization in human body | | | |
| Pathogenicity | | | |
| Laboratory diagnosis | | | |
| Prophylaxis | | | |

**Order** Pseudophyllidea
**Family** Diphillobothriidae
**Genus** *Diphillobothrium*
**Species** *Diphyllobothrium latum* – **broad fish tapeworm**

**Task 6.** Study the life-cycle of *Diphyllobothrium latum*. Note the stages of parasite development and their habitat.




| | *Developmental stage* | *Habitat* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

**Task 7.** Give the characteristics of *Diphyllobothrium latum*.

Disease _____

Morphological features _____

_____

_____

The source of invasion _____

_____

Invasive stage for human _____

Route and factors of transmission _____

_____

_____

Localization inside human body _____

_____

Pathogenicity _____

_____

_____

_____

Laboratory diagnosis _____

_____

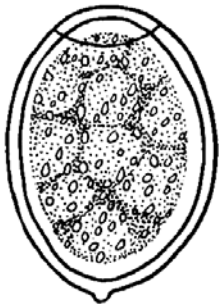
_____

Prophylaxis _____
_____
_____
_____

**Task 8.** Study the morphological distinctions of pathogenic gut tapeworms.

| *Characteristics* | *Taenia solium* | *Taeniarynchus saginatus* | *Diphyllobothrium latum* |
|---|---|---|---|
| Length of body | | | |
| Organs for attachment to host tissues | | | |
| Mature proglottids | | | |
| Mobility of proglottids | | | |
| Shape of gravid uterus | | | |

**Task 9.** Examine the ova of the different species of Cestodes under low and high magnifications of microscope. Determine what species they belong to.

| | |
|---|---|
|  | _____<br>The eggs are oval with a thick, brown shell and measure 28-44×28-38 mcm. Embryophore shell is radially striated and 31-40 mcm in diameter. Egg contains hexacanth embryo. |
|  | _____<br>The egg is oval with a thick, but transparent, yellowish shell. The eggs are 70-83×50-54 mcm. An operculum resides in either pole of egg. Prominence 3,5-6 mcm in breadth resides another side. |

**Test questions:**

**1.** The chain of proglottids is collectively called the ____, and the holdfast or attachment organ is called the ____
- A. scolex, cysticercus
- B. strobila, scolex
- C. scolex, coracidium
- D. cercaria, strobila
- E. cercaria, scolex

**2.** Which of the following is ***mis***matched?
- A. *Diphyllobothrium latum* – broad fish tapeworm
- B. *Taenia solium* - pork tapeworm
- C. Class *Trematoda* - tapeworms
- D. Scolex - attachment or holdfast organ
- E. Proglottid - "hermaphroditic" arrangement of testes and ovaries

**3.** Which stage of *Taeniarhynchus saginatus* development is invasive for an intermediated host?
- A. cysticercoid
- B. cysticercus
- C. plerocercoid
- D. procercoid
- E. egg

| Date | Signature |
|---|---|
| | |

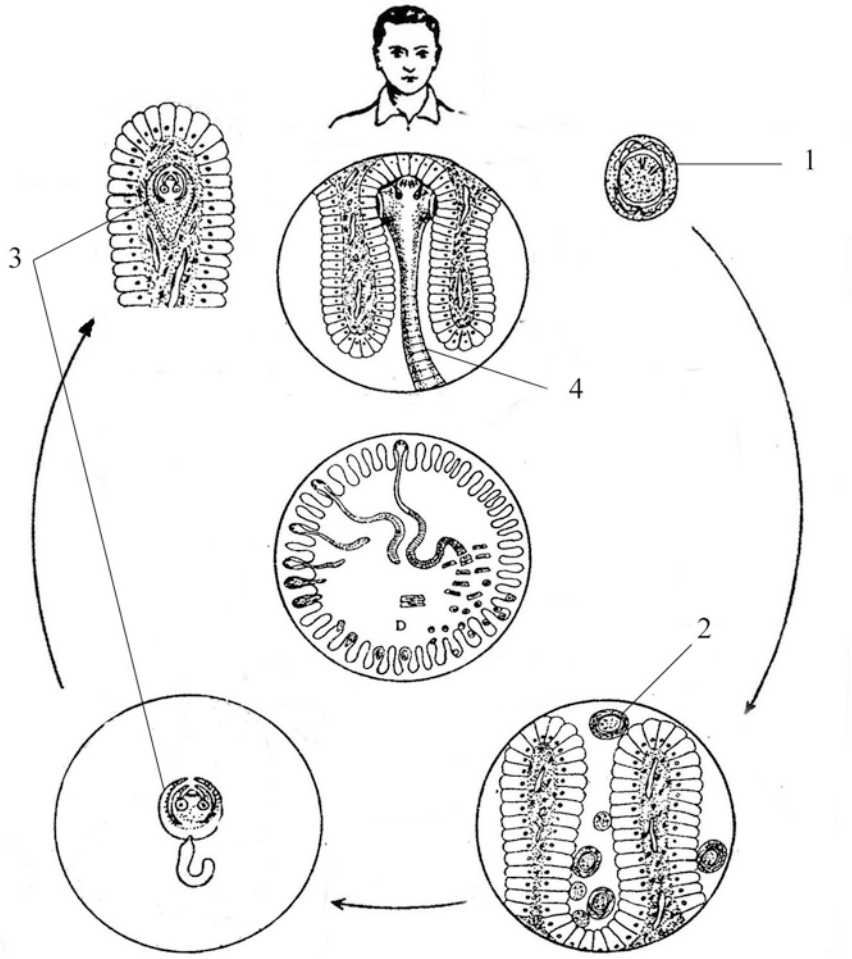
**Theme 28: Phylum Flatworms (Plathelminthes). Class Tapeworms (Cestoidea) II: causative agents of human diseases**

**Order** Cyclophyllidea
**Family** Hymenolepididae
**Genus** *Hymenolepis*
**Species** *Hymenolepis nana* **– dwarf tapeworm**

**Task 1.** Examine a specimen of *Hymenolepis nana* under low magnification of microscope. Sketch it in the notebook. Make the designations: organs for attachment to host tissues, proglottids, uterus.

| | |
|---|---|
| 1. _____<br>2._____ | |

**Task 2.** Study the life-cycle of *Hymenolepis nana*. Note the stages of parasite development and their habitat.




| | ***Developmental stage*** | ***Habitat*** |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |

**Task 3**. Give the characteristics of *Hymenolepis nana*.

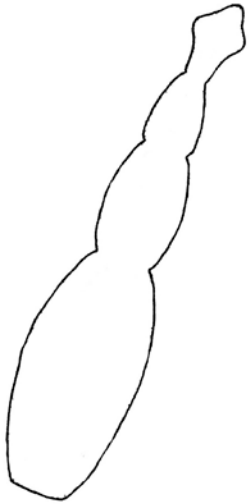
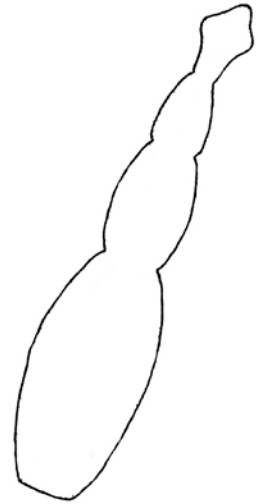
Disease _____
Morphological features _____
_____
_____
_____
_____
Source of invasion _____
Invasive stage for a human _____
Route and factors of transmission _____
_____
Localization inside human body _____
_____
Pathogenicity _____
_____
_____
_____
Laboratory diagnosis _____
_____
Prophylaxis _____
_____
_____
_____

**Order** Cyclophyllidea
**Family** Taeniidae
**Genus** *Echinococcus*
**Species** *Echinococcus granulosus* **– dog tapeworm**
*Echinococcus multilocularis* **– alveolar tapeworm**

**Task 4.** Study the morphological differences of *Echinococcus* species. Sketch the adults of *E. granulosus* and *E. multilocularis*, using the table

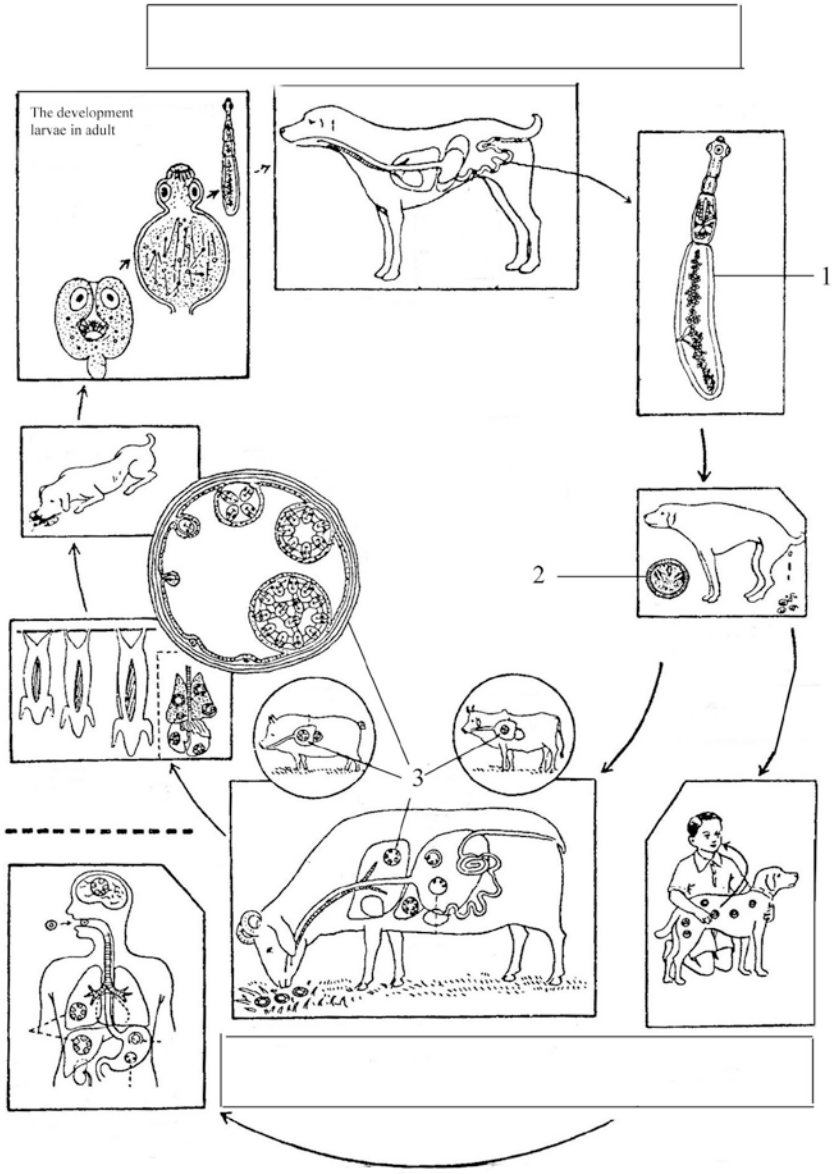
***Morphological differences of Echinococcus species***

| Species | Length of body | Number of proglottids | Length of big hooks | Length of small hooks | Number of testes | Uterus |
|---|---|---|---|---|---|---|
| *E. multi-locularis* | 1.3-3.4 | 3-4 | 23-29 | 19-26 | 21-29 | No lateral branches |
| *E. granu-losus* | 2.7-8.0 | 3-4 | 43-49 | 32-42 | 46-65 | With lateral branches |

| ***Echinococcus granulosus*** | ***Alveococcus multilocularis*** |
|---|---|
|  |  |

1. _____
2. _____
3. _____

**Task 5.** Study the scheme of the *Echinococcus granulosus* life-cycle. Note the stages of parasite development and their habitat.

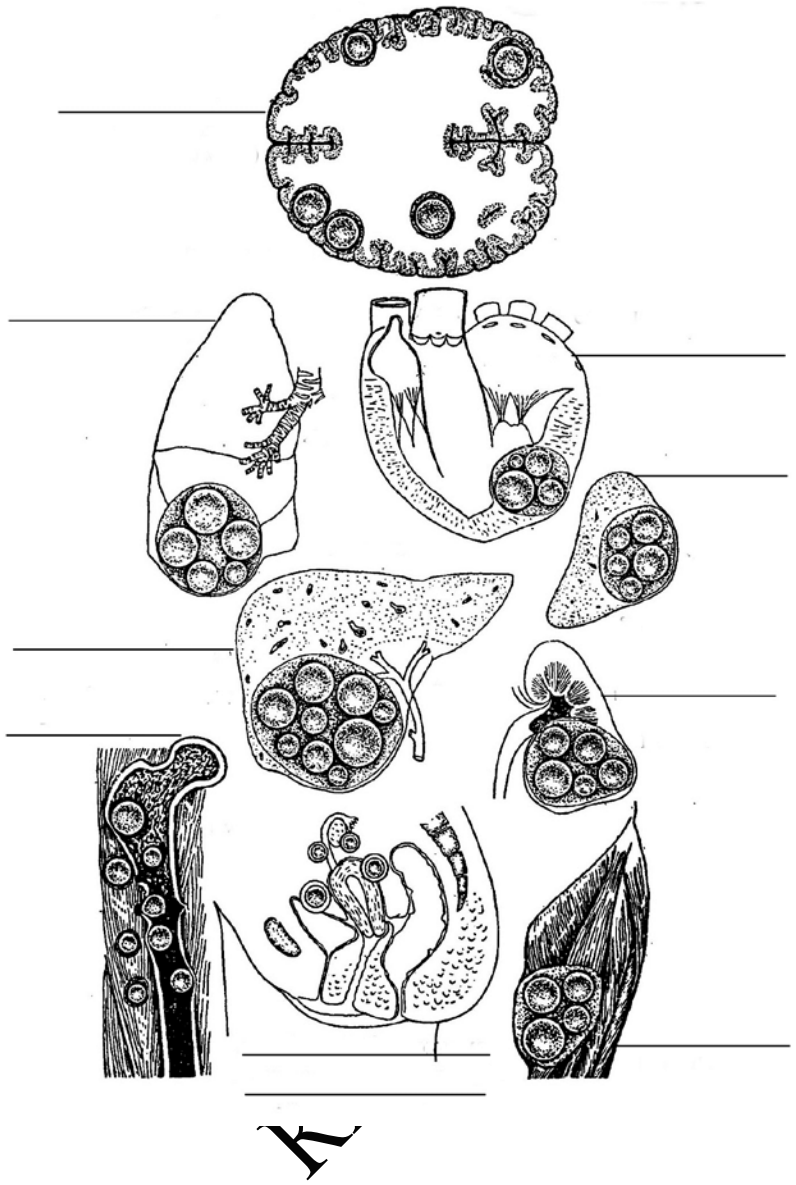



| | *Developmental stage* | *Habitat* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |

**Task 6.** Give the characteristics of *Echinococcus granulosus*.

Disease _____
Morphological features _____
_____
_____
_____
The source of invasion _____
Invasive stage for a human _____
Route and factors of transmission _____
_____
_____
Localization inside human body _____
_____
Pathogenicity _____
_____
_____
_____
_____
Laboratory diagnosis _____
_____
_____
_____
Prophylaxis _____
_____
_____
_____

**Task 7.** Subscribe the organs where *Echinococcus* larvae (hydatid cyst) can locate in human organism.



***WHO: Echinococcosis***

Cystic echinococcosis (CE) is globally distributed and found in every continent except Antarctica. In endemic regions, human incidence rates of CE can reach greater than 50 per 100 000 person-years, and prevalence levels as high as 5–10% may occur in parts of Argentina, Peru, east Africa, central Asia, and China.

The highest prevalence is found in rural areas where older animals are slaughtered. Both cystic echinococcosis and alveolar echinococcosis represent a substantial disease burden. Worldwide, there may be in excess of one million people living with these diseases at any one time. Many of these people will be experiencing severe clinical syndromes which are life-threatening if left untreated. Even with treatment, people often face reduced quality of life. For CE, there is an average 2.2% postoperative death rate for surgical patients and about 6.5% of cases relapsing after intervention that require prolonged recovery time.

WHO is helping to identify countries to develop and implement pilot projects leading to the validation of effective cystic echinococcosis control strategies by 2018.

**Task 8.** Sketch the Cestodes larvae in the notebook.

| | |
|---|---|
| | ***Cysticercus***, or a sac-like *bladder-worm,* is whitish, ovoid, and measure 10 × 5 mm; it is filled with fluid and contains an invaginated protoscolex. Cysticerci occur in striated muscle of mammals. |
| | The ***plerocercoid larva*** is 1 to 1.5 cm long and 1 mm wide. Plerocercoid possesses slit-like two sucking grooves on the anterior end of body. It is found in the muscles and peritoneal cavity of fish. |

| | |
|---|---|
| | ***Cisticercoid*** is elongated larva, which contains an invaginated protoscolex on the anterior end of body. |
| | A ***hydatid cyst*** of *Echinococcus granulosus* is simple with an outer, elastic, laminated layer and a more fragile, inner, germinal layer of epithelial cells from which bud brood capsules. The cyst is filled with clear fluid. The simple cyst sometimes forms daughter cysts. |
| | The ***hydatid cyst*** of *E. multilocularis* causing alveolar echinococcosis is an 'alveolar' or honey-combed structure. |

**Test questions*:***

**1.** In life cycle of dwarf tapeworm, human is
- A. a definitive host
- B. an intermediate host
- C. both a definitive and an intermediate host
- D. a reservoir host
- E. a vector

**2.** The larval stage of *Echinoccocus spp.* is called a:
- A. cysticercus
- B. cysticercoid
- C. procercoid
- D. hydatid
- E. plerocercoid

| Date | Signature |
|---|---|
| | |



**<u>Theme 29:</u> Phylum Roundworms (Nemathelminthes). Class True Roundworms (Nematoda) 1: causative agents of human diseases. Geohelminthes**

**<u>Task 1.</u>** Write the major features of Phylum *Nemathelminthes.*

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
4. _____
8. _____

**Order** Ascaridida
**Family** Ascarididae
**Genus** *Ascaris*
**<u>Species</u>** ***<u>Ascaris lumbricoides</u>* – <u>maw worm</u>**

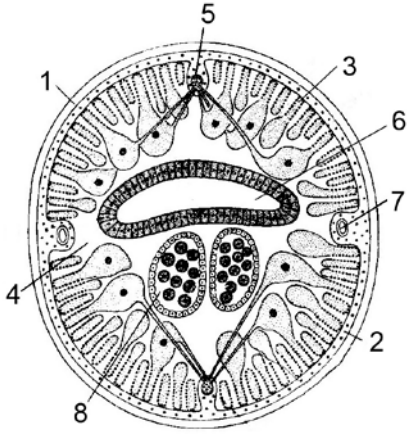
**<u>Task 2</u>.** Study a macropreparation of *Ascaris lumbricoides*. Pay attention to the length of the helminth, its smooth cylindrical body with tapering ends covered by the dense collagen cuticle, sexual dimorphism (a female has straight tail; a male has the curved tail). Sketch the general aspects of the male and the female of *Ascaris lumbricoides*.

*Ascaris lumbricoides*

1._____

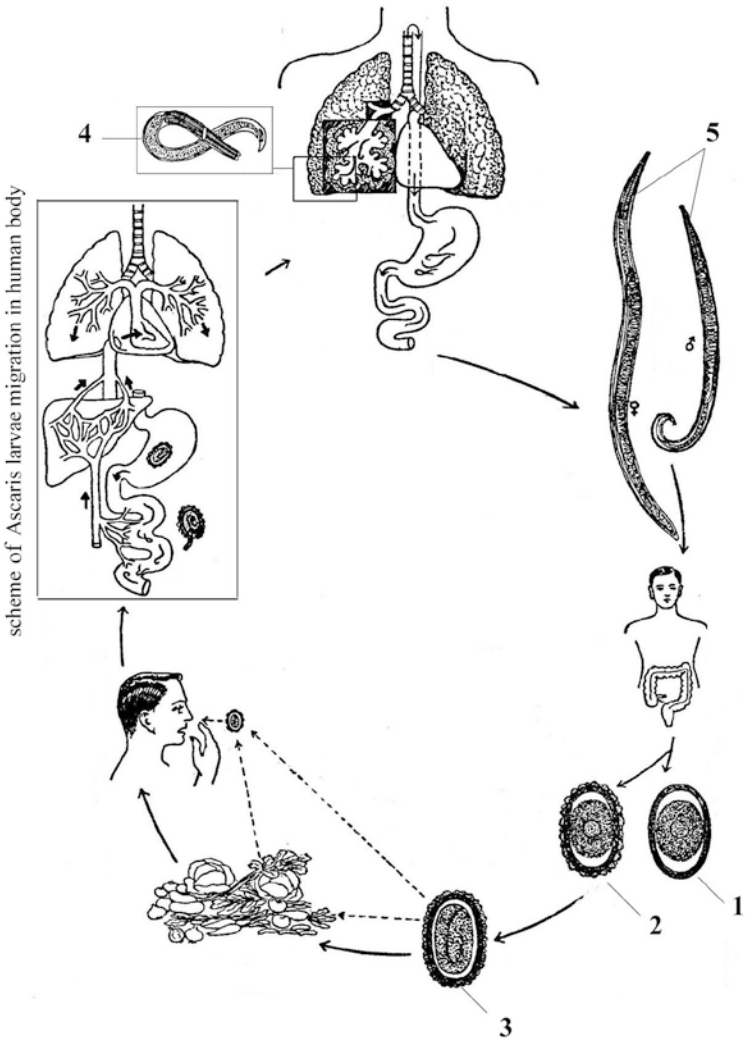
2._____

**Task 3.** Examine a cross-section of *Ascaris lumbricoides* under low magnification of the microscope. Pay attention to the round shape of body, structure of body wall (cuticle, hypodermis, muscles), presence of a pseudocoelom, the canals of excretory system, dorsal and ventral nerves. Sketch the micropreparation in the notebook. Make the designations: cuticle, hypodermis, muscles, body cavity, canals of excretory system, nervous cords, intestine, gonads.




1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

**Task 4**. Study the life-cycle of *Ascaris lumbricoides*.




1. _____
2. _____
3. _____
4. _____
5. _____

***Scheme of Ascaris larvae migration in the human body***

Intestine → _____ → _____ →
_____→ _____ →
_____ → _____ → _____ →
_____→_____→_____→ intestine.

**Order** *Ascaridida*
**Family** *Toxocaridae*
**Genus** *Toxocara*
**Species** *Toxocara canis* **– dog toxocara**
*Toxocara cati* **– cat toxocara**

**Task 5.** Read about the animal nematodes, larvae of which are able to circulate in human organism and cause the diseases.

**Genus** *Toxocara*

Species of genus *Toxocara* cause toxocariasis (also known as toxocaral larva migrans, visceral larva migrans, ocular larva migrans, and covert toxocariasis).

The adult worm is found in the intestine of dogs (*T. canis*) and cats *(T. cati)*. These round worms range from 4-12 cm in length. Humans can become infected after accidentally swallowing *Toxocara* eggs in soil or other contaminated surfaces. The liberated larvae penetrate the intestinal wall and reach the liver and lung via the circulation. Sometimes the parasite penetrates into the eye and brain.

Symptoms may be produced by the presence of the larvae migrating in parts of the body.

There are two major forms of toxocariasis:

1) Visceral larva migrans (VLM), a disease that causes swelling of the body's organs or central nervous system. Symptoms of VLM, which are caused by the movement of the worms through the body, include fever, decreased appetite, abdominal pain, seizures, joint pain/swelling, urticaria, cough, asthma, or pneumonia.

2) Ocular larva migrans (OLM), an eye disease that can cause blindness. OLM occurs when a worm enters the eye. Symptoms include uniocular decreased visual acuity, seeing floaters or 'bubbles'. OLM may cause inflammation and formation of a scar on the retina.

Epidemiologically, puppies are the most important natural hosts and the infection is most commonly seen in children between 1 and 4 years of age. Prevention includes removal of pet faeces, personal hygiene and regular worming of pets, especially puppies.

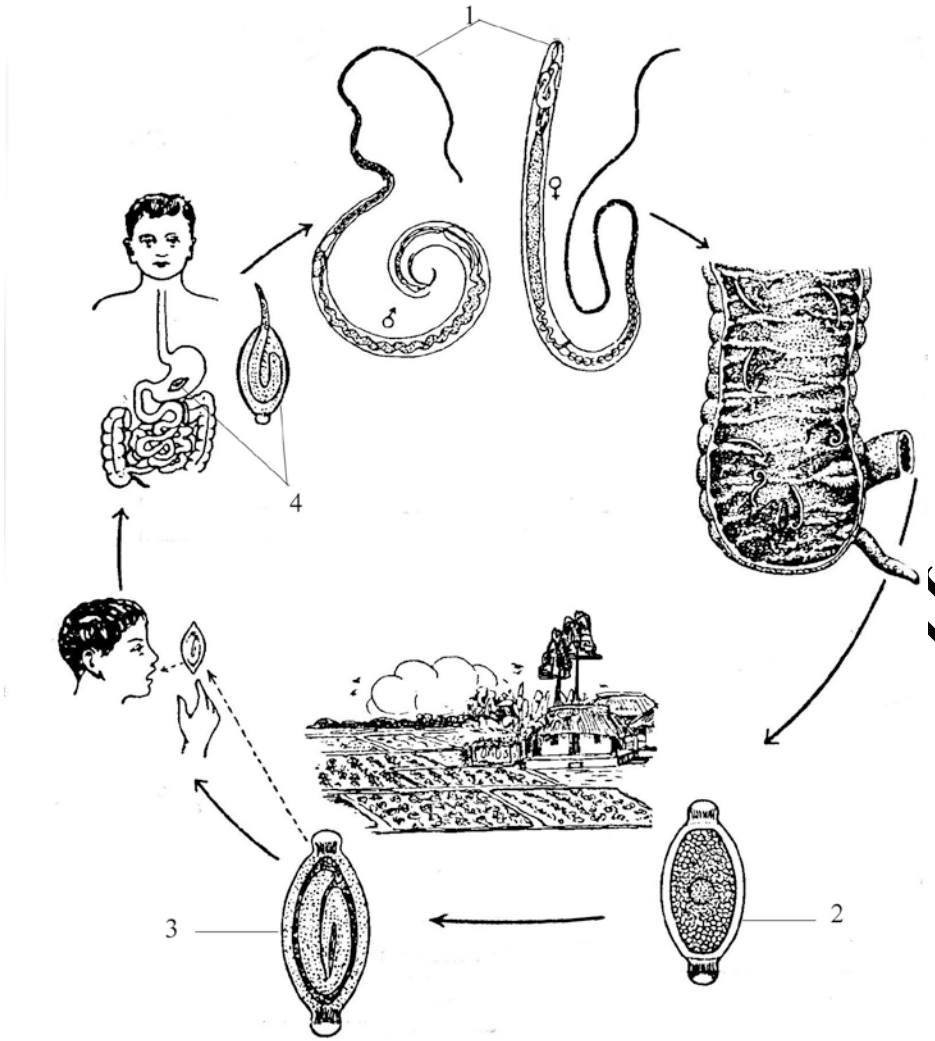
**Order** Trichocephalida
**Family** Trichuridae
**Genus** *Trichocephalus*
**Species** *Trichocephalus trichiurus* (*Trichuris trichiura*) **– whip worm**

**Task 6.** Examine the preparation of *Trichocephalus trichiurus*. Pay attention to the anterior thin elongated end of worm body, by which the worms are attached to the wall of large intestine. Sketch the general aspects of the male and female of *T. trichiurus*.

*Trichocephalus trichiurus*

1. _____
2. _____

**Task 7.** Study the life-cycle of *Trichocephalus trichiurus*. Note the stages of parasite development and their habitat.




1. _____
2. _____
3. _____
4. _____

**Task 8.** Fill in the table.

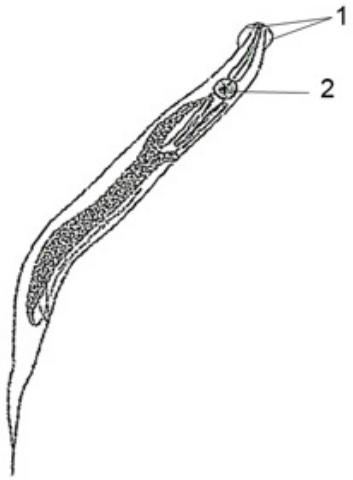
**Comparison of *A. lumbricoides* и *T. trichiurus***

| *Characteristics* | *Ascaris lumbricoides* | *Trichocephalus trichiurus* |
|---|---|---|
| Disease | | |
| Morphological features | | |
| Source of invasion | | |
| Invasive stage for human | | |
| Route of transmission | | |
| Factors of transmission | | |
| Localization in human body | | |
| Features of life cycle | | |
| Pathogenicity | | |

| | | |
|---|---|---|
| Laboratory diagnosis | | |
| Features of dehelminthization | | |
| Prophylaxis | | |

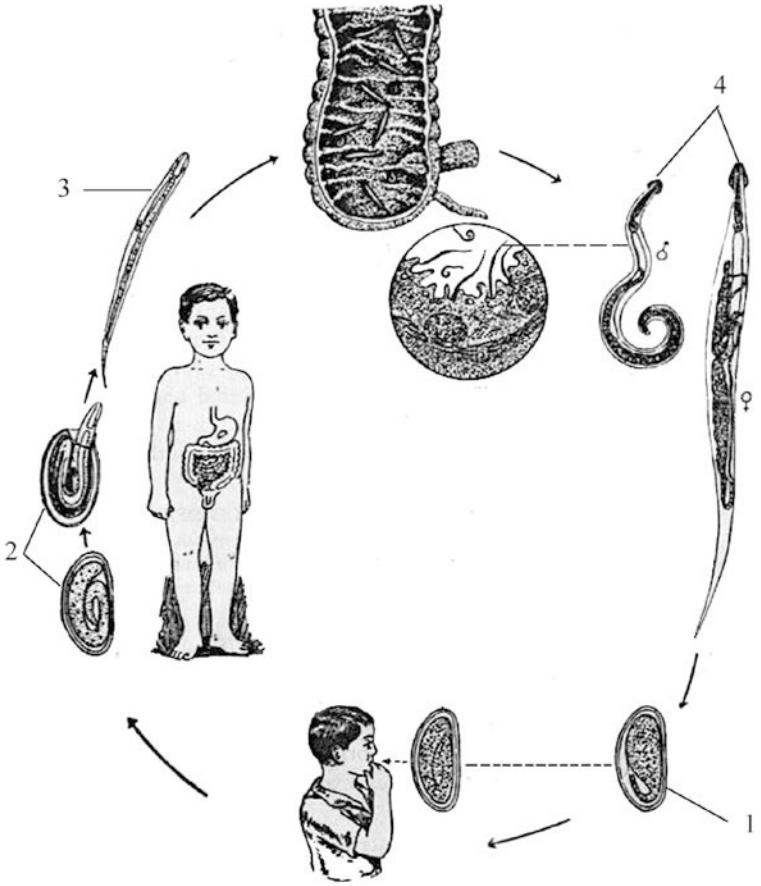
**Order** Ascaridida
**Family** Oxyiridae
**Genus** *Enterobius*
**Species** *Enterobius vermicularis* – **pinworm**

**Task 9.** Examine a fixed specimen of *Enterobius vermicularis* under low magnification of a microscope. Sketch it. Designate a bulbus (dilatation of the esophagus) and cephalic alae on the figure.




1 – _____
_____
2 – _____
_____

**Task 10.** Study the life-cycle of *Enterobius vermicularis*. Note the stages of parasite development.




1. _____
2. _____
3. _____
4. _____

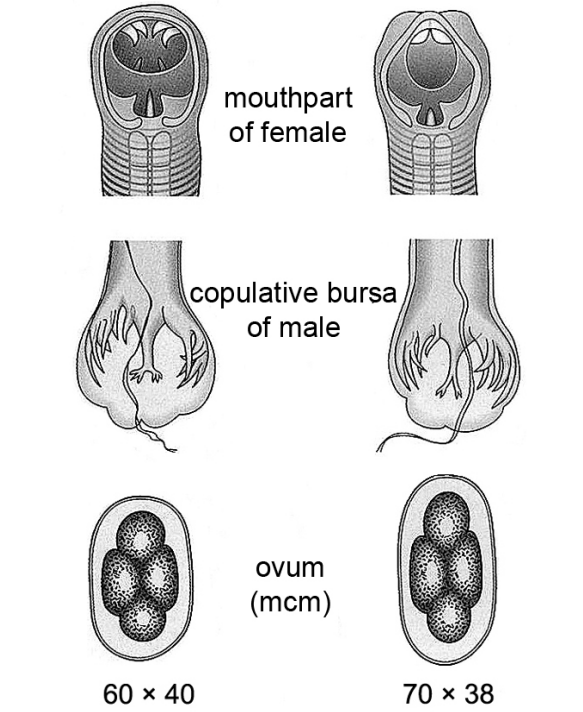
**Task 11.** Give the characteristics of *Enterobius vermicularis*.

Disease _____
Morphological features _____
_____
_____
Source of invasion _____
Invasive stage for a human _____
Route and factors of transmission _____
_____
_____
Localization inside human body _____
_____
Pathogenicity _____
_____
_____
_____
_____
Laboratory diagnosis _____
_____
_____
Prophylaxis _____
_____
_____
_____
_____

**Order** Strongylida
**Family** Ancylostomidae
**Genus** *Ancylostoma*
**Species** *Ancylostoma duodenale* **– tunnel worm**
**Family** Uncinariidae
**Genus** *Necator*
**Species** *Necator americanus*

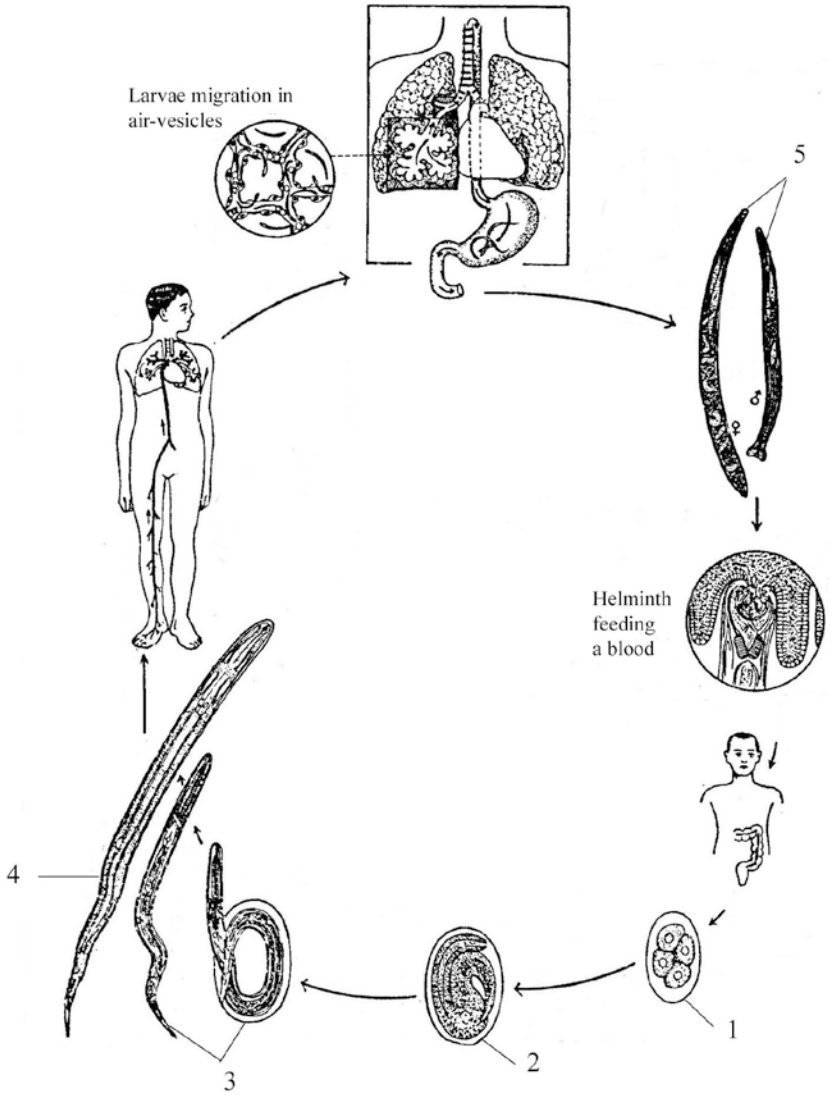
**Hook worms**

**Task 12.** Study the morphological features of hook worms using a table.




**Task 2.** Study the life-cycle of *Ancylostoma duodenale*. Note the stages of parasite development.

1. _____
2. _____
3. _____
4. _____
5. _____



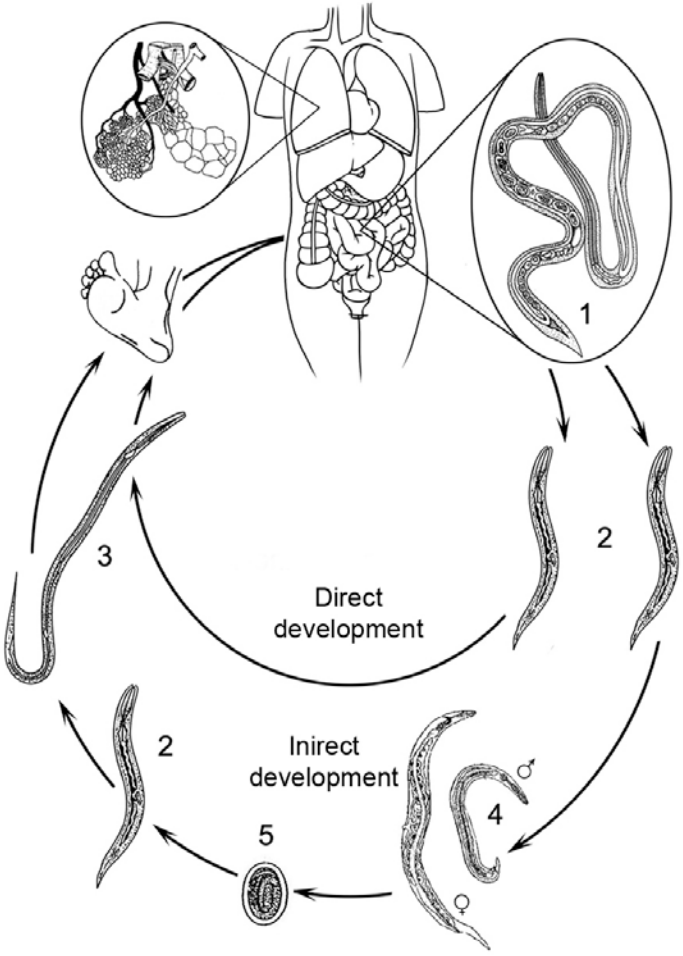

**Order** Rhabditida

**Family** Strongyloidae

**Genus** *Strongyloides*

**Species** *Strongyloides stercoralis* – **palisade worm (threadworm)**

**Task 14.** Study the life-cycle of *Strongyloides stercoralis*. Note the stages of parasite development.



1. _____
2. _____
3. _____
4. _____
5. _____

**Task 15.** Give the characteristics of *A. duodenale* and *S. stercolaris*.

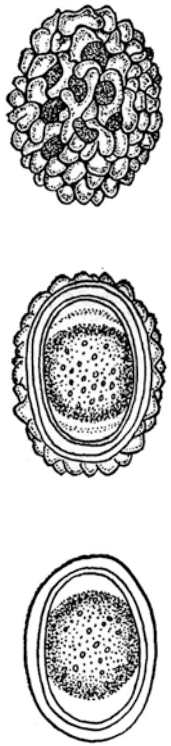
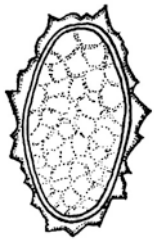
| *Characteristics* | *Ancylostoma duodenale* | *Strongyloides stercolaris* |
|---|---|---|
| Disease | | |
| Morphological features | | |
| Source of invasion | | |
| Invasive stage for human | | |
| Route of transmission | | |
| Factors of transmission | | |
| Localization in human body | | |
| Features of life cycle | | |
| Pathogenicity | | |
| Laboratory diagnosis | | |
| Prophylaxis | | |

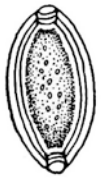
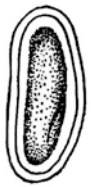
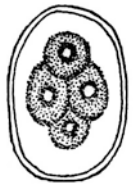
**WHO: *Soil-transmitted helmitiasises (STHs)***

The STHs are among the most common and persistent parasitic infections worldwide. According to the latest estimates, 800 million people are infected with roundworm (*Ascaris lumbricoides*), 600 million with whipworm (*Trichuris trichiura*), 600 million with hookworms (*Necator americanus*, *Ancylostoma duodenale*), and 30−100 million people are thought to be infected with threadworm (*Strongyloides stercoralis*). In Latin America and the Caribbean, STHs are present in all countries, with an estimated 26.3 million school-aged children at risk of infection. In many areas of 13 of the 14 countries in this region, infection prevalence is higher than 20%.

Globally, approximately 300 million people suffer from severe morbidity, resulting in 10 000–135 000 deaths annually. However, the greatest impact of STHs is on the impairment of physical and mental development in children, which ultimately retards educational advancement and economic development.

**Task 16.** Examine the ova of the different species of nematodes under low and high magnifications of the microscope. Take a look at their description.

| | |
|---|---|
|  | ***Ascaris lumbricoides***<br><br>The fertilized eggs are brown, ovoid and measure 60-70×30-50 μm. When freshly passed they are not infective and contain a single cell. In the soil, the larva becomes infective. The cell is surrounded by a thin vitelline membrane.<br>Around the membrane is a thick, translucent shell, which in turn is surrounded by an irregular, protein coat.<br><br>The coat is sometimes lost or can be removed by chemical treatment, resulting in a decorticated egg. |
|  | ***Ascaris lumbricoides***<br><br>The unfertilized eggs are 88-94×40-44 μm and have disorganized contents. |

| | |
|---|---|
|  | ***Trichocephalus trichiurus***<br><br>The egg is yellowish brown, barrel-shaped with two plugs on the poles and measure 50-55×22-25 μm. |
|  | ***Enterobius vermicularis***<br><br>The eggs are generally flattened on one side and measure approximately 50 to 60 μm in length and 20 to 30 μm in breadth. They have a thick, transparent shell. The eggs become infective in 4-6 hours. |
|  | _____<br>_____<br><br>The egg is transparent, oval, colorless with rounded poles. The shell is thin. There are 4-8 blastomeres inside egg. The measures of the egg are 56-76×34-40 mcm. |

**Test questions:**

**1.** All of the following is true about Phylum *Nemathelminthes* except
- A. triploblastic
- B. bilaterally symmetrical
- C. acoelomate
- D. nerves embedded in epidermis
- E. no circulatory or gas exchange organs

**2.** A patient is a 6 year-old male who had been complaining of intermittent abdominal pain for several weeks and, prior to the physician visit, he passed a worm. This worm measured about 20 cm long and was about the thickness of a pencil. The pathogenic worm is
- *A. Ascaris lumbricoides*
- *B. Enterobius vermicularis*
- *C. Trichocephalus trichiurus*
- *D. Fasciola hepatica*
- *E. Taenia solium*

**3**. An autoinfection occurs in
- A. ascariasis
- B. strongyloidiasis
- C. fascioliasis
- D. opistorchiasis
- E. trichocephaliasis

| Date | Signature |
|---|---|
| | |



**<u>Theme 30</u>: Phylum Roundworms (Nemathelminthes). Class True Rounwormes (Nematoda) II: causative agents of human diseases. Biohelminthes**

**Order** Trichocephalida
**Family** Trichinellidae
**Genus** *Trichinella*
**<u>Species</u>** ***<u>Trichinella spiralis</u>*** **– <u>trichina worm</u>**

**<u>Task 1.</u>** Examine the encysted larvae of *Trichinella spiralis* into the striated muscles under low magnification of the microscope. Sketch the micropreparation. Designate the calcareous capsule and larva in its.

*Trichinella spiralis*

1._____

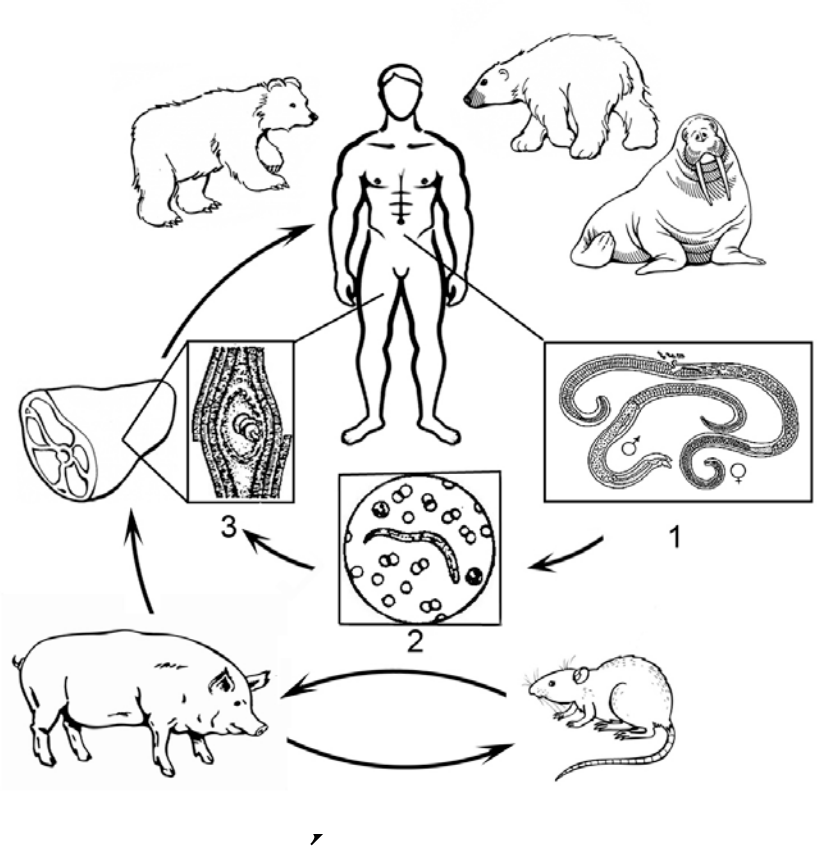
2._____

**<u>Task 2.</u>** Give the characteristics of *Trichinella spiralis*.
Disease _____
Morphological features _____
_____
_____
_____
Source of invasion _____
Invasive stage for a human _____
Route and factors of transmission _____
_____
Localization inside human body _____
_____

Pathogenicity _____
_____
_____
_____
Laboratory diagnosis _____
_____
Prophylaxis _____
_____
_____

**Task 3.**

Study the life-cycle of *Trichinella spiralis*. Note the stages of parasite development and their location.




1. _____
2. _____
3. _____

**Order** Camallanida

**Family** Dracunculidae

**Genus** *Dracunculus*

**Species** *Dracunculus medinensis* **– dragon worm**

**WHO: *Dracunculiasis***

WHO established the International Commission for the Certification of Dracunculiasis Eradication in 1995 to certify the elimination of guinea-worm disease. To date the commission has certified 187 countries and territories as free of guinea-worm disease.

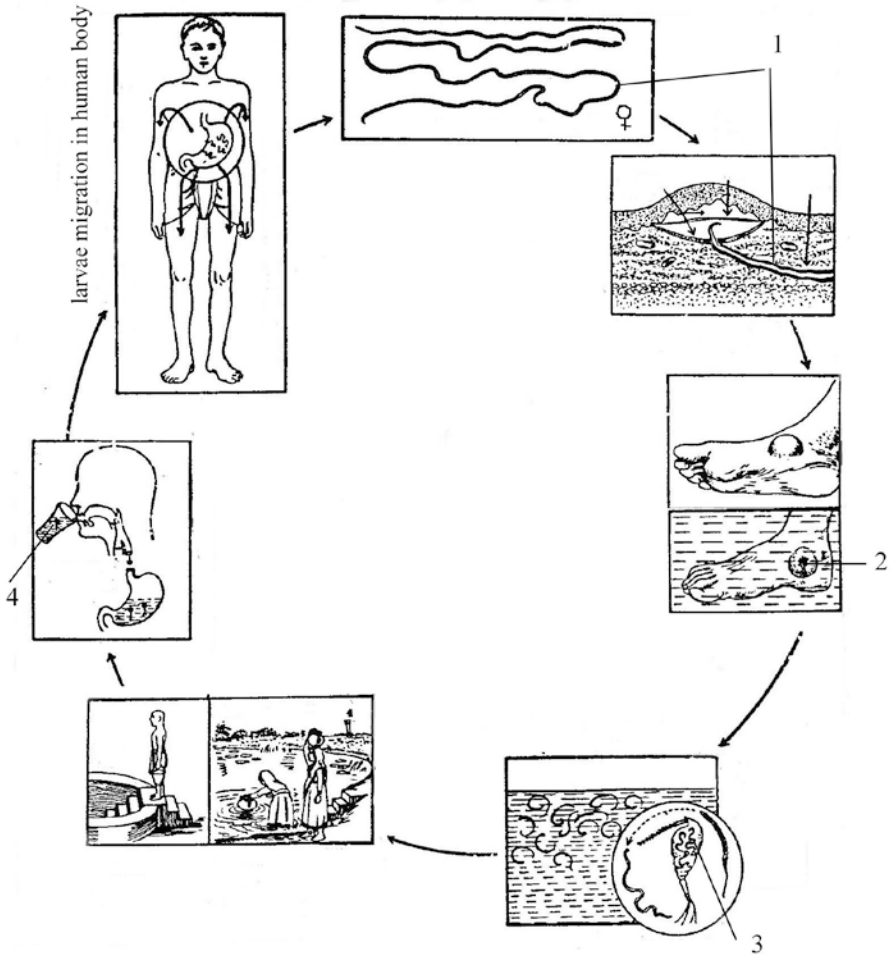
In the mid-1980s, guinea-worm disease was endemic in 20 countries in Africa, the Middle East and Asia, with 3.5 million estimated cases. In 2013, only four endemic countries reported cases: Chad, Ethiopia, Mali and South Sudan; 3 more cases were reported across the border of South Sudan in Sudan, where the last indigenous case was recorded in 2002.

After more than 30 years of continuous struggle and with 148 cases reported to the WHO in 2013, the world is closer than ever to eradicating guinea-worm disease (dracunculiasis) as the first parasitic disease of humans and one which has afflicted humankind for centuries.

*Dracunculiasis. Invasive agent is a dragon worm (Dracunculus medinensis).*

**Task 4.** Study the scheme of *Dracunculus medinensis* life-cycle. Note the stages of parasite development.

1. _____
2. _____
3. _____
4. _____
_____

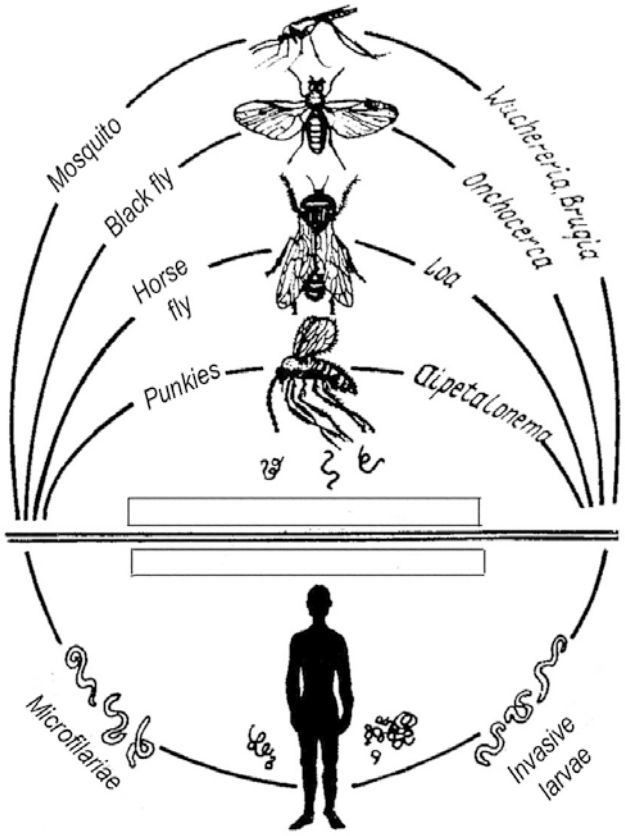



**Task 5.** Give the characteristics of *Dracunculus medinensis*.

Disease _____
Morphological features _____
_____
_____
_____
Source of invasion _____
Invasive stage for a human _____
Route and factors of transmission _____
_____
Localization inside human body _____
_____
Pathogenicity _____
_____
_____
Laboratory diagnosis _____
_____
Prophylaxis _____
_____
_____

**Order** Spirurida
**Family** Filariidae
**Genus** *Wuchereria*
**Species** *Wuchereria bancrofti*
**Genus** *Brugia*
**Species** *Brugia malayi*
**Genus** *Loa*
**Species** *Loa loa* – eye worm
**Genus** *Onchocerca*
**Species** *Onchocerca volvulus*
**Genus** *Dirofilaria*
**Species** *Dirofilaria repens*
**Genus** *Mansonella*
**Species** *Mansonella ozzardi*

**Task 6.** Study the generalized life-cycle of nematodes of the family *Filariidae.*



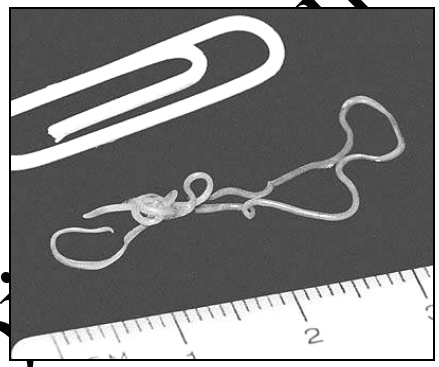

**WHO: *Lymphatic filariasis***

Nearly 1.4 billion people in 73 countries worldwide are threatened by lymphatic filariasis, a parasitic infection that leads to a disease commonly known as elephantiasis. Approximately 80% of these people are living in the following 10 countries: Bangladesh, Democratic Republic of Congo, Ethiopia, India, Indonesia, Myanmar, Nigeria, Nepal, Philippines and the United Republic of Tanzania.

Over 120 million people are currently infected, with about 40 million disfigured and incapacitated by the disease

Globally, an estimated 25 million people suffer with genital disease and over 15 million people are afflicted with lymphoedema. Eliminating lymphatic filariasis can prevent unnecessary suffering and contribute to the reduction of poverty.

**Task 7.** Give the comparative characteristics of family *Filariidae* representatives *(see the next page).*



***Dirofilaria repens,*** the zoonotic filariae, transmitted by mosquitoes, usually affects animals – cats and dogs. Human is accidental host, so adult worms do not reach maturity in human organism. Human dirofilariasis typically manifests as either subcutaneous nodules or lung parenchymal disease.

**Test questions:**

**1.** The parasitic worm found in improperly cooked pork that might cause disease is

A. hookworm
B. pinworm
C. maw worm
D. eye worm
E. trichina worm

**2**. Localization of *Dracunculus medinensis* in human organism is

A. liver
B. small intestine
C. large muscles
D. subcutaneous connective tissues
E. eyes

| Date | Signature |
|---|---|
| | |

**Comparison of parasitic roundworms of family *Filariidae***

| Characteristics | *Wuchereria bancrofti* | *Brugia malayi* | *Onchocerca volvulus* | *Loa loa* |
|---|---|---|---|---|
| Disease | | | | |
| Morphological features | | | | |
| Source of invasion | | | | |
| Invasive stage for human | | | | |
| Route and factors of transmission | | | | |
| Localization inside human body | | | | |
| Pathogenicity | | | | |
| Laboratory diagnosis | | | | |
| Prophylaxis | | | | |

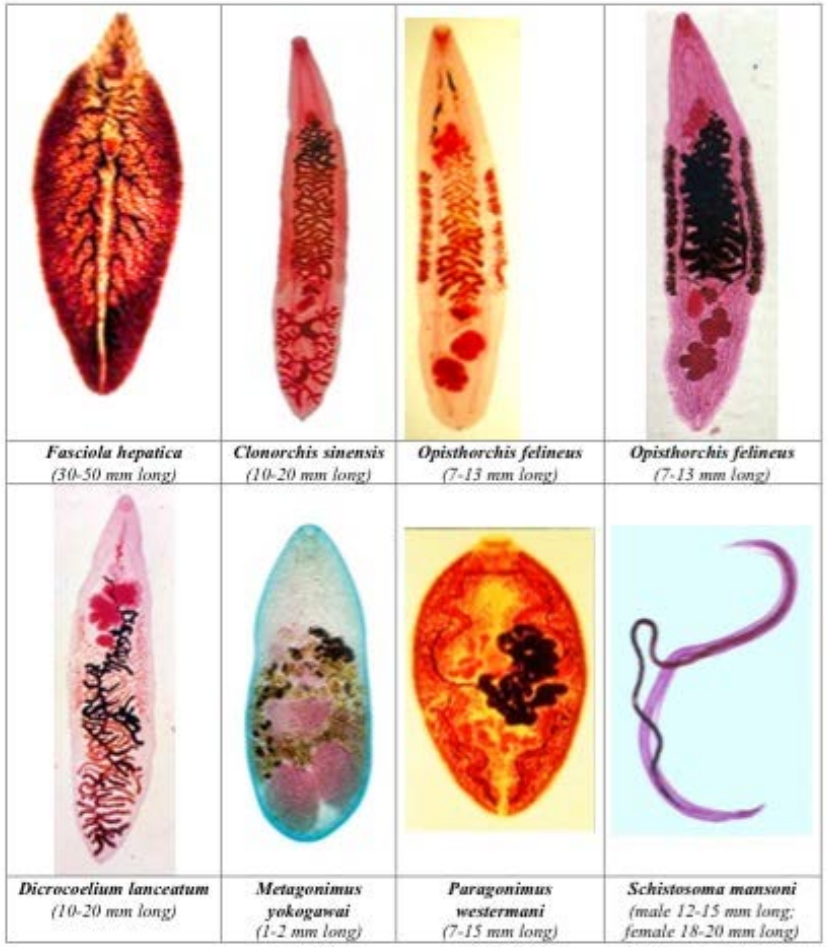
## Theme 31: Lab Practical Exam 4: Medical Helminthology

At the class, the students shall be able to identify the common infectious agents of Phyla Plathelminthes and Nemathelminthes. It includes the identification of photographs, slides, and specimens.

**Link:**

**http://repo.knmu.edu.ua/bitstream/123456789/12559/1/Exam II Worms 2016.pdf**

**FLATWORMS Phylum *Platyhelminthes*. Class *Trematoda***
***Плоские черви. Тип Platyhelminthes. Класс Trematoda***



| | | | |
|---|---|---|---|
| ***Fasciola hepatica*** *(30-50 mm long)* | ***Clonorchis sinensis*** *(10-20 mm long)* | ***Opisthorchis felineus*** *(7-13 mm long)* | ***Opisthorchis felineus*** *(7-13 mm long)* |
| ***Dicrocoelium lanceatum*** *(10-20 mm long)* | ***Metagonimus yokogawai*** *(1-2 mm long)* | ***Paragonimus westermani*** *(7-15 mm long)* | ***Schistosoma mansoni*** *(male 12-15 mm long; female 18-20 mm long)* |

## Theme 32: Phylum Arthropoda. Class Crustacea. Class Arachnoidea. Ticks and mites: causative agents and vectors of human diseases

**Task 1.** Write the progressive features and the evolutionary adaptations of Arthropods in the table.

| *Progressive features* | *Adaptive features* |
|---|---|
| | |
| | |
| | |
| | |
| | |

### Subphylum Branchiata. Class Crustacea

**Crustaceans** (**Crustacea**) are a large group of aquatic and terrestrial arthropods, often also treated as a subphylum. The group comprises almost 52,000 described species, although the number of undescribed species may be 10-100 times higher. They include various familiar animals, such as crabs, lobsters, crayfish, shrimp, krill and barnacles.

**Subclass** Copepoda
**Order** Cyclopoida
**Family** Cyclopidae
**Genus** *Cyclops*

**Order** Decapoda (Crayfish and Crabs)

**Task 2.** Study the macropreparation of crayfish and micropreparation of cyclops. Note their medical significance.

**Cyclops –** _____
_____
_____

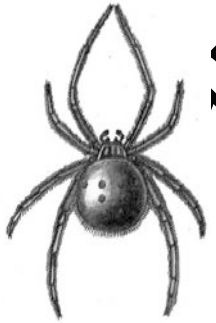
**Crabs and crayfish –** _____
_____
_____
_____
_____

**Subphylum** Chelicerata (includes horseshoe crabs, scorpions, spiders, ticks and mites)
**Class** Arachnoidea (arachnids)
**Order** Acari (ticks and mites)
**Order** Araneae (spiders)
**Order** Scorpiones (scorpions)

**Representatives:**

- redback spiders (*Latrodectus* species and their relatives)
  - black widow spider (*L. mactans tredecimguttatus*)
- wolf spider, or tarantula (*Lycosa* spp.)
- funnel-web spiders (*Atrax* and *Hadronyche* species);
- banana spiders (*Phoneutria* spp.)
- recluse spiders (*Loxosceles* spp.)

**Order** Solifugae (Solpugida) (solpugids and sun spiders)



**WHO: *Bites of spiders***

The *Latrodectus*-specific antivenin is used only in severe envenoming, in high-risk patients (e.g. children and the elderly), and those presenting persistent symptoms several days after the bite. It is administered intravenously, after pretreatment with antihistamines (availability of adrenaline and resuscitation facilities should be ensured). In general not more than 1 or 2, or at most 3 ampoules are required. *Latrodectus* antivenom is the only treatment modality which will relieve the pain.

**Task 3.** Fill in the table.

**Comparison of Class Crustacea and Class Arachnoidea**

| | Class Arachnoidea | Class Crustacea |
|---|---|---|
| Number of walking legs | | |
| Respiratory organs | | |
| Excretory organs | | |
| Structure of eyes | | |

**Task 4.** Study the macropreparations of arthropods: wolf spider, black widow spider, sun spider, and scorpion. Note those species which have venomous glands.

_____
_____
_____
_____

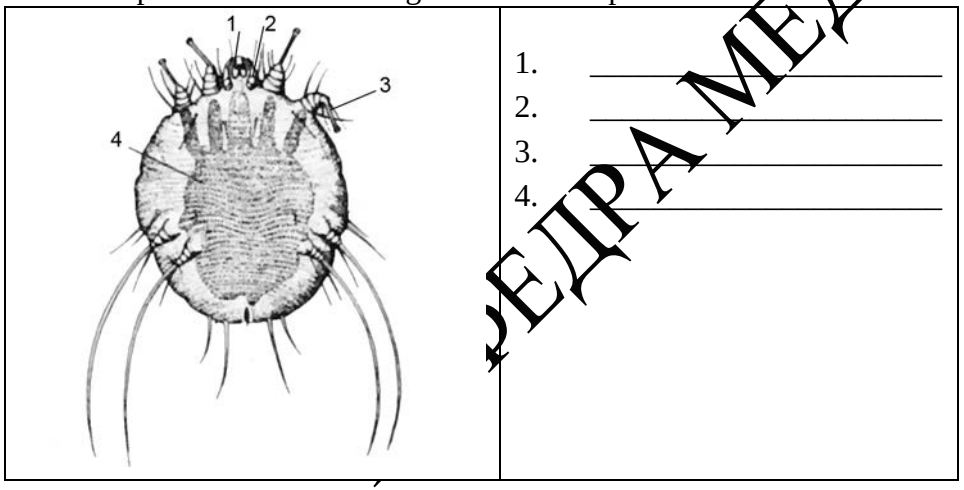
**Task 5.** Examine the structure of mouthparts of spider under low power of microscope. Sketch them in the notebook.

*Mouth parts of spider.*

1. _____
2. _____
3. _____
4. _____

**Order** Acari
**Suborder** Sarcoptiformis
**Family** Acaridae
**Genus** *Sarcoptes*
**Species** *Sarcoptes scabiei* **– human itch mite**

**Task 6**. Examine the human itch mite under the low and high power of microscope and make the designations on the picture below.




1. _____
2. _____
3. _____
4. _____

**WHO:** ***Scabies***

Scabies is a globally occurring ectoparasitic dermatological infection whose burden has been estimated to be as high as 300 million cases per year. Globally, it affects more than 130 million people at any time. Rates of scabies occurrence vary from 0.3% to 46%. In developing countries, scabies is a significant public health problem because it is highly prevalent and complications are frequent. Children appear to be more commonly affected. In the developed world, outbreaks in health institutions and vulnerable communities contribute to significant economic cost in national health services.

However, in resource-poor tropical settings, the sheer burden of scabies infestation, as well as their complications, imposes a major cost on health-care systems. In 2010, it was estimated that the direct effects of scabies infestation on the skin alone led to more than 1.5.million YLDS (years lived with disability).

**Suborder** Trombidiformis
**Family** Demodicidae
**Genus** *Demodex*
**Species** *Demodex folliculorum* **– follicle mite**

***Demodex folliculorum*** *(also known as follicle mite or face mite)* is causative agent of glandular itch. The main features of glandular itch are acne, vesicular eruption, desquamation of skin, shedding of cilia.

**Suborder** Parasitoformis
**Family** Ixodidae (Hard Ticks)
**Genus:** *Ixodes*
**Species**: *Ixodes ricinus* **– dog tick**
*Ixodes persulcatus* **– taiga tick**
**Genus:** *Dermacentor*
*Dermacentor pictus* **– graze tick**
*Dermacentor nuttalli*

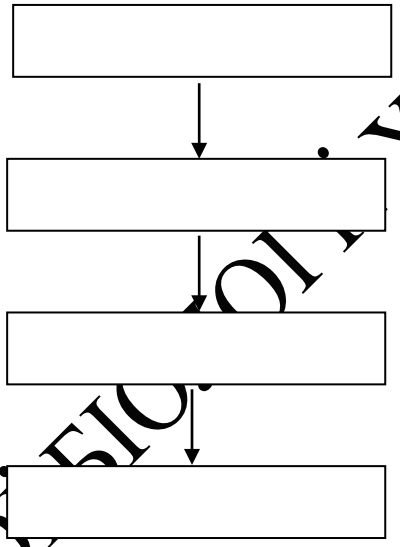
**Family** Argasidae (Soft Ticks)
**Genus:** *Ornithodoros*
**Species**: *Ornithodoros papillipes*

**Task 7**. Examine the structure of mouth parts of dog tick under low magnification of the microscope. Sketch them in the notebook.

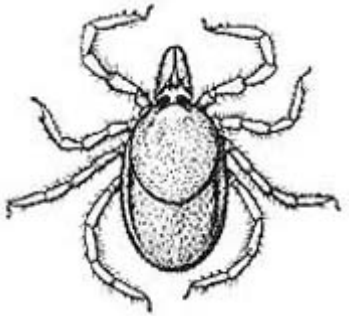
Structure of mouthparts of tick

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

**Task 8**. Note the stages of the tick life cycle.



**Task 9.** Examine an *Ixodes* tick larva under low power of microscope. Pay attention to the difference in morphology: the tick larva is smaller and has 3 pairs of legs but adult – 4 ones.

| | |
|---|---|
|  |  |
| ***Larva*** | ***Adult*** |

**Task 10.** Fill in the table.

**TICKS AND THEIR ROLE IN DISTRIBUTION OF DISEASES**

| Species | Diseases | | Role in distribution of disease (vector, reservoir, causative agent) | Vector (facultative, obligatory) | Character of disease (transmissive, focal) |
|---|---|---|---|---|---|
| | viral | bacterial | | | |
| *Sarcoptes scabiei* | | | | | |
| *Ixodes ricinus* | | | | | |
| *Ixodes persulcatus* | | | | | |
| *Dermacentor marginatus* | | | | | |
| *Dermacentor nuttalli* | | | | | |
| *Ornithodorus papillipes* | | | | | |

**Test questions:**

**1.** Which of the following is a characteristic of ***all*** crustaceans, but ***not*** all arthropods?

A. exoskeleton
B. jointed appendages
C. segmentation
D. gills
E. muscles

**2.** Ticks are interesting to epidemiologists because they are the second only to mosquitoes as _____ for serious diseases.

A. sources of drugs
B. sources of antibiotics
C. agents
D. sources of antivenoms
E. vectors

| Date | Signature |
|---|---|
| | |

**Theme 33**: **Phylum Arthropoda. Class Insecta: causative agents and vectors of human diseases**

**Task 1.** Write down the main features of Class *Insecta*.

1._____
_____
2._____
_____
3._____
_____
4._____
_____
5._____
_____
6._____
_____

**Order** Anaplura (sucking lice)
**Family** Pediculidae
**Genus** *Pediculus*
**Species** *Pediculus capitis* – **head louse**
*Pediculus vestimenti* – **body louse**

**Family** Phtiridae
**Genus** *Phtirius*
**Species** *Phtirus pubis* – **pubic louse** or **crab louse**

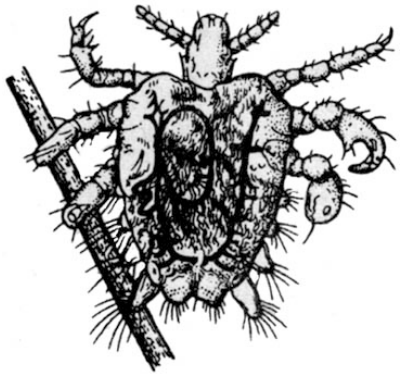
***Biological transfer*** – _____
_____
_____
_____
_____

**Head louse – *Pediculus capitis***

**Task 2.** Examine *Pediculus capitis* under low magnification of the microscope. Sketch a louse and its egg.

| | |
|---|---|
| *Pediculus capitis* | *Egg of Pediculus capitis* |

**Pubic louse – *Phthirus pubis***



***Phthirus pubis***, pubic lice, also called "crabs," are parasitic insects found in the genital area of humans. These lice can also be found in armpit hair, eyelashes and eyebrows. The louse may cause an eye infection (blepharitis) in young children. Infection is common and found worldwide.
Risk factors include:
1. Having multiple sexual partners
2. Having sexual contact with an infected person
3. Sharing bedding or clothing with an infected person

**Task 3.**Give the characteristics of different species of lice affecting a human

| Characteristics | *Pediculus capitis* | *Pediculus vestimenti* | *Phthirus pubis* |
|---|---|---|---|
| Morphological features | | | |
| Life cycle | | | |
| Route of pathogen transmission | | | |
| Geographic distribution | | | |
| Medical significance | | | |
| Prophylaxis | | | |

**Order** Siphonaptera **(** = *Aphaniptera*)
**Family**: Pulicidae
**Genus**: *Pulex*
**Species**: *Pulex irritans* – **human flea**

**Task 4.** Examine *Pulex irritans* under low magnification of the microscope. Pay attention to laterally compressed body of. Fill the table

| | |
|---|---|
| Route of transmission of causative agent of plague | |
| Modes of plague infestation of humans | |
| Reservoirs of plague | |

**Task 5.** Give the characteristics of *Pulex irritans*.

Morphological features _____
_____
_____
_____
Life cycle _____
_____
_____
_____
Route of pathogen transmission of_____
_____
Geographic distribution _____
Medical significance _____
_____
Prophylaxis _____
_____
_____
_____

**Order** Heteroptera (= Hemiptera)
**Family** Reduviidae
**Genus** *Triatoma*
**Species**: *Triatoma infestans* – **kissing bug**

**Family** Cimicidae
**Genus** *Cimex*
**Species** *Cimex lectularius* **– bed bug**

**Task 6.** Examine *Cimex lectularius* under low magnification of a microscope. Fill the table.

| Characteristics | *Cimex lectularius* | *Triatoma infestans* |
|---|---|---|
| Morphological features | | |
| Route of pathogen transmission | | |
| Geographic distribution | | |
| Medical significance | | |

**Order** Diptera
**Suborder** Nematocera
**Family** Culicidae
**Species** *Anopheles maculipennis*
**Species** *Culex pipiens*

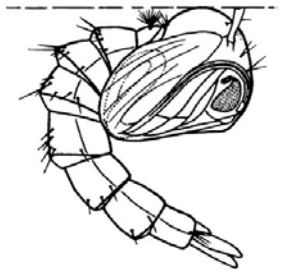
**Task 7.** Examine the eggs of *Culex pipiens* and *Anopheles maculipennis* mosquitoes under low magnification of the microscope. Pay attention to presence of floats in eggs of *Anopheles* mosquito. Sketch the mosquitoes' eggs.

| | |
|---|---|
| *Eggs of Culex mosquito* | *Eggs of Anopheles mosquito* |

**Task 8.** Examine the larvae of *Culex pipiens* and *Anopheles maculipennis* mosquitoes under low magnification of a microscope. Sketch the mosquitoes' larvae and note the presence of respiratory siphon in *Culex* larva.

| | |
|---|---|
| *Larva of Culex mosquito* | *Larva of Anopheles mosquito* |

**Task 9.** Study the pupas of *Culex pipiens* and *Anopheles maculipennis* mosquitoes under low magnification of the microscope. Pay attention to the distinguishing features of pupas: the shape of two short breathing tubes on the pupas' "".

| | |
|---|---|
|  |  |
| *Pupa of Culicine mosquito* | *Pupa of Anopheles mosquito* |

**Task 10.** Examine the heads of the female *Culex pipiens* and *Anopheles maculipennis* mosquitoes under low magnification of the microscope. Sketch the heads of mosquitoes, designate proboscis, palps, and antennae.

| | |
|---|---|
|  |  |
| *Head of the female Culex* | *Head of the female Anopheles* |

1. _____
2. _____
3. _____

**Task 11.** Fill in the table.

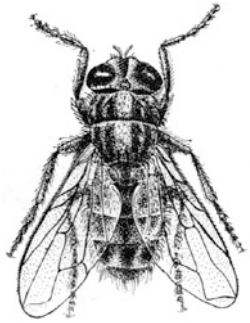
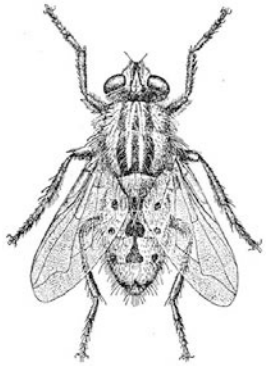
**Comparison of *Culex* and *Anopheles* mosquitoes**

| | *Culex mosquito* | *Anopheles mosquito* |
|---|---|---|
| Egg | | |
| Larva | | |
| Pupa | | |
| Imago | | |

**Order** Diptera
**Family** Muscidae
**Genus** *Musca*
**Species** *Musca domestica* **– housefly**

**Family** Sarcophagidae
**Genus** *Wohlfahrtia*
**Species** *Wohlfahrtia magnifica* – **spotted flesh fly**

**Task 12.** Examine a leg of *Musca domestica* under low magnification of the microscope. Pay attention to the structure of the housefly's legs that facilitates the attachment of pathogens.
Fill the table "Comparative features of *Musca domestica* and *Wohlfahrtia magnifica*"

| Characteristics | *Musca domestica* | *Wohlfahrtia magnifica* |
|---|---|---|
| Morphological features |  |  |
| Geographic distribution | | |
| Medical significance | | |

**Order** Diptera
**Family** Glossinidae
**Genus** *Glossina*
**Species *G. palpalis*** ("riverine" species) } **tsetse flies**
***G. morsitans*** ("savannah" species) }
**Family** Simuliidae (black flies)
**Genus** *Simulium*
**Family** Ceratopogonidae
**Family** Tabanidae (horse flies or deer flies)
**Genus:** *Chrysops*
**Family**: Psychodidae (sand flies)
**Genus** *Phlebotomus*
**Species** *Phlebotomus papatasi*
**Genus** *Lutzomyia*

**Task 13**.Fill the table.

**Diseases transmitted by biting Diptera**

| *Vector* | *Disease* |
|---|---|
| Tsetse flies (*Glossina*)<br>- *G. palpalis*<br>- *G. morsitans* | |
| Blackflies (*Simulium*) | |
| Sandflies (*Phlebotomus*, *Lutzomyia*) | |
| Horse flies or deer flies (*Tabanidae*) | |

**Order** Blattoidea (cockroaches)
**Species** *Blatta orientalis* - Oriental cockroach
*Blattela germanica* - German cockroach
*Periplaneta americana* – American cockroach

**Task 14.** Write down the medical significance of cockroaches.

_____
_____
_____

**Order** *Hymenoptera*
**Family** Formicidae (ants)
**Genus** *Formica*
**Species**: *Formica rufa*

***Medical significance of ants*** _____
_____
_____

**Test questions:**

**1.** How many pairs of legs do Insects have?
A. 2
B. 3
C. 4
D. 5
E. 6

**2.** Insect *Triatoma infestans* is a vector of
A. malaria
B. leishmaniasis
C. Chagas disease
D. African sleeping sickness
E. pediculosis

**3.** In life cycle of *Dicrocoelium lanceolatum,* the second intermediate host is:
A. *Culex pipiens*
B. *Triatoma infestans*
C. *Glossina palpalis*
D. *Cyclops* spp
E. *Formica rufa*

| Date | Signature |
|---|---|
| | |



**Theme 34: The biosphere as a system that provides existence of human being. Human Ecology**

**Task 1.** Give the definitions of the terms:

Ecology _____
_____
Biosphere _____
_____
_____
Components of biosphere _____
_____
_____
_____
Ecosystem _____
_____
_____

Biotic components of ecosystem:
Producers _____
_____
Consumers _____
_____
Decomposers _____
_____

**Task 2.** Determine human taxonomic position within the living world.

*Kingdom* – _____
*Phylum* – _____
*Subphylum* – _____
*Class* – _____
*Order* – _____
*Family* – _____
*Genus* – _____
*Species* – _____

**Task 3.** Learn the environmental factors affecting human being. Give the examples.

1._____
2._____
_____
3._____
_____

**Task 4.** What water pollutants are the most harmful for human organism?

1) inorganic compounds _____
_____
_____
2) organic compounds _____
_____
_____
3) microorganisms _____
_____
_____

Give the examples of causative agents of water-borne invasive diseases.
_____
_____
_____

**Task 5.** List the methods of water purification.

1) _____
2) _____
3) _____

**Task 6.** Explain the effects of the given factors on human organism.

1. Iron deficiency _____
_____
2. Iodine deficiency _____
_____
3. Cobalt deficiency _____
_____
4. Oxygen deficiency _____
_____
5. Copper deficiency _____
6. Molybdenum excess _____
_____
7. Strontium excess _____
_____

**Task 7.** Fill in the table.

***The effects of changes of body temperature***

| Rising of body temperature | Falling of body temperature |
|---|---|
| | |
| | |
| | |
| | |

**Task 8.** Give the definitions of the terms.

Ecogenetics _____
_____
Pharmacogenetics _____
_____

| *Enzyme defect* | *Triggering drug* | *Pathological reaction* |
|---|---|---|
| Glucose-6-phosphate dehydrogenase | Antimalarial medications (primaquine, quinine), sulfanilamides | Hemolysis of red blood cells |
| Acetyltransferase | Isoniazid, sulfadimidine | Side effects of drugs |
| Pseudocholynesterase | Dithylinum | Long-term respiratory arrest |
| Methemoglobin reductase | Diaphenyl sulfone, primaquine, phenacetin | Cyanosis |
| Glutathione reductase | Topical glucocorticoids (eyes) | The increase of pressure in the eye |

**Task 9.** Explain the origin of individual variation in substance response in some patients.

1. Hemolysis of red blood cells – _____
2. Lactose intolerance – _____
3. Gluten (wheat protein) intolerance – _____
_____
4. Sensitivity to oxygen deficiency – _____
_____
5. Sensitivity to tobacco smoke and industrial air pollution – _____
_____
6. Alcohol intolerance – _____
_____

**Task 10**. Give the definition of the term. Classify biorhythms.

Biorhythms – _____
_____

Types of biorhythms: _____
_____
_____

Effects of biorhythms on human organism:

_____
_____
_____
_____

Individual biorhythm cycles:

a) _____
b) _____
c) _____

Chronic diseases with annual periodicity:

1) _____
2) _____
3) _____
4) _____
5) _____

**Task 12.** Name the adaptation of human being to:

1. Hypoxia _____
_____
2. Hypokinesia _____
_____
3. High and low temperature _____
_____
4. Changes of nutrition _____
_____
5. Oxygen deficiency _____
_____

**Task 13.** Name poisonous organisms.

**Poisonous organisms**

| Venomous organisms | Poisonous organisms |
|---|---|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

Poisonous plants: _____
_____
_____
_____
_____

**Test questions:**

**1.** A minimal dose which causes toxic but reversible effect is
- A. threshold dose
- B. minimal lethal dose
- C. minimal toxic dose
- D. toxin
- E. venom

**2.** When you eat an apple, you are a ____
- A. primary producer
- B. decomposer
- C. primary consumer
- D. secondary consumer
- E. tertiary consumer

**Theme 35: Lab Practical Exam 5: Medical Arachnoentomology**

At the class, the students shall be able to identify the common infectious agents of Phylum Arthropoda. It includes the identification of photographs, slides, and specimens.

**Link:**

**http://repo.knmu.edu.ua/bitstream/123456789/12560/1/Exam III Arthropoda 2016.pdf**