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A. Kucherova, V. Volodymyrets

BIOLOGY AND ECOLOGY OF LIVING ORGANISMS

Practical manual

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Рецензенти:

Польовий В.М., доктор сільськогосподарських наук, директор Інституту сільського господарства Західного Полісся НААН;

Сахнюк О.В., кандидат філологічних наук, доцент Національного університету водного господарства та природокористування, м. Рівне.

Kucherova A.V., Volodymyrets V.A.

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Практикум містить матеріали навчального та навчально-методичного характеру англійською мовою для проведення лабораторних і практичних занять із біологічних дисциплін. У ньому наведений короткий теоретичний матеріал, методичні рекомендації для виконання лабораторних і практичних робіт, контрольні завдання, словник для перекладу та термінологічний словник.

Практикум призначено для студентів природничих і природничо-прикладних спеціальностей із поглибеним вивченням англійської мови, що вивчають біологічні дисципліни.

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CONTENTS

PREFACE

Informative awareness, a free orientation in the world informational space is the necessary condition for the modern specialist to be successful in any sphere of activity. These give the special value to the study of foreign languages by students. Therefore knowledge of a foreign language is a necessary element in training skilled and creative specialists. It largely determines the possibility of their professional realization, continuous addition of the newest openings to their knowledge, wider communication and collaboration with the specialists of different countries

As a result of extremely rapid increase of information flow in the different areas of theoretical and applied science the role of current as well as special vocabulary is growing. Thus the effective method to foreign language mastering is its study through the professionally oriented disciplines.

The given practical manual contains materials of educational and educational-methodical character in the English language to conduct laboratory and practical units on studying biological and ecological features of different systematic groups of organisms. It contains theoretical material with applied information which embraces economic and ecological aspects, methodical recommendations for implementation of laboratory and practical works from the different sections of biology, control tests, vocabulary for translation and terminology glossary.

Laboratory and practical units include material about an external and internal structure, reproduction, biological, ecological and other peculiarities of different groups of organisms – *Procaryotes and Plant, Protozoa, Worms, Arthropods, Chordates.* The study of populations structure of higher organisms and descriptions of main biomes are also provided.

The content of the practical manual is based on such principles, as scientific character, unity of theory and practice, informing, evidentness, clearness in accordance with professional interests of students.The offered practical manual is intended for the students of the following specialities –“Ecology and environment protection”, “Agrochemistry and soil science”, “Water bioresources”, as well as for the students of natural science and agrarian specialities, if their curriculum includes biological subjects.

PART 1
PROCARYOTES, FUNGI AND PLANTS

Subject 1. The determination of general and distinguishing features of biological and ecological characteristics of Bacteria specimens. The study of ecological and economic importance of Bacteria

Objectives:

- to get acquainted with a different morphological forms of Bacteria's;
- to comprehend ecological role and economical importance of different bacteria and make the comparative analysis.

Materials: microscope, cover slip, glass slide, bacterial colonies, slides, burner, placards, identification guide books.

Features of Bacteria

The distinguishing feature of bacteria is that they are prokaryotic, which means that they have no membrane-bound organelles – that is, no nucleus, no mitochondria, and no chloroplasts.

Although most bacteria are 1-5 μm in diameter (much smaller than plant cells). The distinguishing features of different bacteria are their shapes, metabolism, and chemical composition. Bacterial cells typically have one of such shapes: spherical, rod-shaped, spiral-shaped, or corkscrew-shaped, filamentous or unusual (fig.1.1). Bacteria can be further distinguished by a diagnostic test called the Gram stain. This stain distinguishes two bacterial groups: Gram-positive bacteria (*Clostridium butyricum, C. pasteurianum*, *Bacillus subtilis* etc) and Gram-negative bacteria (*Azospirillum lipoferum, Leptospira interrogans, Azotobacter chroococcum* etc).

Bacteria are far more diverse metabolically than all of the eukaryotes. This diversity is reflected in the range of energy sources that bacteria can use. Different bacteria can use sulfide, iron, methane, or carbon dioxide in energy metabolism. Moreover, many bacteria can fix nitrogen, which means they can convert atmospheric nitrogen (N_2) into metabolically useful forms for other organisms.

The Generalized Life Cycle of Bacteria

Bacteria reproduce only asexually (mainly by fission, which occurs when a cell reaches a certain size and then pinches in half to form two cells). However, genetic exchange can occur between a donor and a recipient. New genotypes of bacteria arise by absorbing DNA into their plasmid genomes, by genetic transfer from viruses, and by high rates of mutation.

The Diversity of Bacteria

Traditional views and molecular phylogenies do agree on the classification of prokaryotes into two main groups, the Eubacteria (“*eu”* – true) and the Archaebacteria (“*archae”* – ancient). These two groups are often classified as subkingdoms of the Monera.

The Eubacteria include the Gracilicutes, Firmacutes, and Mollicutes. Archaebacteria seem to be more closely related to the eukaryotes than to the Eubacteria.

By Bergj determinant (1984) all bacteria unite into 4 divisions: Gracilicutes (include 3 classes: Scotobacteria, Anoxyphotobacteria, Oxyphotobacteria), Firmacutes (include 2 classes: Firmibacteria, Thallobacteria), Tenericutes (include 1 class: Mollicutes), and Mendosicutes (include 1 class: Archaebacteria).

Bacterial Ecology

Bacteria are everywhere. They grow in such extreme environmental conditions that they must be considered the most hardy of all organisms. They live in the intestines of all kinds of animals, in soil, in clouds, in water, on airborne dust particles, and in smog. Many can tolerate hot acids, others can survive temperatures below freezing for years, and still others thrive in boiling hot springs. Their tolerance of high temperature requires methods of sterilization that include a combination of high heat (120 ^{0}C) and high pressure. However, there are deep-sea bacteria that live near volcanic vents, where the temperature approaches 360 ^{0}C and the pressure can reach more than 26 megapascals.

Bacteria play an important role in every habitat on earth. Photosynthetic bacteria help maintain the global carbon balance, and nitrogen-fixing bacteria account for about a quarter of the total nitrogen fixed in oceans. Some of the most important bacteria in agriculture live and fix nitrogen in the root nodules of crops such as alfalfa, soybean, and pea (*Rhizobium meliloti, Rh. japonicum, Rh. leguminisarium).*

Saprobic bacteria – those that obtain nourishment from dead organic matter – are partially responsible for decomposing and recycling organic material in the soil. Decomposition by saprobic bacteria and their cohorts, saprobic fungi, produces as much as 90 % of the biologically made CO_2 in the atmosphere. Without these organisms, the earth’s surface would be knee-deep in dead plants and animals in matter of weeks. So much carbon would be tied up in organic matter that less atmospheric CO_2 would be available, which would limit photosynthesis by plants.

The Economic Importance of Bacteria

Bacteria effect every aspect of our lives. They are the pivotal organisms in many diseases of plants and animals, including humans, and they are the microscopic laborers in many multimillion-dollar industries. Thus, we can think of the economic importance of bacteria as either positive or negative.

The Positive Aspects:

The cyanobacterium *Spirulina* is cultivated for human consumption. This organism, which is common in saline lakes, has a dry-weight protein content of about 70 %. The genus *Bacillus* includes many species important to humans. For example, three species have been approved for biological control of pests. *Bacillus thuingiensis* (BT) reproduces only in the intestinal tracts of caterpillars, which are killed by a toxin from the bacterium. This toxin is harmless to all other living organisms. BT is currently being used to control more than one hundred species of plant pests, including tomato hornworms and corn borers.

Several species of *Lactobacillus* are mainstays of the dairy, beverage, and baking industries. Lactobacilli are used to make acidophilus milk, kefir, cheeses, yogurt, and related foods. These bacteria are also used in the production of wine, beer, sourdough bread, sauerkraut, and many other commercial products.

Antibiotic chemicals from actinomycete bacteria account for about two-thirds of the more than 4000 antibiotics that have been discovered. Actinomycetes were the original sources of such well-known antibiotics as tetracycline, neomycin, aereomycin, and streptomycin.

The Negative Aspects:

In water supplies, cyanobacteria frequently clog filters, corrode steel and concrete, soften water, and produce undesirable odors or coloration in the water. Cyanobacteria also produce toxins. Fish that are immune to the toxins produced by certain cyanobacteria become toxic to their predators after eating these bacteria.

Unlike their helpful counterparts mentioned, some bacilli cause diseases such as diphtheria, periodontal disease in humans, and anthrax in cattle. The most dangerous of the bacilluslike bacteria may be the clostridia: species of *Clostridium* cause tetanus, gas gangrene, and botulism. *Clostridium botulinum*, which cause botulism, makes the most powerful toxin known to humankind.

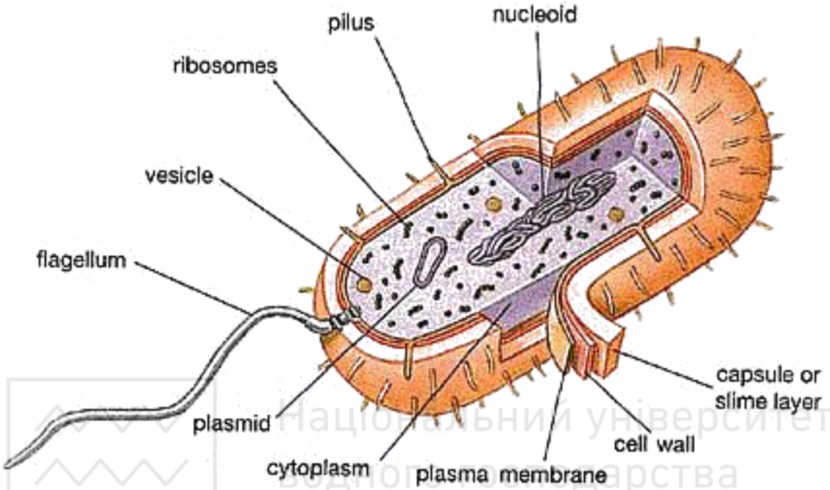

Fig. 1.1. Structure of Bacteria cell

Practice

1. Observe the staining of the bacteria, using the high power lens of the microscope (an oil immersion lens would be an advantage).
2. Record your observations.
3. Examine and sketch different morphological shapes of Bacteria.
4. Fill in the table:

Species Name	Genus	Shape of the Cell	Nutrition Type	Existence Condi-tions	Ecological and Economic Importance
1	*2*	*3*	*4*	*5*	*6*

Subject 2. The determination of general and distinguishing features of biological and ecological characteristics of Algae specimens from different divisions. The study of ecological and economic importance of Algae

Objectives:

- to get acquainted with a diversity of Algae specimens;
- to comprehend biological peculiarities of some Algae species and their ecological role and make the comparative analysis.

Materials: standard microscopic equipment, dropper, dissecting needle, slides and cover glasses, filter paper, chemical glass, algal culture, placards.

General Features of Algae

Algae are an informally defined group of eukaryotes that are usually classified in seven divisions. These divisions are at least partially distinguished by their pigments, their energy-storage polymers, their cell-wall components, and the number and types of their flagella. In addition the organisms within each division have a variety of life cycles.

Although the simplest algae are unicellular, the most complex algae rival the giant redwoods as the largest of all photosynthetic organisms. Most algae are somewhere between these two extremes. Colonial algae are those with groups of cells that are loosely attached to each other and sometimes surrounded by a slimy sheath. Filamentous algae are either branched or unbranched, and have either uninucleate or multinucleate cells. Some filamentous algae are coenocytic because they have no cross walls.

The kelps and other macroscopic algae have organs that resemble leaves, stems, and roots. The blades of the leaflike structures consist of parenchyma cells. The stemlike organs, called stipes, have many cell types, including sieve cells (fig. 2.1).

Generalized Life Cycles

As in plants and fungi sexual reproduction in algae entails an alternation between diploid and haploid phases, which alternate between fertilization and meiosis.

Three distinct versions of generalized life cycle occur among algae. One version resembles the life cycle of plants because certain cells of a multicellular diploid phase undergo meioses to make spores. This type of life cycle is based on sporic meiosis, because meiosis produces spores.

Sporic meiosis is common among all divisions of algae that have multicellular forms.

The second type of life cycle resembles that of animals. Certain cells of a multicellular diploid phase undergo meiosis to make gametes, not spores. Because meiosis produces gametes directly, it is called gametic meiosis. Gametic meiosis is rare in the algae.

The third type of life cycle resembles that of fungi, in that the only diploid cells are the zygotes. This type of meiosis is called zygotic meiosis. Most of the green algae, including almost all of the unicellular forms, reproduce by zygotic meiosis.

Asexual Reproduction

Unicellular algae reproduce asexually by mitosis and cell division. Multicellular algae also reproduce asexually, either by vegetative fragments, by vegetative propagation (i. e., growth of new individuals from rootlike structures), or by mitotically produced spores that form clones of the parent.

Division *Chlorophyta*: The Green Algae

The division *Chlorophyta*, includes about 7500 species. Most green algae live in fresh water, but different species also occur in marine habitats, clouds, snow banks, soil or on the shady moist sides of trees, buildings, and fences. Green algae also live simbiotically with several different kinds of animals and with the fungi of lichens. Examples of Green Algae are: *Chlamydomonas*, *Tetracystis*, *Chlorella*, *Volvox*, *Spirogyra*, *Chara*, *Ulva*, *Cladophora* (fig. 2.2).

Division *Phaeophyta*: The Brown Algae

Almost all of the approximately 1500 species of brown algae are marine organisms, but a few species live in fresh water. There are no unicellular, colonial, or unbranched filamentous organisms among the Phaeophyta.

There are three main orders of brown algae; these groups are represented by *Ectocarpus* (Order *Ectocarpales*), *Laminaria* (Order *Laminariales*), *Fucus* (Order *Fucales*).

Division *Rhodophyta*: The Red Algae

Like the brown algae, the red algae are mostly marine organisms. Red algae are red because they have an abundance of phycoerythrin, a red phycobilin. Phycoerythrin absorbs blue light, which penetrates more deeply into water than do other colours of light. This means that red algae can photosynthesize at greater depths than other algae, and explains why red algae can grow at depths of more than 200 m. (*Polysiphonia*).

Division *Chrysophyta:* Diatoms and the Golden-Brown and Yellow-Green Algae

The Chrysophyta form the largest division of algae, with more than 11000 species. About 10000 species are diatoms in the class *Bacillariophyceae*, almost all of which are unicellular. Diatoms are unique because of their exquisitely ornamented glass cell walls. The golden-brown algae (*Chrysophyceae*) and yellow-green algae (*Xanthophyceae*) are also mostly unicellular, but some are colonial or filamentous and coenocytic. Chrysophytes occur both in fresh water and in solt water.

Divisions of Unicellular Algae

Three divisions of algae consist exclusively of flagellated unicellular organisms: the euglenoids (*Euglenophyta*, 800 species), the dinoflagellates (*Pyrrhophyta*, 3000 species), the cryptomonads (*Cryptophyta*, 100 species). These three divisions are traditionally studied by botanists and zoologists alike because of the plantlike and animallike features of different species.

The Ecology of Algae

Algae are nearly ubiquitous and occupy a wide rarity of habitats. They live primarily in marine and fresh water either free-floating or attached to rocks, wood pilings, shells of shellfish, or to other algae. Many species are terrestrial on moist soil, rocks, stone roofs and walls, or tree bark. Green algae live symbolically with fungi and cyanobacteria in lichens.

The most significant ecological role of algae is as plankton. Algae and other unicellular organisms are eaten by small animals, which in turn are eaten by larger animals. Thus, algae are the primary producers that support life in marine and freshwater habitats. The oxygen that planktonic algae produce is equally important to life; perhaps 50-70 % of the earth's atmospheric oxygen comes from unicellular marine algae.
Brown and red algae form "forests" in intertidal zones and shallow coastal waters. These marine forests are habitats for teeming populations of many kinds of animals. Coral reefs are special habitats whose primary production comes from coralline red algae. Planktonic and other microscopic algae are especially conspicuous when their populations expand rapidly into large blooms. These blooms may be induced by

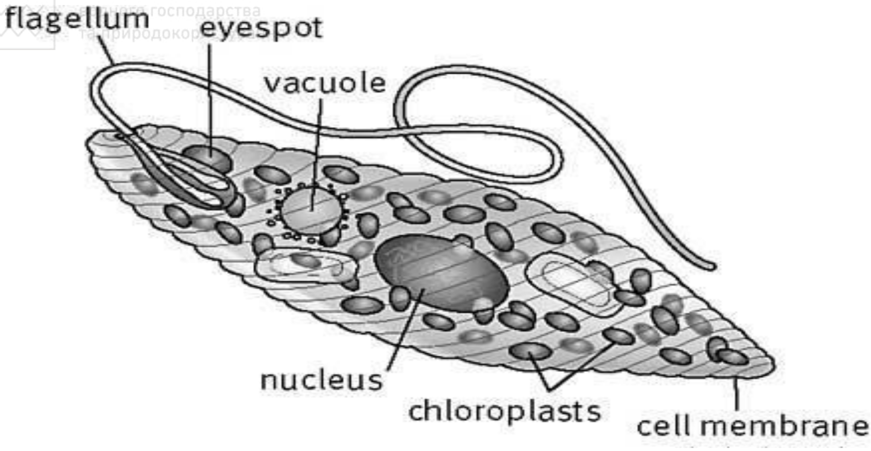

Fig. 2.1. Structure of unicellular algae

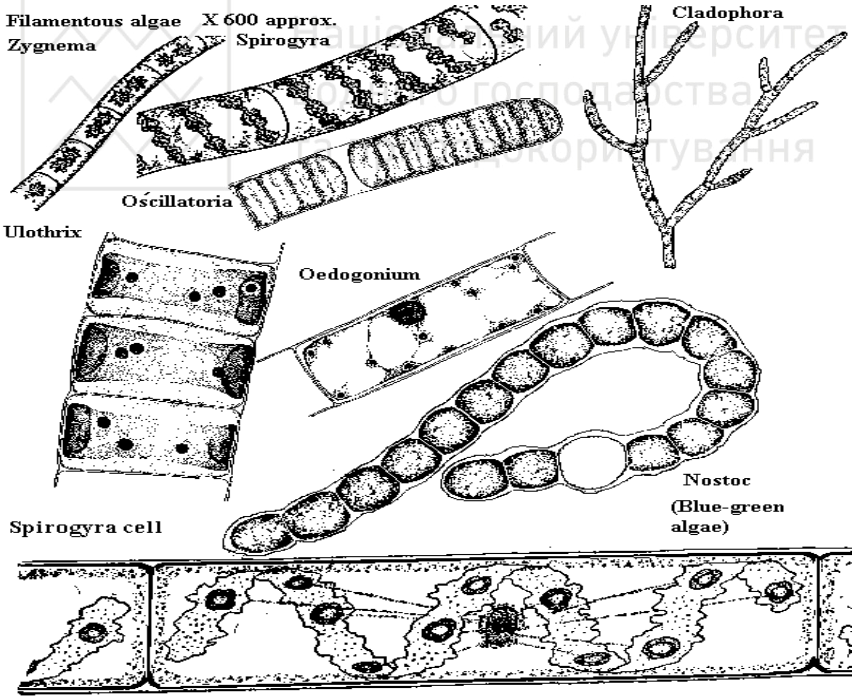

Fig. 2.2. Filamentous algae

warm temperatures, phosphate pollutants, or other factors that enhance algae growth. In fresh water, algal blooms sometimes get so large that when they ultimately begin to decay, oxygen is used by the respiration of decomposing bacteria faster that it can be replenished by algal photosynthesis. When this happens, fish and other animals die from lack of oxygen, and their decaying bodies make the problems worse.

The Economic Importance of Algae

As a group, the diatoms are perhaps the most economically important algae. Indeed, they make the fishing industry possible because of their role as food for freshwater and marine animals. Diatom cell walls are also harvested from large deposits as diatomaceous earth, which is used in many industries. For example, diatomaceous earth is an abrasive in metal polishes and a few brands of toothpaste; it is also used in swimming-pool filters and in filters for clarifying beer and wine.

Red and brown algae produce cell-wall polysaccharides that have many industrial uses. The main red algal polysaccharides are carrageenan from seaweeds such as Irish moss (*Chondrus crispus*) and agar from several other seaweeds, including species of *Gracilaria*. Many algae have been traditionally as food (species of *Ulva*, *Laminaria*, and other seaweeds).

Practice

1. Having looked through the recommended books, placards, tables, comprehend typical peculiarities of different Algae specimens, study a variety of Algal specimens.
2. Prepare and examine cover-glass preparation of unicellular and multicellular algae under the microscope.
3. Sketch the texture of examined algae specimens.
4. Fill in the table:

Species Name	Division	Texture Peculiarities	Reproduction Peculiarities	Nutrition Type	Existence Conditions	Ecological and Economic Importance
1	*2*	*3*	*4*	*5*	*6*	*7*

<u>Subject 3.</u> The determination of general and distinguishing features of biological and ecological characteristics of Fungi specimens from different divisions. The study of ecological and economic importance of Fungi

<u>Objectives:</u>

- to get acquainted with a diversity of Fungi specimens;

- to comprehend biological peculiarities of some Fungi species, their ecological role and economical importance and make the comparative analysis.

<u>Materials</u>: microscope, microscopic slides, glass slides, cover slips, bread, yeast, herbarium, placards, identification guide books.

Features of Fungi

The fungi are usually filamentous, eukaryotic, spore-producing organisms that lack chlorophyll. They have cell walls made of chitin combined with other complex carbohydrates, including cellulose (chitin is also the main component of the exoskeletons of insects, spiders, and crustaceans). The main storage carbohydrate of fungi is glycogen, which is also the main storage carbohydrate of animals (but not plants). All species of fungi are either saprobes or symbionts (i.e., live with other organisms). As symbionts, they may be parasitic, they may provide a benefit to their host, or they may be parasitized by their host.

The main vegetative feature of fungi is a tubular, thread-like, whitish or colorless filament called a hypha. The hyphae of most fungi branch repeatedly, intertwine, or fuse with other hyphae, forming a mass known as a mycelium (fig. 3.1).

The Generalized Life Cycle of Fungi

Reproduction in fungi can be either asexual or sexual; most fungi exhibit both forms. Asexual reproduction usually occurs by mitosis and cell divisions or by budding. Other forms of asexual reproduction include mycelial fragmentation and the mitotic production of spores.

The sexual life cycles of many fungi involve a dominant haploid phase and a diploid phase consisting of just the zygote.

The Diversity of Fungi

Nearly 100000 species of fungi are known, and descriptions of more than 1000 new species are published each year. Fungi are most often classified into three sexually reproducing groups variously treated as divisions: the *Zygomycetes*, the *Ascomycetes* and the *Basidiomycetes*.

Furthermore, fungi that apparently cannot reproduce sexually, which are referred to as imperfect fungi or *Deuteromycetes*.

More than 750 species of zygomycetes are known, examples of which are representatives of genera as *Mucor*, *Rhizopus*, *Phycomyces*, *Zygorhynchus*, *Mortierella*.

There are about 30000 known species of ascomycetes, the most famous of which are brewer's or baker's yeast (*Saccharomyces cerevisiae*), bread mold (*Neurospora crassa*).

The most famous of the basidiomycetes are the common edible mushrooms (*Agaricus brunnescens*, *Boletus edulis*), and poisonous fungi (*Amanita muscaria*, *Amanita phalloides*) (fig. 3.2).

Deuteromycetes are mostly free-living and terrestrial, but some are pathogenic. The most famous deuteromycetes are species in the genus *Penicillium*: especially *P. notatum* for its role in the discovery of penicillin.

Lichens are symbiotic relationships consisting of a fungus and green algae, a fungus and a cyanobacterium, or a fungus with both, in a spongy body called a thallus.

Approximately 20000 species of lichens are known (a foliose lichen *Physcia sp*., a fruticose lichen *Cladonia deformis*).

The Ecology of Fungi

The ecology of fungi is especially important for plants. For example, tiny orchid seeds cannot germinate until they are invaded by hyphae of the soil fungus *Rizoctonia*, and plants of all kinds are healthier when their underground parts associate with soil fungi. Members of all 400 families of flowering plants, with the exception of possibly fewer than a dozen, form mycorrhizae. A mycorrhiza, meaning "fungus-root," is an association between a fungus and the underground parts of plant. The association is a mutually beneficial symbiosis: the plants provide a source of carbon for the fungus, and the fungus absorbs phosphorus or other minerals that the plant cannot otherwise get easily from the soil.

The Economic Importance of Fungi

Fungi have greatly benefited human societies as sources of industrial chemicals, antibiotics, medicines and vitamins. They are the mainstay of the brewing and baking industries, and are also important for making certain dairy foods, including gourmet cheeses. Fungi also cause many plant and animal diseases. Fungi produce gallic acid, which is used in photographic developers, dyes, and indelible black ink, and in the

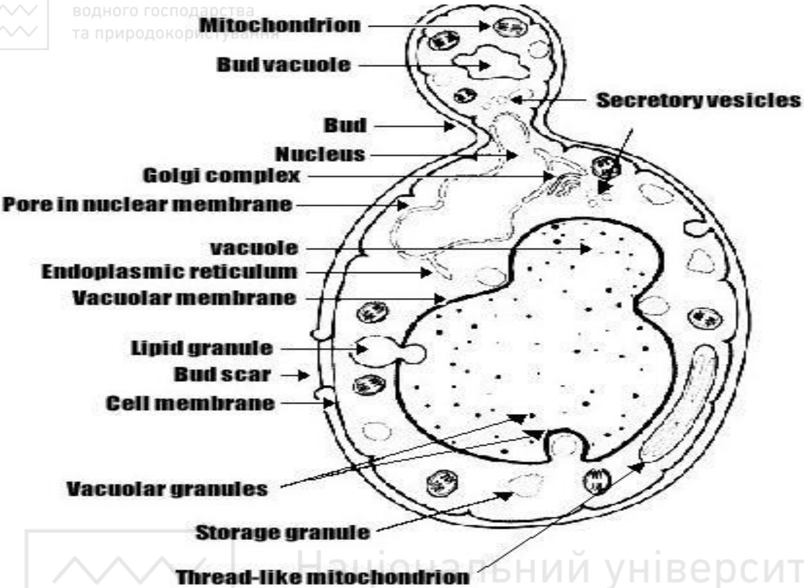

Fig. 3.1. Structure of fungi cell

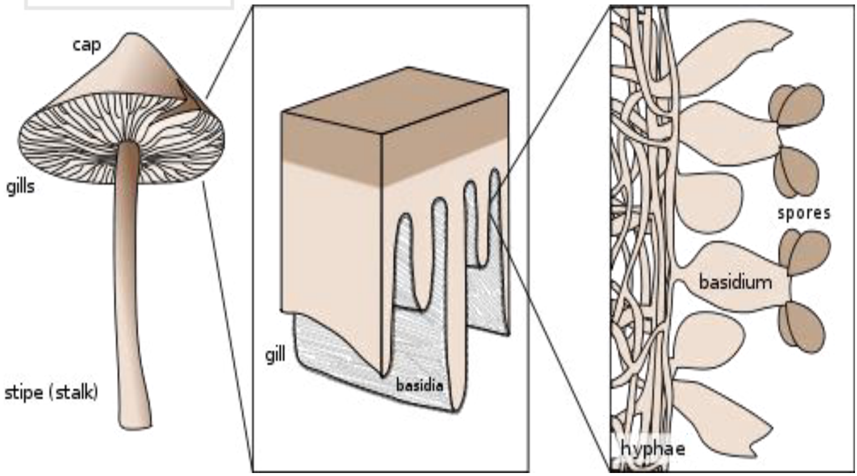

Fig. 3.2. Fruiting body of pileate fungi

production of artificial flavoring and perfumes, chlorine, alcohols, and several acids. Fungi are also used to make plastics, toothpaste, and soap, and in the silvering of mirrors.

Plant disease that has had a significant impact on human society is caused by the ergot fungus *Claviceps purpurea*. This fungus infects the inflorescences of rye and other grain crops.

Practice

1. Examine small portion of the bread microscopically for fungal mycelium and reproductive bodies.
2. Examine various types of toadstools and straw mushrooms.
3. Consider the importance of fungi, particularly of soil fungi, in nature.
4. Read further about yeast and its economic importance.
5. Read further about lichens and their economic importance.
6. Fill in the table:

Species Name	Division	Texture Peculiari-ties	Existence Conditions	Ecological and Economic Importance
1	*2*	*3*	*4*	*5*

<u>Subject 4.</u> The determination of general and distinguishing features of biological and ecological characteristics of Bryophytes specimens from different divisions. The study of ecological and economic importance of Bryophytes

<u>Objectives:</u>

- to get acquainted with a diversity of Bryophyte specimens;

- to comprehend biological peculiarities of some Bryophyte species, their ecological role and economical importance and make the comparative analysis.

<u>Materials:</u> microscope, microscopic slides, glass slide, cover slip, balance (analytical, torsion), drying oven, sodium carbonate, water, filter paper, dissecting needle, *Politrichum commune* specimens, *Sphagnum* specimens.

Features of Bryophytes

Bryophytes have the following general features: 1) most bryophytes are small, compact, green plants; 2) bryophytes lack well-developed vascular tissues and lignified tissues. As a result, they grow low to the ground and absorb water by capillarity; 3) since bryophytes lack true vascular tissues, they also lack leaves and roots; 4) bryophytes get their nutrients from dust, rainwater, and substances dissolved in water at the soil's surface. Tiny rhizoids (hairlike extensions of epidermal cells) along their lower surface anchor the plants but do not absorb water or minerals. Water and dissolved minerals move by capillarity over the surface of bryophytes; 5) the gametophyte dominates the life cycle. Gametes form by mitosis in multicellular gametangia called antheridia (male) and archegonia (female). Each flask-shaped archegonium produces one egg, and each saclike antheridium produces many sperm; 6) the sporophyte is short-lived. The sporophytes of bryophytes have no direct connection to the ground. Spores have a cutinized coat and are usually dispersed by wind; 7) biflagellate sperm swim through water to eggs. Thus, bryophytes need free water for sexual reproduction.

The Generalized Life Cycle of Bryophytes

Unlike many green algae, bryophytes have heteromorphic alternation of generations; that is, the sporophyte and gametophyte are distinctly different. Haploid spores formed by meiosis begin the gametophyte generation. The spore germinates to form a gametophyte. The gametophyte produces antheridia and archegonia. Antheridia (singular, antheridium) produce sperm, and archegonia (singular, archegonium) produce eggs. Sexual reproduction in bryophytes requires free water, because the sperm must swim to the egg. A sperm fertilizes an egg and forms a diploid zygote, thus beginning the sporophyte generation of the life cycle.

Sporophytes produce sporangia containing spore-producing tissue. This tissue undergoes meiosis to produce spores, which are released to the environment. If the spore lands in a dry area, it can remain dormant, often for several decades. When water becomes available, the spore germinates and forms the gametophyte, thus completing the sexual life cycle (fig. 4.1).

The Diversity of Bryophytes

The three major groups of bryophytes are variously treated as classes of a single division, Bryophyta, or as three separate divisions.

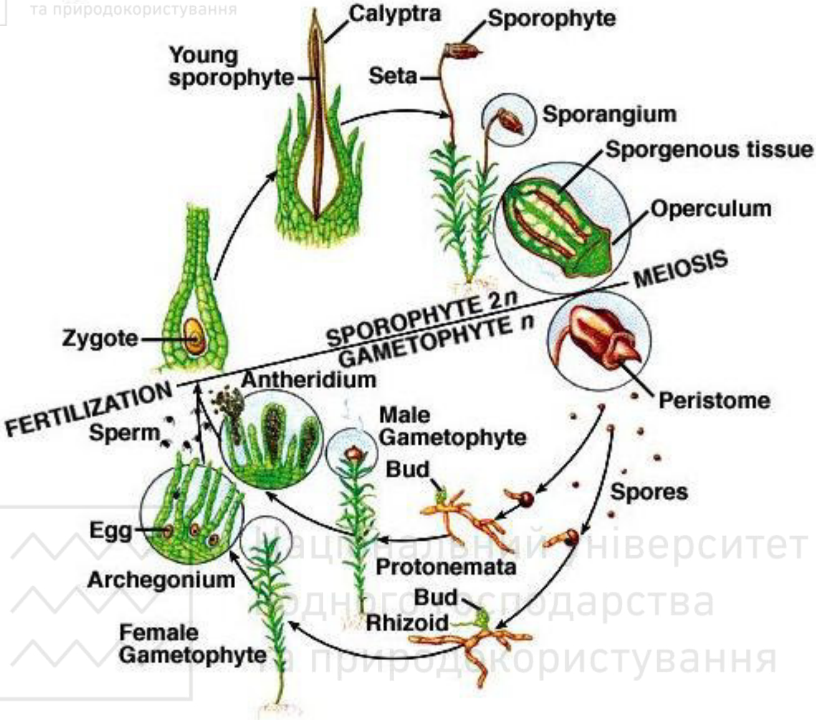

Fig. 4.1. Moss life cycle

They are: Division *Bryophyta* (mosses), Division *Hepatophyta* (liverworts), and Division *Anthocerotophyta* (hornworts).

The Ecology and Distribution of Bryophytes

Bryophytes live in almost all places that plants can grow and in some places where vascular plants cannot grow. For example, bryophytes grow on moist soil, rooftops, the faces of cliffs, tombstones, and bird’s nests; they carpet forest floors, dangle like drapery from branches, and sheathe the trunks of trees in rain forests.

The greatest diversity of bryophytes, especially of hornworts, occurs in tropical habitats. Examples of the extremes of bryophyte habitats include exposed rocks and volcanically heated soil (up to 55^0 C), and they grow in Antarctica where summer temperatures seldom exceed -10^0 C. Many bryophytes, such as the genus *Hypnum*, are notoriously sensitive to pollution, especially sulfur dioxide. As a result, most bryophytes are rare in cities and industrialized areas.

Bryophytes increase the humus in soil and often indicate the presence or absence of particular salts, acids, and minerals. For example, the liverwort Carrpos grows only on gypsum-rich “salt pans”, and Mielichoferia and Scopelophila are mosses that grow only on copper-rich substrates.

Peat moss can absorb 20-25 times its weight in water; it is therefore an excellent soil conditioner that helps to prevent flooding and minimizes erosion. Peat moss produces large amounts of acids and antiseptics that kill decomposers.

The Economic Importance of Bryophytes

Bryophytes are generally not edible. Mosses are used as stuffing in furniture, as a soil conditioner, as an absorbent in oil spills, and for cushioning. For example, florists use peat moss as a damp cushion when shipping plants. Sphagnum has also been used aboriginal people for diapers and as a disinfectant. Because of its acidity, peat moss is an ideal dressing for wounds. The rapid growth of peat moss suggests that peat bogs may be an important source of renewable energy. Countries of the former Soviet Union have an annual harvest of more than 200 million tons of peat, which is used as fuel for nearly eighty power plants.

Practice

1. Examine and sketch male and female specimens of *Polytrichum commune*.
2. Examine leaf of *Sphagnum* using the microscope.
3. Determine the total moisture capacity of *Sphagnum*.
4. Fill in the table:

Species Name	Division	Texture Peculiari-ties	Existence Condition s	Ecological and Economic Importance
1	*2*	*3*	*4*	*5*

<u>Subject 5.</u> The determination of general and distinguishing features of biological and ecological characteristics of Seedless Vascular Plants division specimens. The study of ecological and economical importance of Seedless Vascular Plants

<u>Objectives:</u>

- to comprehend general biological and ecological features of Seedless Vascular Plant;
- to get acquainted with a variety of their specimens and make the comparative analysis of examined species.

<u>Materials:</u> standard microscopic equipment, magnifying glass, glass slides and cover slips, dissecting needle, dropper, edge, chemical glass, filter paper, microscopic slides, herbarium, spirit specimens, placards, schemes.

<u>Features of Seedless Vascular Plants</u>

For comparison with the algae and bryophytes, the general features of vascular plants are summarized as follows: 1) the life cycle of seedless vascular plants is similar to that of bryophytes and algae that exhibit sporic meiosis. The diploid sporophyte produces haploid spores by meiosis. Each spore germinates and grows into a gametophyte that produces gametes by mitosis. The gametes (eggs and sperm) fuse to firm diploid zygotes; 2) eggs are produced in archegonia, and sperm are produced in antheridia; 3) the zygote germinates to produce a multicellular embryo that depends on the gametophyte for its nutrition. To complete the life cycle, the embryo grows into a mature sporophyte; 4) seedless vascular plants have a well-developed cuticle to minimize water loss. They also have stomata to allow gas exchange for photosynthesis; 5) seedless vascular plants produce chlorophylls *a* and *b*, carotenoids, starch, cellulose cell walls, and motile sperm; 6) flagellated sperm swim through water to eggs; 7) seedless vascular plants have well-developed vascular tissues. Xylem transports water and dissolved minerals great distances from the soil; 8) sporophytes and gametophytes of seedless vascular plants are nutritionally independent of each other. 9) The sporophyte of seedless vascular plants, which dominates the life cycle, is long-lived and often highly branched.

<u>The Diversity of Seedless Vascular Plants</u>

The four divisions of living seedless vascular plants are distinguished.

Division *Psilotophyta*: Whisk Ferns. Division *Lycopodophyta*: Club Mosses.

Division *Equisetophyta*: Horsetails. Division *Polypodiophyta*: Ferns.

Division *Polypodiophyta:* Ferns

Ferns include approximately 12000 living species, making this division by far the largest among the seedless vascular plants. Ferns are primarily tropical plants, but some species inhabit temperate regions, and some even live in deserts. Some genera of ferns have leaves that are the largest and most complex in the plant kingdom. For example, one species of tree fern in the genus *Marattia* has leaves that are up to 9 meters long and 4 meters wide, which is nearly the size of a two-car garage. At the other extreme, the aquatic ferns *Salvinia* and *Azolla* have relatively tiny leaves. For most people, however, a typical example of a fern is the bracken fern, *Pteridium aquilinum* (fig. 5.1).

The Ecology of Seedless Vascular Plants

The ecology of many ferns is well understood because these plants can be such noxious weeds. For example, when people burn native forests to establish pastures, bracken ferns can quickly invade the newly available habitats. Populations of this plant spread rapidly from an extensive network of fast-growing rhizomes. The problem of bracken infestation is worsened by the toxicity of this plant to the cattle raised in such pastures. Herbicides can alleviate the problem somewhat, but this damages other plants and leaves a toxic residue in the soil. Weed scientists are now studying how to control bracken fern by introducing pathogenic fungi into invasive populations.

Kariba weed (*Salvinia molesta*), an aquatic fern, can be a more serious problem than bracken fern, even though it is not poisonous.

The Economic Importance of Seedless Vascular Plants

Seedless vascular plants are little economic importance today. Perhaps their greatest economic impact comes from their aid in discovering fossil fuel deposits. Many seedless vascular plants, especially ferns, are often found in greenhouses or are grown as houseplants and groundcovers.

In China, where petroleum-based fertilizers are not affordable, *Azolla* is substituted as a rotated crop in rice paddies. This aquatic fern hosts a cyanobacterium, *Anabaena azollae* that fixes nitrogen from the air, thereby acting as a fertilizer to replenish the nitrates removed from the soil by other crop plants.

Many *Lycopodium* species synthesize complex, nitrogen-containing chemicals called alkaloids that are potent animal poisons. The dried and powdered leaves containing these chemicals are used directly as pesticides in parts of Eastern Europe.

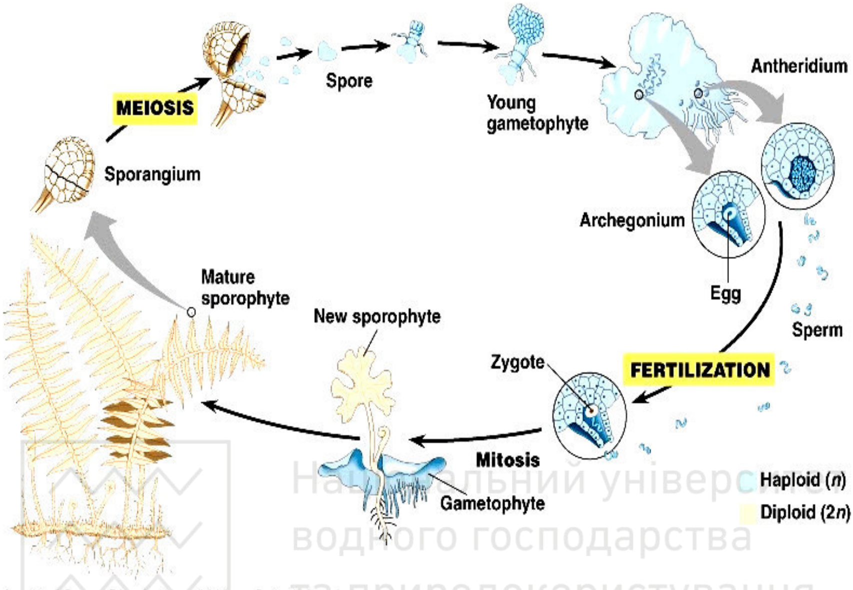

Fig. 5.1. Fern life cycle

Practice

1. Study general features of Seedless Vascular Plants, having looked the recommended books, herbarium specimens.
2. Descry soruses of different Fern species using the magnifying glass. To make a sketch figure.
3. Sketch the Ferns Life Cycle.
4. Fill in the table:

Species Name	Division	Texture Peculiarities	Reproduction Peculiarities	Existence Conditions	Ecological and Economic Importance
1	*2*	*3*	*4*	*5*	*6*

<u>Subject 6.</u> The determination of general and distinguishing features of biological and ecological characteristics Gymnosperms specimens from different divisions. The study of ecological and economic importance of Gymnosperms

<u>Objectives:</u>

- to study the main features of Gymnosperms;
- to get acquainted with a diversity of Gymnosperms specimens;
- to analyze the ecological and economical importance of Gymnosperms.

<u>Materials</u>: magnifying glass, cones with pine seeds, placards, tabes, schemes.

<u>Features of Gymnosperms</u>

The term gymnosperm derives from the Greek word roots *gymnos*, meaning "naked", and *sperma*, meaning "seed". Gymnosperms are plants whose pollen goes directly to ovules (unfertilized seeds) instead of to a stigma (as in the flowering plants), and whose seeds are naked (i.e., are not enclosed in fruits). Thus, by definition, gymnosperms are all fruitless plants.

Gymnosperms are characterized by secondary growth that usually forms woody trees or shrubs, but some species are more vinelike. Most gymnosperms lack vessels in their xylem, with the exception of the gnetophytes.

Considering the relatively small number of living gymnosperms (about 720 species in 65 genera), they are remarkably diverse in their reproductive structures and leaf types.

Gymnosperms, like angiosperms, differ from the seedless plants in not requiring water for sperm to swim in to reach the egg.

The most significant development leading to the evolution of gymnosperms was the origin of the seed. Seeds probably arose from megasporangium that became surrounded by an integumentlike layer of tissue with fingerlike projections. All seed plants are heterosporous.

<u>A Generalized Life Cycle of Gymnosperms</u>

The alternation between sporophytic and gametophytic phases in gymnosperms is the same as that in other plants. Like angiosperms, gymnosperms have heterosporous sporophytes, which means that the gametophytes are unisexual. Unlike lycopods and angiosperms, which include species with bisporangiate strobili (i.e., perfect flowers in angiosperms), gymnosperms have only microstrobili and megastrobili.

Pollination in gymnosperms involves a pollination droplet that protrudes from the micropyle when pollen grains are being shed. This droplet provides a large, sticky surface that catches the normally wind-borne pollen grains of gymnosperms, so that the ovule is more likely to be fertilized. During pollination, dozens of pollen grains may stick to each droplet. After pollination the droplet evaporates and contracts, carrying the pollen grains into the pollen chamber and into contact with the ovule (fig. 6.1).

The Diversity of Gymnosperms

Most classifications of gymnosperms include about 65 genera and 720 species. They are separated into four divisions: *Ginkgophyta* (maidenhair tree), *Cycadophyta* (cycads), *Pinophyta* (conifers), and *Gnetophyta* (gnetophytes).

Division *Pinophyta:* Conifers

Most of the approximately 550 species of conifers live in temperate climates, although many also live in alpine habitats or in deserts. Pines (*Pinus silvesstris L.*), spruces (*Picea*) and many other conifers have needle-shaped leaves. Still others have scale-like leaves (*Juniperus*) or leaves with flat blades (*Araucaria*). Although a few conifers are deciduous, most members of this division are evergreen.

The Ecology of Gymnosperms

Division of *Pinophyta* is dominated by trees and shrubs that are well adapted for temperate or cold climates, especially where free water is scarce for part of the year. Accordingly, northern forests in some areas consist mostly of pines and their relatives, and southern forests consist mostly of araucarias and their relatives. These gymnosperms are adapted to such regions by their sunken stomata, thick cuticle, and tough hypodermis. Some gymnosperms, such as *Ephedra, Welwitschia,* live in deserts. Only a few gymnosperms are tropical; the cycads and *Gnetum* are the main examples.

The Economic Importance of Gymnosperms

The gymnosperms are second only to the angiosperms in their daily impact on human activities and welfare.

The greatest economic impact of gymnosperms comes from the use of their wood for making paper and lumber. Indeed, conifers produce about 75% of the world’s timber and much of the pulp used to make paper.

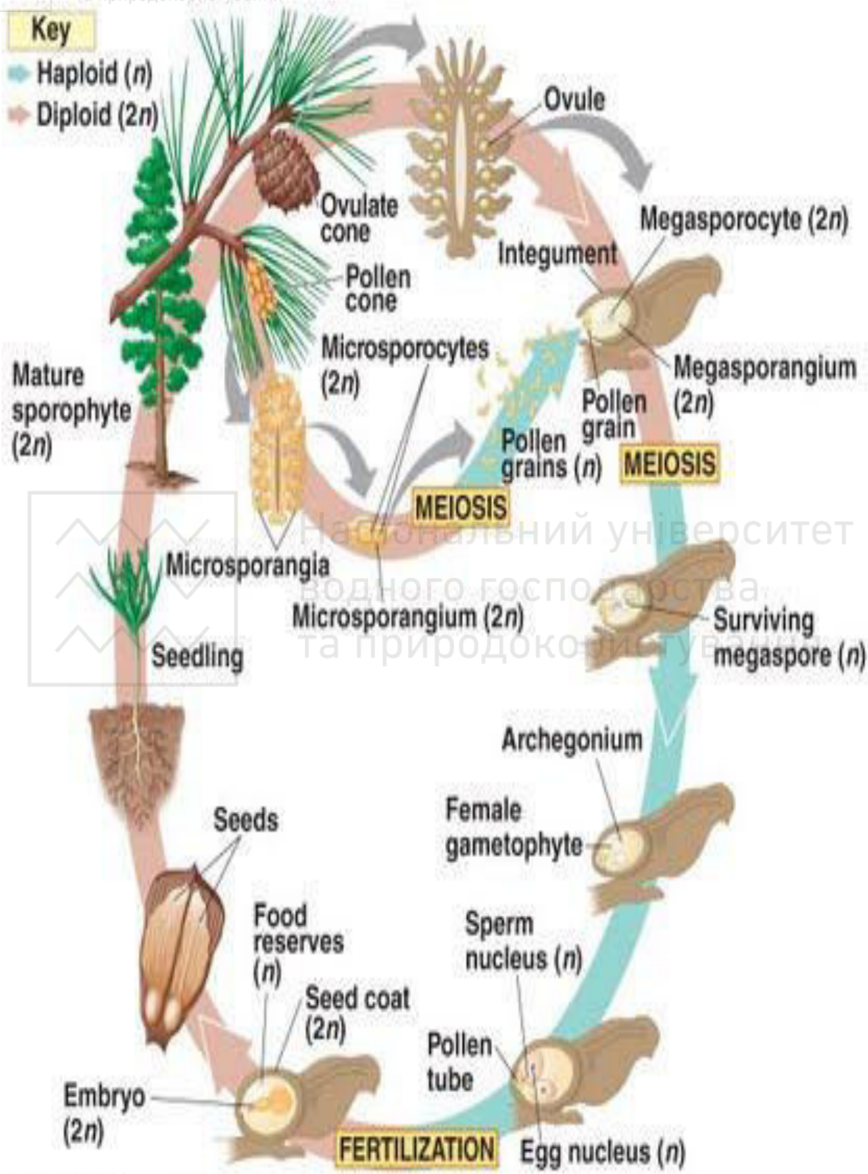

Fig. 6.1. Life Cycle of Gymnosperms

Important wood products besides lumber and pulp include resin, which is the sticky, aromatic substance in the resin canals of conifers. It is a combination of a liquid solvent called turpentine and a waxy substance called rosin. Turpentine and rosin are often referred to as naval stores, a term that originated when the British Royal Navy used large amounts of resin for caulking and sealing their sailing ships and for waterproofing wood, rope, and canvas.

Turpentine is the premier paint and varnish solvent, and is also used to make deodorants, shaving lotions, drugs, and limonene – the lemon flavoring in lemonade, lemon pudding, and lemon meringue pie.

Practice

1. Examine male and female sporophylls and also cones with pine seeds using the magnifying glass.
2. Make a sketch figure.
3. Sketch the Pines Life Cycle.
4. Fill in the table:

Species Name	Division	Texture Peculiarities	Reproduction Peculiarities	Existence Conditions	Ecological and Economic Importance
1	*2*	*3*	*4*	*5*	*6*

<u>Subject 7.</u> The determination of general and distinguishing features of biological and ecological characteristics of Angiosperms

Objectives:

- to comprehend general biological and ecological features of Angiosperms;

- to get acquainted with a variety of their specimens and make the comparative analysis of examined species.

<u>Materials:</u> microscope, magnifying glass, glass slide, cover slip, dissecting needle, dropper, herbarium, live material, placards, schemes, tabes.

General Features of Angiosperms

Botanists estimate that there are at least 260000 species of angiosperms, which makes the Anthophyta by far the largest divisions of plants. Flowering plants are the dominant photosynthetic organisms nearly everywhere on land. They represented by different life forms: trees, shrubs, herbs, grasses.

As a group, the flowering plants are defined by the formation of flowers, by double fertilization that results in a zygote as well as a nutritive endosperm tissue, by the presense of vessels, by the formation of ovules in organs that develop into fruits, and by few-celled gametophytes.

Reproduction in Flowering Plants

Vegetative Propagation. Large numbers of flowering plants are able to reproduce asexually. To summarize: 1) wegetative reproduction is a means of rapid spread under favourable conditions, without the need for seed production and without dependence upon external agents; 2) it is a means whereby plants may be grown from year to year with the same genetic inheritance, so that particular varieties may be maintained, for example, strawberries, apples, pears, potatoes; 3) it has a limitation in that since all such plants are genetically alike they are all susceptible to the same disease organisms.

Sexual Reproduction. The reproductive structures in flowering plants are the flowers (fig. 7.1). The following points about flowers should be noted: 1) they are temporary structures, often produced in very large numbers; 2) each may be regarded as a specially modified shoot, consisting of special leaves; 3) each consists of a stem generally bearing four types of floral leaf. In order, from the outside there are sepals, petals, stamens, and carpels. Flowers are usually hermaphrodite. Sometimes flowers lack either carpels or stamens and are therefore male or female. These single-sex flowers may occur in the same plant, as in hazel, or in separate plants, as in holly.

Pollination

Pollination is the transfer of pollen grains from the ripe anther to the stigma. If this occurs within the same flower or between different flowers on the same plant, it is called self-pollination; if it is occurs between flowers from the different plants of the same species it is referred to as cross-pollination. Flowers differ greatly, depending on whether they are insects or wind pollinated.

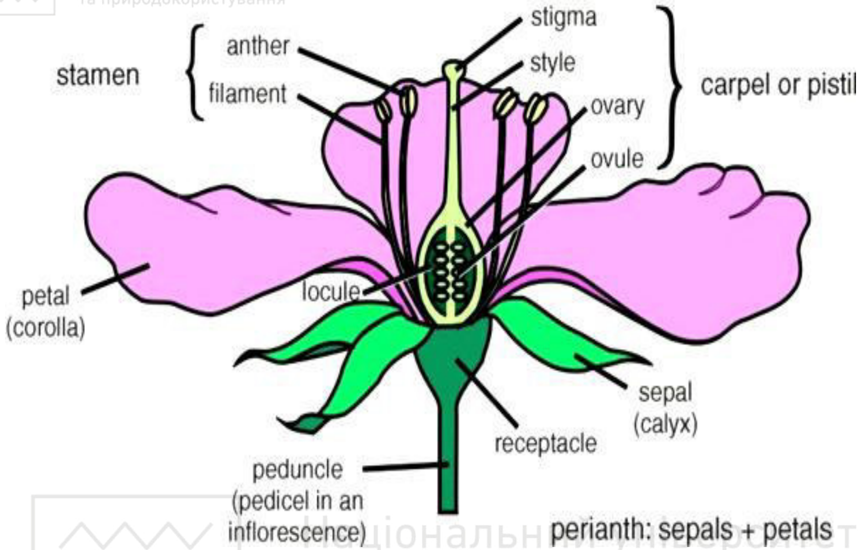

Fig. 7.1. The structure of the Flower

Fertilization

After successful pollination the following events take place: 1) the pollen begins to germinate under the stimulus of the sugary secretion produced by the stigma; 2) the inner membrane, together with its contents, puts out a tube, the pollen tube, which grows out through one of the pores in the outer wall of the pollen grain; 3) the two pollen grain nuclei pass into the tube; 4) the pollen tube is positively chemotropic and negatively aerotropic, i.e. it is attracted by the chemical secretions of the stigma and it grows away from the air; 5) it grows down the style and into the ovary wall. Penetrating the ovary wall, it enters the micropyle of the ovule; 6) one of the pollen grain nuclei disappears; as the pollen tube nucleus, its task is finished. The other divides into two; 7) after entry of the pollen tube into the ovule, one nucleus fuses with the nucleus of the egg cell, the other fuses with the nucleus of the endosperm cell.

The formation of the fruit and seed

After fertilization has occurred, most of the flower parts wither away, since their purpose has been served. In all plants the main changes after fertilization involve the ovary and its contents.

Ovary: Its wall is called the pericarp. It increases in size, becoming: leathery, as in buttercup; woody, as in oak or hazel; dry and brittle, as in most legumes or fleshy, as in succulent fruits, with differentiation into two or more distinct layers.

Ovule: This becomes the seed. Its integument becomes the testa. The micropyle, which serves for the entry of the pollen tube, persists and serves for the entry of water in the germinating seed. The fertilized egg cell develops into the embryo plant. The endosperm cell also undergoes division, forming a tissue called the endosperm. This grows by digesting the tissue of the nucellus which disappears. In non-endospermic seeds the endosperm is digested and absorbed by the fleshy cotyledons of the embryo.

The transformed ovary with its contents becomes the fruit (fig. 7.2).

The Diversity of Angiosperms

Flowering plants are divided into two classes, the *Magnoliopsida* (180000 species) and the *Liliopsida* (80000 species). The *Magnoliopsida* are informally called Dicotyledons (dicots), which refers to seeds that have 2 cotyledons (seed leaves). Dicots are also characterized by flowers whose parts are usually in fours or fives, by netlike venation in leaves, by primary vascular bundles occurring in a ring in the stem, and by the presence of a vascular cambium and true secondary growth in many species. The dicots include the great majority of familiar angiosperms of all kinds – almost all kinds of trees and shrubs, snapdragons, mints, peas, sunflowers, and other familiar plants. Conversely, the *Liliopsida* are called Monocotyledons (monocots) because they form seeds that have a single cotyledon. Also in contrast to dicots, monocots have flowers whose parts usually occur in threes or six, whose leaves have parallel venation, and whose stems have primary, mascular bundles that are scattered. Monocots also lack a vascular cambium and true secondary growth. Among the monocots are thelilies, grasses, cattails, palms, agaves, orchids, pondweeds and irses.

Flowering plants can also be classified according to the length of their life-cycles: 1) ephemerals – more than one life-cycle completed in each year; 2) annuals – one life-cycle completed in each year; 3) biennials – one life-cycle completed every 2 years; 4) perennials – life-cycle completed only after several years.

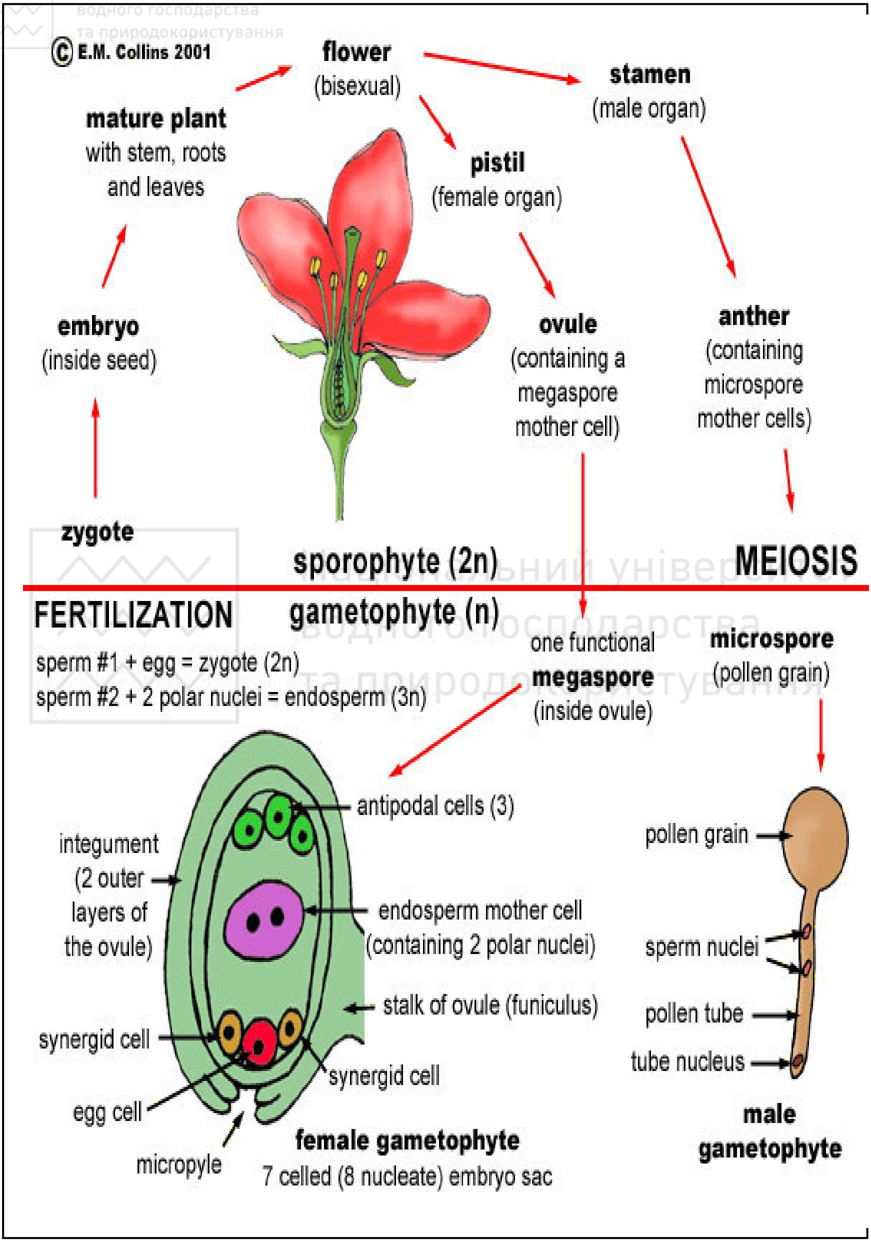

Fig. 7.2. Life Cycle of Angiosperms

Practice

1. Study general features of Angiosperms look in the recommended books, herbarium specimens.
2. Observe the flower parts of monocot and dicot plants.
3. Examine the reproductive structures of the given flower.
4. To get acquainted with a type variety of fruit.

Subject 8. The study of peculiarities to organize the individual ecological groups of plants and their dependence on specific ecological factors

Objectives:

- to comprehend the "ecological group" term;
- to get acquainted with plants ecological group variety;
- to determine the organization peculiarities of different ecological group representatives;
- to analyse the dependence of these peculiarities on specific ecological factors.

Materials: standard microscopic equipment, micropreparations, herbarium, placards.

Ecological groups of plants

Every plant and animal occupies its place in the order of Nature by the action of two forces – the inherent constitutional life – force with all its acquired habits, the sum of which is heredity; and the numerous complicated external forces or environment.

Plants and animals study demonstrates the evidence, that under conditions of existence, they acquire similar adaptation forms irrespective of their taxonomic relationships. There are ecological factors which determine the nature and peculiarities of those organisms' adaptation forms.

Adaptation is a characteristic of an organism that makes it better able to survive and reproduce in its environment. The word adaptation also refers to the ability of living things to adjust to varying conditions in their environment.

Various ecological conditions and accordingly adaptation diversity, of ways and means of adaptational processes became an objective pre-condition to make up innumarable ecological classifications and to single out a great number of ecological groups.

Different criteria, like nutrient ways, attitude to different abiotic factors, external texture peculiarities etc may be taken as a starting point of the ecological classification. In view of this, under the term "ecological group", we understand the aggregate of different species of the living things, irrespective of their taxonomic property, characterized by similar adaptational peculiarities according to a certain ecological factor.

Environmental factors include sunlight, climate and soil conditions.

All plants need light, a suitable climate, and an ample supply of water and minerals from the soil. But some species grow best in the sun, and others thrive in the shade. Plants also differ in the amount of the water they require and in the temperatures they can survive.

According to sunlight a few ecological group of plants (heliomorphes) are singled out, namely:

heliophytes – light-requiring plants, which give preference to brightly lighting places. Among them are: *Zea mays, Stipa capillata, Chenopodium album, Euphorbia cyparissias,* etc;

sciophytes – shade-enduring plants which are able to endure the (considerable) shading. Among them are: *Equisetum silvaticum, Polygonatum officinale, Licopodium annotinum,* etc;

heliosciophytes – plants, which grow well on the lighting places, but may be tolerant to moderate shading. Among them are: *Fragaria vesca, Veratrum abbum, Coronaria flos-cuculi,* etc.

In respect to water such ecological groups may be singled out:

hydatophytes – aquatic plants, that grow partly or completely submerged in water. Among them are: *Elodea canadensis, Victoria regia, Nuphar luteum,* etc;

hydrophytes – amphibious plants, which are partly water and grow along banks, on shallow water and swamps. Among them are: *Stellaria palustris, Phragmites communis, Equisetum heleocharis,* etc;

hygrophytes – land plants, which live in increased air humidity conditions and often on humid soils. Among them are: *Impatiens noli tangere, Cirsium oleraceum,* etc;

mezophytes – the most numerical ecological group, which unify plants, which may endure not strong drought during period. These are plants, that grow at medium humid, fication, temperate thermal regimen and at quite good providion with unorganic nutrient;

xerophytes – plants, that grow at areas of insufficient humidification and have adaptations, so as to store water in them, to limit water evaporation or to stare up it for drought period. Xerophytes may be divided into 2 main types: succulents (*Aloe arborescens, Opuntia vulgaris, Sempervivum ruthenicum,* etc), and sclerophytes (*Stipa capillata, Artemisia taurica, Festuca ovina,* etc).

Succulent is a name for a fleshy plant, such as cactus, that has large stems or leaves in which water is stored. By using the water stored in their leaves and stems, succulents can survive long droughts. Sclerophytes are dry in appearance, often have narrow small leaves and well developed sclerenchyma bast-cells.

Ecological group of plant are also singled out regarding soil peculiarities, i.e. edaphic factors. Thus in respect of soil acidity such groups are distinguished: acidophilic species (*Eriophorum angustifolium, Licopodium clavatum,* etc), which grow on acidic soils, neutrophilic species which grow on soils at pH 6,7-7,0, basophilic species (*Anemone silvestris,* etc), which grow at pH more than 7,0, and indifferent species (*Convallaria majalis, Festuca ovina,* etc), which may grow on soils having various values of pH.

Regarding soil bulk composition we differ: oligotrophic plants (*Pinus silvestres,* etc) supplied with a little ash content, eutrophic plants (*Quercus robur,* etc), required large ash content, mesotrophic plants (*Picea abies,* etc) which need in moderate ash content.

Practice

1. Having looked in the recommended books, get acquainted with plant ecological groups diversity.
2. Comprehend organization peculiarities of the given representatives of different heliomorphes using micropreparations, herbarium, placards.
3. Fill in the table:

Species Name	Light Conditions of Growth Place	Morphological and Anatomical Peculiarities of Species	Physiological and Other Peculiarities of Species	Heliomorpha
1	*2*	*3*	*4*	*5*

4. Comprehend organization peculiarities of the given representatives of different hydromorphes.
5. Fill in the table:

Species Name	Hydrological Conditions of Growth Place	Morphological and Anatomical Peculiarities of Species	Physiological and Other Peculiarities of Species	Hydromorpha
1	*2*	*3*	*4*	*5*

<u>Subject 9.</u> Plants as an object of human practical activity

<u>Objectives:</u>

- to get acquainted with main group of plants according to their economic importance;

- to determine practical importance of some plant species in our life.

<u>Materials:</u> herbarium, placards, atlases of crops and medicinal plants.

<u>Introduction</u>

Throughout previous units you've seen many examples of how plants affect our lives. We eat grains, fruits, and vegetables, and are clothed by fibers from stems and leaves. Plants generate the oxygen we breathe, and trees provide us with lumber, paper, and welcome shade on hot days. Many plants make medicines, brilliant dyes, industrial chemicals, and useful oils. The colors and fragrances of flowers and foliage satisfy our aesthetic senses, while plant-derived spices such as black pepper, nutmeg, ginger, clover, and cinnamon have enhanced our enjoyment of food since before the time of the Roman Empire. Spices can also preserve foods, which made possible the colonization of the New World. Tea and coffee are the world's most popular beverages. From the body paints of Amazon Indians to modern cosmetics, and from early Egyptian papyrus of more than 5000 years ago to today's pulp mills that produce more than 200 million tons of paper each year, plants affect all aspects of our lives.

<u>Plants as Food</u>

Our most important use of plants is as food. Today, as much as 90 % of the total calories consumed by humans comes from crop plants:

Grains: wheat, rice, corn, sorghum, millet, barley, oats, rye.

Tuber and root crops: potato, yam, sweet potato, and cassava.

Sugar crops: sugar cane, sugar beets.

Protein seeds: beans, soybeans, peas, lentils.

Oil seeds: olive, soybean, peanut, coconut, sunflower, and corn.

Fruits and berries: citrus, mango, banana, and apple.

Vegetables: cabbage, lettuce, and onion.

Most of the calories in our diet come from wheat, rice, corn, and potatoes. Cereals provide much dietary carbohydrate, and the seeds of legumes (beans, lentils, peanuts, and soybeans) are reach in protein. Cereals have different types of amino acids than legumes, so eating these two foods together provides a good balance of proteins. The best plant-derived nutrition combines a cereal (rich source of carbohydrate) with a legume (a source of protein), a green, leafy vegetable (rich in vitamins and minerals), and perhaps small amounts of sunflower oil, or olives (which provide fats).

Cereals such as wheat (*Triticum aestivum*), rice (*Oryza sativa*), and corn (*Zea mays*) include nine of the ten most economically important groups of plants and provide about half of all the protein in our diets. These plants are all the members of the grass family (Poaceae).

Plant as Medicine

Just as people learned to exploit plants for food, so they learned to use plants as medicine. Here are some of the more common drugs derived from plants and fungal parasite of a plant:

Reserpine is extracted from snakeroot (*Rauwolfia serpentina* a low evergreen shrub) and used as a sedative and to decrease blood pressure. Many schizophrenics and others with mental disorders can lead nearly normal lives after being treated with reserpine.

Ephedrine, which extracted from *Ephedra*, is used to ease bronchitis.

Digitoxin, extracted from *Digitalis purpurea* (foxglove, a garden ornamental), is taken as a heart stimulant (by more than 3 million Americans each day).

Cocaine comes from the leaves of *Erythroxylon cola*. This plant, the “divine plant” of the Inca civilization, is native to the eastern slopes of the Andes. Cocaine, an ingredient of Coca-Cola until 1904, is grown mostly in Peru and Bolivia. Cocaine is a stimulant and hunger depressant. Nicotine, which comprises 1-3 % of the weight of tobacco, is an ingredient of many insecticides.

Other more familiar plants have healing properties as well (table 9.1).

A good example of medicines derived from plants used today are the chemicals called *alkaloids,* which come from the periwinkle plant and other species. Alkaloid-derived drugs such as leucocristine and vincaleukoblastine (both from periwinkle; *Vinca roseus*) have helped revolutionize the treatment of some leukemias (blood cancers), and alkaloid narcotics derived from the opium poppy, including morphine, are excellent (but addictive) painkillers.

Today nearly half of all prescription drugs contain chemicals manufactured by plants, fungi, or bacteria, and many other drugs contain compounds that were synthesized in a laboratory but modeled after plant-derived substances. The many medicines that we use from the plant kingdom are a compelling reason why we must stop destroying the world's forests, (especially tropical rain forests) where plant life is so abundant and diverse that all of the species have not even been identified, much less studied.

Table 9.1

Some Important Medicinal Plants and Fungi

Plant	Plants Parts Use	Active Compounds	Uses in Medicine
Atropa belladonna (belladonna)	Leaves, roots	Atropine, hyoscyamine, scopolamine	Cardiac stimulant, pupil dilator, antidote for organophosphate poisoning, motion sickness, antiemetic
Cannabis sativa (marijuana)	Leaves, inflore-scence	Tetrahydrocanna-binol (THC)	Treatment of glaucoma, relief of nausea from chemotherapy
Catharan-thus roseus (madagascar periwinkle)	Leaves	Vindblastine, vincristine	Treatment of leuke-mia, Hodgkin's di-sease, and other cancers

table 9.1 (continuation)

Cinchona sp. (fever bark tree)	Bark	Quinine	Treatment of malaria
Colchicum autumnale (autumn crocus)	Corm	Colchicine	Treatment of gout
Digitalis purpurea (foxglove)	Leaves	Digitoxin, digoxin	Cardiac stimulant, diuretic
Dioscorea sp. (yam)	Tubers	Steroids	Production of corti-zone, sex hormones and oral contra-ceptives
Ephedra sp. (Mor-mon tea)	Stems	Ephedrine	Decongestant, treatment of low blood pressure and asthma
Erythro-xylon coca (coca)	Leaves	Cocaine	Local anesthetic
Hydnoca-rpus kurzii (chaulmoogr a tree)	Seeds, fruits	Ethyl esters of chaulmoogra oil	Treatment of leprosy and related skin diseases
Hydrastis canadensis (goldenseal)	Roots, rhizo-mes	Hydrastine	Treatment of infla-med mucous mem-branes
Nicotiana tabacum (tobacco)	Leaves	Nicotine	Stimulant
Papaver somniferum (opium poppy)	Latex from capsule	Morphine, codeine	Narcotic, analgesic, cough suppressant

table 9.1 (continuation)

Penicillium notatum (penicillin)	Hyphae	Penicillin	Antibiotic
Podophyllum peltatum (May apple)	Roots, rhizomes	Podophyllotoxin	Treatment of venereal warts
Rauwolfia serpentina (rauwolfia)	Roots	Reserpine	Treatment of high blood pressure and psychosis
Salix sp. (willow)	Bark	Salicin	Analgesis, antiinflammatory, treatment of rheumatoid arthritis and headaches

Feeding the World

There are many factors involved in feeding the world's population, the most important of which is the size of the population. Our population is growing extremely fast. For example, at the beginning of agriculture about 12000 years ago, only about 5 million people lived on Earth. By the time Christ was alive, the population had grown to 250 million. Thereafter, it doubled to 500 million in 1650, doubled again to 1 billion in 1985, doubled again to 2 billion in 1930, and doubled again to 4 billion in 1976. Today's ever-increasing population of more than 5,6 billion demand huge amounts of food.

Scientists have struggled to produce enough food for the population. Our rapidly growing population, combined with ineffective governmental policies and food-distribution methods, has overwhelmed our agricultural system. Solving this problem is a tremendous – perhaps impossible – challenge. However, all hope is not lost. One of the most promising tools for helping to feed the world: biotechnology. Botanists are now using genetic recombination to create high-yielding crops that resist disease, drought, and pests. Another strategy to increase our supply of plant foods is to look for new crops among the many naturally occurring plants. Fewer than 30 of the 240000 species of flowering plants provide more than 90 % of plant-based foods eaten by people. One of the most promising plants that botanists are studying as a new source of food is the majestic-looking amaranth, a member of the pigweed family. Botanists have also established gene banks to help conserve rare plants and to increase the world food supply. Plant banks offer three priceless services to humanity: a source of variants in case a major crop is felled by disease or an environmental disaster; the return of endangered or extinct varieties to their native lands; and, perhaps most important, a supply of genetic material from which researches can fashion useful plants in the years to come, even after the species represented in the bank have become extinct.

Practice

1. Having looked in the recommended books, get acquainted with representatives of Plant Kingdom according to their economic importance.
2. Fill in the table:

Plant	Plants Parts Use	Active Compounds	Economic importance
1	*2*	*3*	*4*

TEST 1

Write the letter of the correct answer in the blank.

1. The distinguishing feature of bacteria is that they are __________, which means that they have no membrane-bound organelles – that is, no nucleus, no mitochondria, and no chloroplasts.
   a. microscopic; **b.** prokaryotic; **c.** saprobic; **d.** eukaryotic.

2. Bacteria reproduce only asexually mainly by __________, which occurs when a cell reaches a certain size and then pinches in half to form two cells.
   a. budding; **b.** meiosis; **c.** osmosis; **d.** fission.

3. ____________ belongs to the Gram-negative bacteria.
   a. *Clostridium butyricum*; **b.** *Azotobacter chroococcum*;
   c. *C. pasteurianum*; **d.** *Bacillus subtilis*.

4. Those bacteria which get all the carbon they need from free carbon dioxide are known as ____________ bacteria.
   a. autotrophic; **b.** anaerobic; **c.** chemosynthetic; **d.** heterotrophic.

5. By Bergj determinant (1984) all bacteria unite into 4 divisions: Firmacutes, ____________ , Tenericutes and Mendosicutes.
   a. Ascomycetes; **b.** Mollicutes; **c.** Gracilicutes; **d.** Deuteromycetes.

6. All Algae with the exception of _____________ are eukariotic.
   a. Cyanophyta; **b.** Xanthophyta; **c.** Prochlorophyta; **d.** Charophyta.

7. ___________ algae are those with groups of cells that are loosely attached to each other and sometimes surrounded by a slimy sheath.
   a. photosynthetic; **b.** free-floating; **c.** colonial; **d.** planktonic.

8. There are no unicellular, colonial, or unbranched filamentous organisms among the ______________.
   a. *Cryptophyta*; **b.** *Pyrrophyta*; **c.** *Chrysophyta*; **d.** *Phaeophyta.*

9. Examples of Green algae are: *Chlorella,* __________, *Volvox.*
   a. *Delesseria*; **b.** *Chara*; **c.** *Spirogyra;* **d.** *Laminaria.*

10. The fungi are usually filamentous, eukaryotic, spore-producing organisms that lack ____________.

a. mycelium; **b.** hyphae **c.** chlorophyll **d.** cells.

11. The hyphae of fungi forming a mass known as a ___________.

a. chitin; **b.** lichen; **c.** integument; **d.** mycelium.

12. Fungi are most often classified into three sexually reproducing groups variously treated as divisions: the Basidiomycetes, the ________________ and the Zygomycetes.

a. Actinomycetes; **b.** Ascomycetes; **c.** Macrocystis; **d.** Agaricus.

13. Lichens are symbiotic relationships consisting of a fungus and a ______________.

a. photosynthetic microorganism; **b**. soil microorganism;
c. non-photosynthetic microorganism; **d.** yeast.

14. Fungi that apparently cannot reproduce ______________ are referred to as imperfect fungi.

a. asexual; **b.** by budding; **c.** sexual; **d.** by vegetative propagation.

15. Bryophytes need free _____________ for sexual reproduction.

a. nutrients; **b.** water; **c.** cells; **d.** air.

16. The ______________ is a dominant form of the bryophytes life cycle.

a. sporophyte; **b.** arghegonium; **c.** gametophyte; **d.** antheridium.

17. Bryophytes, which include hornworts, ___________, and mosses are small plants that produce chlorophylls a and b, cellulosic cell walls and motile sperm.

a. fungi; **b.** ferns; **c.** liverworts; **d.** horsetails.

18. ______________ are the largest and most familiar group of bryophytes.

a. horsetails; **b.** mosses; **c.** ferns; **d.** hornworts.

19. Each _______________ produces one egg, and each ______________ produces many sperm.

a. antheridium; **b.** gametangium; **c.** archegonium; **d.** sporangium.

20. The _______________ of seedless vascular plants is a dominant form of the life cycle.
a. sporophyte; **b.** arghegonium; **c.** gametophyte; **d.** antheridium.

21. The leaves of ferns have dark spots on their lower surfaces, each of which is a collection of sporangia, together called a _____________.
a. stomata; **b.** sporophyte; **c.** sorus; **d.** spore.

22**.** Such species _____________, *Dryopteris filix-mas, Athyrium filix-foemina* belong to the Pteridophyta.
a. *Penicillium notatum;* **b.** *Politrichum communi;*
c. *Pteridium aquilinum;* **d.** *Licopodium selago.*

23. The seedless vascular plants include about 13000 species and are divided into four divisions: Psilotophyta, Equisetophyta, ___________ and Pteridophyta.
a. Lycopodophyta; **b.** Bryophyta; **c.** Deuteromycetes; **d.** Phaeophyta.

24. Features of seedless vascular plants that enable them to thrive on land include a resistant cuticle, _____________, absorptive root hairs, complex stomata and desiccation-resistant spores.
a. sexual reproduction; **b.** vascular tissues; **c.** mitosis; **d.** rhizoids.

25. Gymnosperms, like angiosperms, differ from the seedless plants in not requiring water for ___________ to swim in to reach the egg.
a. fruit; **b.** microsporangia; **c.** needle; **d.** sperm.

26. All seed plants are ______________.
a. non-vascular; **b.** heterosporous; **c.** homosporous; **d.** aquatic.

27. Gymnosperms separated into four divisions: Gnetophyta, Cycadophyta, _______________ and Ginkgophyta.
a. Pinophyta; **b.** Chrysophyta; **c.** Pyrrophyta; **d.** Pteridophyta.

28. Gymnosperms are plants whose seeds are ______________

(i.e. are not enclosed in _____________).

a. large; **b**. fruits; **c.** flowers; **d.** naked.

29. *Pinus silvesstris L., Picea abies* have ______________ leaves.

a. scale-like; **b.** orbiculate; **c.** needle-like; **d.** palmatisected.

30. Most members of the conifers are _____________.

a. deciduous; **b.** evergreen; **c.** tropical; **d.** aquatic.

31. The flowering plants are defined by the formation of flowers, by double fertilization, by the formation of ovules in organs that develop into ______________.

a. sporophyte; **b.** vessel; **c.** fruit; **d.** antheridium.

32. Angiosperms are divided into two classes, the Magnoliopsida and the _______________.

a. Dicotyledons; **b.** Anthophyta; **c.** Bryopsida; **d.** Liliopsida.

33. The Magnoliopsida are informally called __________________, because they form seeds that have two cotyledons.

a. monocots; **b.** perennials; **c.** dicots; **d.** annuals.

34. Flowering plants according to the length of their life cycles classified as annuals, biennials, perennials and _____________.

a. legumes; **b.** ephemerals; **c.** shrubs; **d.** epiphyte.

35. _______________ is the transfer of pollen grains from the ripe anther to the stigma.

a. fertilization; **b.** pollination; **c.** hybridization; **d.** nitrification.

36. The main structures of the flower are: petals, sepals, ___________, pistil, and receptacle.

a. fruit; **b.** nectar; **c.** tissue; **d.** stamen.

37. Grain crops represented by such plants as wheat, corn, rice, rye, ___________ , sorghum, millet, oat.

a. carrot; **b.** bean; **c.** barley; **d.** beet.

PART 2
ANIMALS

Subject 10. The study of Protozoa species diversity

Objectives:

- to get acquainted with a diversity of Protozoa specimens;
- to comprehend biological peculiarities of some Protozoa species, their ecological role and make the comparative analysis.

Materials: standard microscopic equipment, dropper, dissecting needle, slides and cover glasses, filter paper, chemical glass, 10 % methyl cellulose solution, yeast, fresh pond water, placards, identification guide books.

Features of Protozoa

Protozoans are eukaryotic, unicellular, heterotrophic organisms. These are microscopic animals, varying in size from less than 0,005 mm (*Leichmania tropica*) to those which are just visible to the unaided eye (*Porospora gigantea*).

Diversity of Protozoa

Scientists traditionally classify protozoans as animals and place them in the subkingdom Protozoa. However, many scientists group protozoans as neither animals nor plants. They place protozoans with other simple organisms in the kingdom Protista. The most prevalent is classification by which protozoans separated in 5 phyla subkingdom Protozoa:

1) Sarcomastigophora (Subphyla *Sarcodina*: *Amoeba proteus, Entamoeba histolytica, Elphidium crispa, Thalassicola nucleata, Clathrulina elegans* etc; Subphyla *Mastigophora*: *Bobo edox, Trihomonas hominis, Lamblia intestinalis, Trypanosoma gambiense, Leishmania tropica, Leptomonas davidi* etc);
2) *Sporozoa* (*Corycella armata, Eimeria magna, Toxoplasma gondii, Plasmodium vivax, P. malaria* etc);
3) *Cnidosporidia* (*Myxosoma celebralis, Myxobolus cyprini* etc);
4) Microsporidia (*Nosema apis, N. bombycis* etc);
5) *Ciliophora* (*Paramecium caudatum, Vorticella nebulifera*, *Stentor coeruleus*, *Dinidium nasutum, Balantidium coli, Ichthyophthirius multifiliis* etc) (fig. 10.1).

Ecology and Importance of Protozoa

The species of protozoans are found throughout the world in both fresh and salt waters; they also abundant in soil and some are parasites of animals.

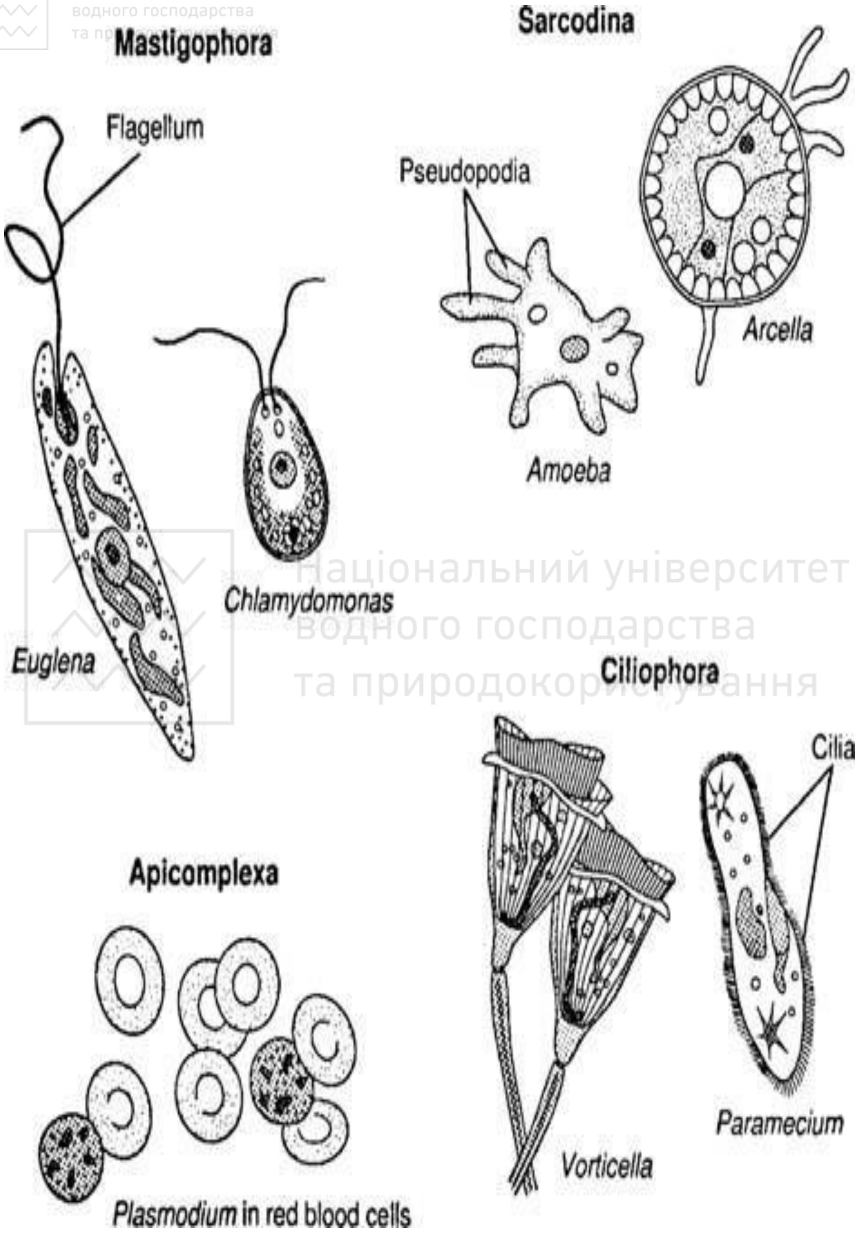

Fig. 10.1. Representatives of Protozoa

Parasitic species such as *Entamoeba histolitica* causes amoebic dysentery in humans.

Among the diseases for which trypanosomes are responsible are trypanosomiasis (sometimes called "sleeping sickness") causes by *Trypanosoma brucei gambience* causes, Chagas' disease causes by *Trypanosoma cruzi,* all of great importance in tropical areas. The trypanosomes that cause these diseases are spread by biting insects, including tsetse flies. A serious effort is now under way to produce a vaccine for trypanosoma – caused diseases, which deprive a large portion of Africa of meat and milk from domestic cattle and thus pose a serious obstacle to the alleviation of hunger there with high – quality food.

Also we must name the malarial parasite, *Plasmodium*. As for people, the most pathogenic are such species as *Plasmodium vivax, P. malariae, P. falciparum*. They are spread from person to person by mosquitoes of the genus *Anopheles*; at least 65 species of this genus are involved. Malaria, caused by the infections by the *Plasmodium*, is one of the most serious diseases in the world. About 100 million people are affected by it at any one time, and approximately 1 million of them, mostly children, die each year.

Millions of protozoans swim in the sea, where they are eaten by sea animals.

Some protozoans, such as the foraminifera (often informally called "forams"), are covered with pore-studded shells (called tests) composed of organic materials usually reinforced with grains of inorganic matter. Forams have contributed massive accumulations of their tests to the fossil record for more than 200 million years. Because of the excellent preservation of their tests and the often striking differences among them, forams are very important as geological markers. The pattern of occurence of different forams, for example, is often used as a guide in searching for oil-bearing strata. Limestones all over the world are often rich in forams, and the White Cliffs of Dover, the famous landmark of southern England, are made up almost entirely of their tests.

Practice

1. Examine fresh pond – water microscopically for different types of protozoans.
2. Investigate the movement of Amoeba, and of other types of

protozoans under the microscope – the movements of Paramecium etc can be slowed down by adding a drop of 10 % methyl cellulose solution.

3. Examine the feeding currents of Paramecium in a dilute suspension of yeast.
4. Read further about other protozoa, particularly about those that cause disease.
5. Fill in the table:

Typical indications	*Amoeba proteus*	*Trypanosoma brucei gambiense*	*Toxoplasma gondii*	*Paramecium caudatum*
Body form				
Movement				
Nutrition				
Contractile vacuole				
Nucleus apparatus				
Reproduction				
Existence conditions				

<u>Subject 11.</u> The study of biological and ecological features of Worms specimens from different phyla

<u>Objectives:</u>

- to get acquainted with a diversity of Worms specimens;
- to comprehend biological peculiarities of Flatworms, Roundworms, Segmented worms species, their ecological role and make the comparative analysis.

<u>Materials:</u> standard microscopic equipment, lens, dropper, dissecting needle, slides and cover glasses, filter paper, chemical glass, dish, microscope slides, soil, distilled water, glass container, placards, identification guide books.

General characteristics

Phylum *Platyhelminthes*

The flatworms (phylum *Platyhelminthes*) consist of some 12000 species. These animals so called because they are flattened dorsoventrally, from top to bottom. Flatworms are among the simplest of bilaterally symmetrical animals, but they have a definite head at the anterior end. Their bodies are solid: the only internal space consists of the digestive cavity.

Flatworms range in size from a millimeter or less to many meters long, as in some of the tapeworms.

Flatworms lack circulatory system, and most of them have a gut with only one opening. They excrete wastes directly from the gut, but also by means of a network of fine tubules that has ciliated flame cells on the side branches. Their nervous systems are simple.

The reproductive systems of flatworms are complex. Most flatworms are hermaphroditic; in many of them, fertilization is internal. Flatworms are capable of asexual regeneration (fig. 11.1).

Phylum *Nemathelminthes*

The pseudocoelomates comprise a large phylum, *Nemathelminthes*, with some 16000 recognized species. They are bilaterally symmetrical, cylindrical, unsegmented worms. The pseudocoelomates were the first animals to possess an internal body cavity (that develops between the mesoderm and endoderm). Among many other advantages, this cavity makes the animal's body rigid, permitting resistance to muscle contraction and thus opening the way to muscle-driven movement. The pseudocoelomates lack a defined circulatory system; its role is performed by the fluids that move within the pseudocoel. They also lack a respiratory system. All pseudocoelomates have a complete, one-way digestive tract. Reproduction is sexual, with the sexes usually separate. Sometimes are hermaphroditic. Fertilization is internal (fig. 11.2).

Phylum *Annelida*

The annelids (phylum *Annelida*), one of the major animal phyla, are segmented, bilaterally symmetrical, protostome coelomates; internally the segments are divided from one another by partitions called septa**.**

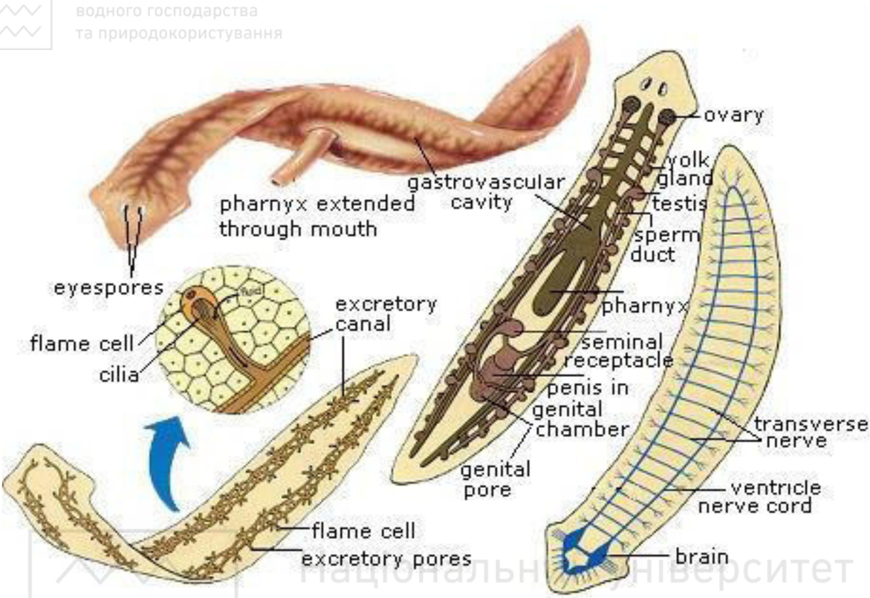

Fig. 11.1. Diagram of flatworm anatomy

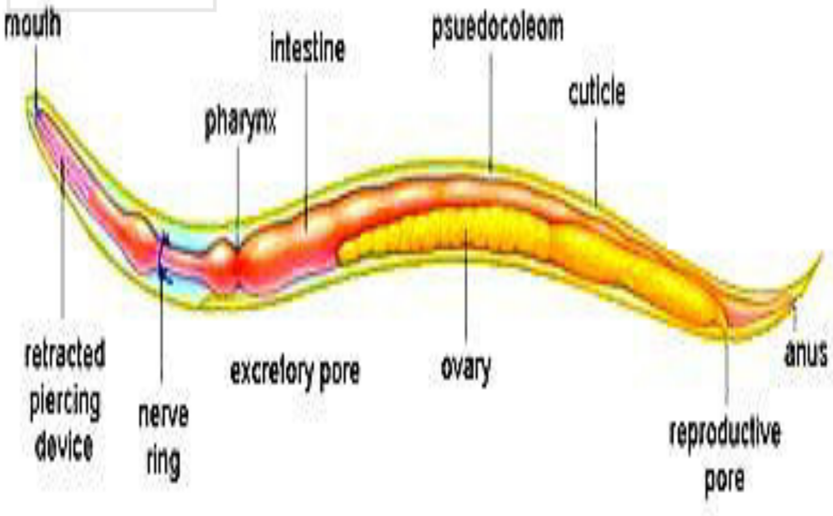

Fig. 11.2. Structure of the roundworm

The basic body plan of the annelides is a tube within a tube, with the internal digestive tract suspended within the coelom. Each segment of an annelid typically possesses setae, that help to anchor the worms during locomotion or when they are in their burrows. They are absent in the leeches.

The members of this phylum have a well-developed cerebral ganglion, or brain, in one of the anterior segments. Also they have a closed circulatory system. The annelids exchange oxygen and carbon dioxide with the environment through their body surfaces; they lack gills, lungs, and similar organs. The excretory system of the annelids consists of ciliated, funnel-shaped nephridia. Reproduction is sexual or asexual; some annelids have distinct male and female individuals others are hermaphroditic (fig. 11.3).

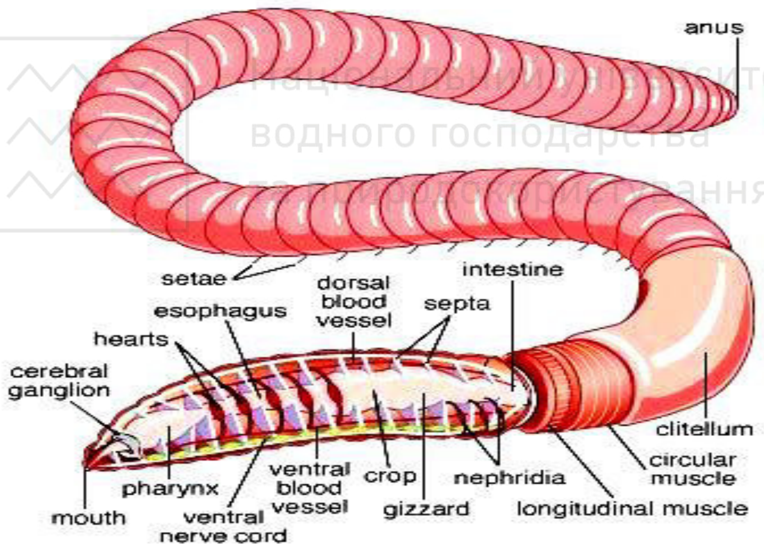

Fig. 11.3. An earthworm: external view with a longitudinal section showing the anatomy in simplified form

The roughly 12000 described species of annelids occur in many different habitats. They range in length from as little as 0,5 millimeter to more than 3 meters in some giant Australian earthworms.

Diversity

Phylum *Platyhelminthes*

There are three main classes of flatworms:

Class *Turbellaria.*

Turbellarians (*Dendrocoelum lacteum, Thysanozoon brochii* etc) are free-living flatworms; they move from place to place by means of their ciliated epidermis, and have eyespots, which are absent in their parasitic relatives.

Class *Trematoda.*

Flukes (*Clonorchis sinensis, Fasciola hepatica* etc) are parasitic flatworms with a digestive tract, and often complex life cycles that involve two or more hosts.

Class *Cestoda.*

Tapeworms (*Taenia saginata, Diphyllobotrium latum* etc) are parasitic flatworms that lack a digestive tract and absorb food through their body walls; complex life cycles.

Phylum *Nemathelminthes*

Among main classes of this phylum are:

Class *Gastotricha* (*Chaetonotus maximus, Macrodasys buddenbrock* etc).

Class *Nematoda* (*Trichoderma minutum, Placentonema gigantissima, Enterobius vermicularis, Ascaris lumbricoides, Acrobeles complexus* etc).

Class *Rotatoria* (*Asplanchna priodonta, Lindia brotzkayae, Stephnoceros fimbriatus, Brachionus diversicornis* etc).

Class *Acanthocephala* (*Macrocanthorhynchus hirudinaceus* etc).

Phylum *Annelida*

There are three main classes of annelids:

Class *Polychaeta*, which are free-living, almost entirely marine bristleworms, comprising some 8000 species (*Sabella melanostigma, Oenone fulgida*, *Nereis diversicolor* etc);

Class *Oligochaeta*, the terrestrial earthworms and related marine and freshwater worms, with some 3100 species (*Aeolosoma hemprichi, Tubifex tubifex, Lumbricus terrestris* etc);

Class *Hirudinea*, the leeches, mainly freshwater predators or bloodsuckers, with about 500 species (*Piscicola geometra, Limnatis nilotica, Hirudo medicinalis* etc).

Ecology and Importance

Flatworms (phylum *Platyhelminthes*)

Most species of flatworms are parasitic; they occur within the bodies of members of many other kinds of animal. A number of other kind flatworms, however, are free living, occurring in a wide variety of marine and freshwater habitats, as well as moist places on land. Free-living flatworms are carnivores and scavengers; they eat various small animals and bits of organic debris. They move from place to place by means of their ciliated epithelial cells, which are particularly concentrated on their lower surfaces.

To human being, one of the most important flatworms is the human liver fluke, *Clonorchis sinensis*, which lives in the bile passages of the liver of humans, cats, dogs, and pigs. An individual fluke may live for 15 to 30 years in the liver. In humans a heavy infestation of liver flukes may cause cirrhosis of the liver and dearth.

Other very important flukes are the blood flukes of genus *Schistosoma*, which afflict about 1 in 20 of the world's population, more than 300 million people throughout tropical Asia, Africa, Latin America, and the Middle East. Three species of *Schistosoma* cause the disease called schistosomiasis or bilharzia. Some 800000 people die each year from this disease.

Tapeworms live as parasites like flukes. The beef tapeworm, *Taenia saginata*, occurs as a juvenile primarily in the intermuscular tissue of cattle but as an adult in the intestines of human beings. When beef of infected cattle is eaten rare, infection of human beings by these tapeworms is likely to result. As a result, the beef tapeworms is quite frequent as a human parasite.

As for turbellarians, they are free living and one of the most familiar is the freshwater genus *Dugesia*, the common planaria, which is used worldwide in biology laboratory exercises.

Phylum *Nemathelminthes*

The members of this phylum are ubiquitous. *Nemathelminthes* are abundant and diverse in marine and freshwater habitats, and many members of this phylum are parasites of vertebrates, invertebrate, and plants. Many pseudocoelomates are microscopic animals that live in soil. Some of these worms live in environments that are very hot, dry, cold, or salty; when these conditions occur seasonally, they may be able to avoid them by entering a dormant state. As for nematodes, some of these animals are being investigated as agents of biological control of insects and other agricultural pests.

Pinworms, *Enterobius*, are parasites of people and where it is estimated they infect about 30 % of all children and about 15 % of adults. Adult pinworms live in the human large intestine and blind gut. These worms can easily be controlled by drugs.

The intestinal roundworm, *Ascaris*, infects approximately one of six people worldwide but is rare in most areas with modern plumbing. Various species of this genus parasitize other animals.

The most serious common nematode-caused disease in temperate regions is trichinosis, caused by worms of the genus *Trichinella*. Infection in human beings or other animals arises from eating undercooked or raw pork in which the cysts of *Trichinella* are present.

Other nematode-caused diseases are extremely serious in the tropics. *Filaria* cause filariasis, which infects at least 250 million people worldwide. These worms live in the lymphatic system, which they may seriously obstruct, causing potentially severe inflammation and swelling.

Phylum *Annelida*

Polychaetes live in such places as in burrows, under rocks, in tubes of hardened mucus that they manufacture, and inside shells. They are often a crucial part of marine food chains, being extremely abundant in certain habitats. A number of polychaetes are commensal; they live inside sponges, in the shells of mollusks, within echinoderms or crustaceans, and in other animals, eating the food particles left over by these organisms. A very few of these worms are parasites; some are active predators.

Oligochaetes include terrestrial earthworms and related marine and freshwater worms. The importance of earthworms in maintaining soil fertility was noted many hundred years ago. They aerate and enrich the soil.

Leeches occur mostly in fresh water, although a few are marine and some tropical leeches occur in terrestrial habitats. Most leeches are predators or scavengers, but some have evolved the habit of sucking blood from mammals, including humans, and other vertebrates. Many freshwater leeches live as external parasites, remaining on their hosts for long periods and sucking their blood from time to time. The best known leech is the *Hirudo medicinalis*, which is now used as asourse of anticoagulant, which is used in research into blood clotting. The animal is still widely collected by European pharmaceutical companies for this purpose – to remove excess blood following operations and against atherosclerosis and trombosis. As a result of their harvest, leeches are becoming rare in certain areas.

Practice

1. Collect planarians from beneath stones in streams. Investigate their response to light; examine their method of feeding with small pieces of meat. Place a planarian in a dish of distilled water; cut the animal across into halves and keep the dish in a cool dark place – examine daily for signs of generation.
2. Examine with a lens whole specimens and microscope slides of parasitic worms including tapeworms. Note carefully any features which might be considered as adaptations to a parasitic life.
3. Set up a wormery. Three-quarters fill a glass container with damp soil, place several worms on the soil and cover with dead leaves. Keep the wormery in a dark place. At intervals investigate the effect of the worms on the soil and on the leaves; also examine the activities of the worms seen through the glass sides.
4. Place an earthworm on damp blotting paper in a dish and investigate the animales movement.
5. Place a leech in a dish of water. Observe its movements; how do they differ from those of an earthworms?
6. Read further about parasitic worms and their method of transference from host to host, read further about ecological and economic importance of segmented worms.
7. Fill in the table:

Species Name	Type	Body Structure and Movement	Digestive System	Excretory System	Respiratory System	Circulatory System	Nervous System	Reproductive System	Life Cycle	Existence Conditions	Ecological and Economic Importance
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*

Subject 12. The determination of general and distinguishing features of biological and ecological characteristics of Arthropods specimens from different classes. The study of Insects species diversity

Objectives:

- to get acquainted with a diversity of Arthropods specimens;
- to comprehend biological peculiarities of Arthropod Phylum;
- make the comparative analysis of biological and ecological peculiarities of specimens from different Insect Orders.

Materials: lens, dissecting needle, microscope slides, placards, identification guide books.

General characteristics of Arthropods

Arthropods are the most successful of all animals in terms of numbers of individuals and species, as well as terms of ecological diversification. Approximately 900000 species described and many more to be found – about two thirds of all the named species on earth – are members of this gigantic phylum.

The great majority of arthropod species consist of small animals – mostly about a millimeter in length – but members of the phylum range in adult size from about 80 micrometers long (some parasitic mites) to 3,6 meters across (a gigantic crab found in the sea off Japan).

The name "*arthropod*" comes from two Greek words, "*arthros*", jointed, and "*podes*", feet. We recognize the members of this phylum, especially because of their jointed appendages. The numbers of these appendages are progressively reduced in the more advanced members of phylum, and their nature differs greatly in different subgroups. Thus individual appendages may be modified into antennae, mouthparts of various kinds, or legs. Still others – the wings of certain insects, for example – are not homologous to the other appendages of arthropods; insect wings evolved separately.

Arthropod bodies are segmented like those of annelids, a phylum to which at least some of the arthropods are clearly related. The members of some classes of arthropods have many body segments. In others, the segments have become fused together into functional groups, or tagmata (singular, tagma), such as the head or thorax of an insect, by a process known as tagmatization, which is of central importance in the evolution of the arthropods. All arthropods have a distinct head, sometimes fused with the thorax to form a tagma called cephalothorax.

The arthropods have a rigid, chitinous exoskeleton, a horny material secreted by the epidermis. Arthropods periodically undergo ecdysis. The exoskeleton protects arthropods from water loss and helps to protect them from predators, parasites, and injury.

An important structure of many arthropods is a compound eye.

The circulatory system of arthropods is open; their blood flows through cavities between the internal organs and not through closed vessels.

The respiratory system of terrestrial arthropods consists of a network of tubes called tracheae that transmits oxygen from the outside to the organs; external tracheal openings are controlled by opening and closing spiracles. Many spiders and some other chelicerates have a unique system of respiration that involves book lungs, a series of leaflike plates within a chamber into which air is drawn and from which it is expelled by muscular contraction. One small class of marine chelicerаters, the horseshoe crabs, have book gills, which are analogous to book lungs but function in water. The crustaceans lack such structures and have gills.

There are various kinds of excretory systems in different groups of arthropods. As for terrestrial arthropods they eliminate metabolic waste by a unique system of Malpighian tubules that extend from the digestive tract into the blood. Fluid enters the tubes, waste is precipitated, and the fluid is reabsorbed, passing out through the tube walls back into the body cavity.

The central feature of the arthropods nervous system is a double chain of segmented ganglia running along the animal's ventral surface. At the anterior end of the animal are three fused pairs of dorsal ganglia, which constitute the brain. However, much of the control of an arthropod's activities is relegated to ventral ganglia.

Reproduction in all arthropods is sexual. Most have separate sexes and a few are hermaphroditic.

Most members of this phylum change their characteristics as they develop from stage to stage, a process called metamorphosis.

Diversity of Arthropods

Arthropods consists of three subphyla:

1. Subphylum *Chelicerata*: scorpiones, spiders, mites, horseshoe crabs, sea spiders (*Euscorpius tauricus, Lactrodectus tredecimguttatus, Ixodes ricinus,* etc). About 60000 species.
2. Subhylum *Crustacea*: crabs, lobsters, shrimps, barnacles, beach

fleas, and many others (*Triops cancriformis, Daphnia pulex, Eriphia verrucosa, Astacus astacus,* etc). About 35000 species.

3. <u>Subhylum *Tracheata (Uniramia)*</u>: insects, centipedes, and millipedes (*Sarmatoiulus kessleri, Leus dunlopi, Blettella germanica, Gryllotalpa gryllotalpa, Locusta migratoria, Melolontha melolontha, Leptinotarsa decemlineata,* etc). More than 800000 described species (fig. 12.1).

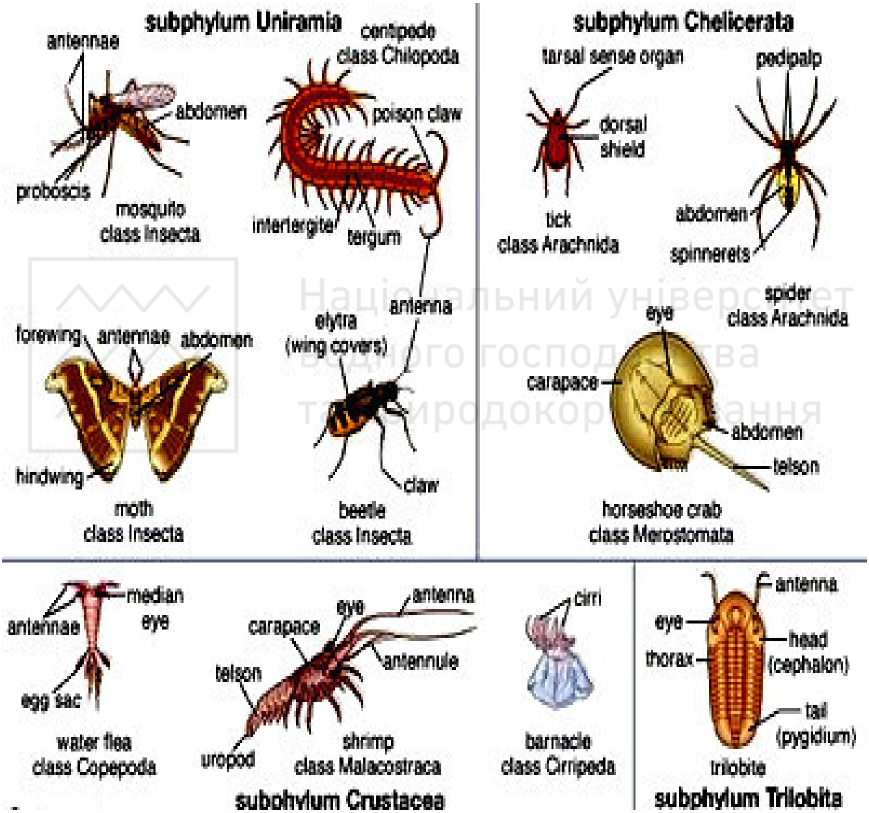

Fig. 12.1. Some common Arthropods

<u>The Ecology and Economic Importance of Arthropods</u>

We will focus here on the ecology only of some arthropods from different classes and orders.

As for arachnids most of them are carnivorous, although the mites are largely herbivorous. Arachnids occur primarily in terrestrial habitats. But not all arachnids live on land; some 4000 known species of mites and one species of spider live in fresh water, and a few mites live in the sea. Arachnids breathe by means of tracheae, book lungs, or both.

There are some 1200 species of scorpions, all terrestrial, which occur throughout the world, although they are more common in tropical, subtropical, and desert regions.

Spiders play a major role in virtually all terrestrial ecosystems, where they are particularly important as predators of insects and other small animals. Spiders hunt their prey or catch it in webs of remarkable diversity that have constructed.

Some members of this order (*Araneae*), such as the black widow and brown recluse, have bites that are poisonous to humans and other large mammals.

Mites are very diverse in their habits. They are found in virtually every terrestrial, freshwater, and shallow marine habitat known and feed on fungi, plants, and animals; they act as predators and as internal and external parasites of both invertebrates and vertebrates.

Many mites are well known to human being because of their irritating bites and the diseases that they transmit. Follicle mites live in the hair follicles and wax glands of the human forehead, nose, and chin, but usually cause no symptoms. Other mites cause mange in dogs and cats, often with severe consequences. A number of species of mites can cause house-dust allergy, which is aggravating to millions of people throughout the world; they are inhaled along with dust. The larvae of some species of chiggers, inflict annoying bites on human skin.

Ticks, which are also members of this order, are blood-feeding ectoparasites-parasites that occur on the surface of their host – of vertebrates. They are larger than most other mites and cause discomfort directly by sucking the blood of human beings and other animals. Some of them also inject toxins into their hosts. A few ticks of this kind are known to cause paralysis in people they bite. Ticks are also carriers of many diseases, including some caused by viruses, bacteria, and even protozoa. In addition to the diseases they cause in humans and other animals, mites cause extensive and often severe damage to plants. The group known as spider mites, or red spiders, are often the most serious pests of houseplants. Mites of this group also damage many crops. On the positive side, in recent years mites have been used as agents of biological control: certain mites attack harmful insects or other mites and have been introduced to control their numbers and therefore the harmful effects of their prey.

Most daddy longlegs are predators of insects, other arachnids, snails, and worms, but some live on plant juices and many scavenge dead animal matter. These animals best represented in the tropics of Asia and South America.

Sea spiders are relatively common, especially in coastal waters. They are found in oceans throughout the world but are most abundant in the far north and far south. Adult sea spiders are mostly external parasites or predators of other animals, including sea anemones.

The crustaceans, a group of primarily marine and fresh water arthropods that includes crabs, lobsters, shrimps, and related animals, are important as sources of human food.

The centipedes, of which some 2500 species are known, are all carnivorous and feed mainly on insects. The appendages of the first trunk segment are modified into a pair of poison fangs. The poison is often quite toxic to human beings, and many centipede bites are extremely painful, sometimes even dangerous.

In contrast, most millipedes are herbivores, feeding mainly on decaying vegetation; a few millipedes are carnivorous, like the centipedes.

Millipedes live primarily in damp, protected places, such as under leaf litter, in rotting logs, under bark or stones, or in the soil.

Insects live in every conceivable habitat on land and in fresh water, and a few have even invaded the sea. They are of enormous economic importance and affect all aspects of human life. They compete with humans for food of every kind and cause billions of dollars of damage to crops, both before and after harvest. They are by far the most important herbivores in all terrestrial ecosystems; virtually every kind of plant is eaten by one or many species of insect. Insects also prey on, parasitize, or otherwise obtain food from most kinds of animals. The diseases that they spread cause enormous financial damage each year and strike every kind of domesticated animal and plant, as well as human beings (fig. 12.2).

On the positive side, the pollination of certain crops by insects is of key significance, as is their role in controlling other insects and weeds. A

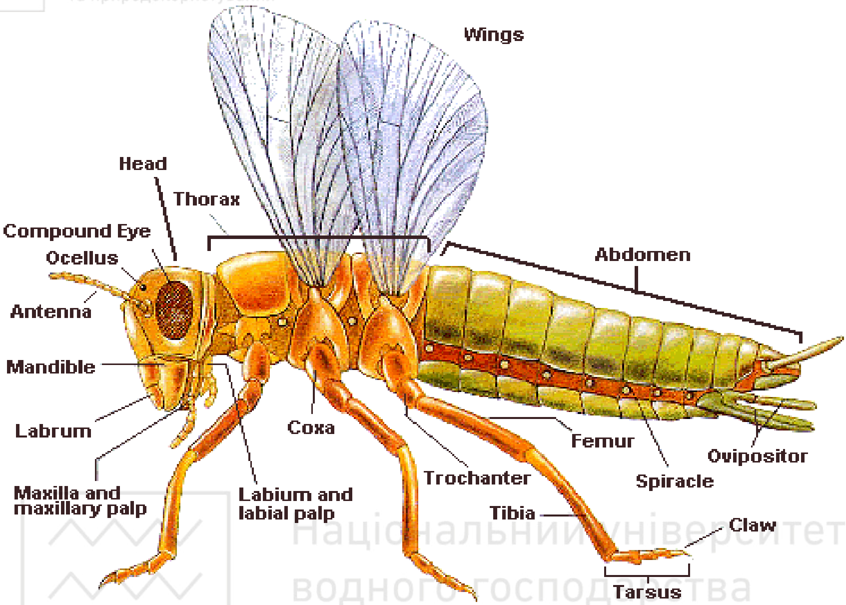

Fig. 12.2. Structure of Insect body

number of products, such as silk and honey, are produced directly by insects.

Insects and other arthropods are important elements in recycling organic matter within the soil and elsewhere, and herbivores play an especially important role in this process. At normal population levels, insects and other arthropods in the ecosystem speed the cycling of nutrients, have little effect on the amount of living plant material, and strongly influence the stock of dead and decaying organic matter. These are only a very few of the ways in which arthropods are involved in human welfare.

Practice

1. Look through the collection of insects, both adults and larvae. Identify species from different orders.
2. Examine external features of grasshopper and lobster.
3. Research two principal kinds of metamorphosis in insects and illustrate with the examples.

<u>Subject 13.</u> The determination of characteristic features of Chordates. The study of general and distinguishing features of biological and ecological characteristics of principal classes of living vertebrates

<u>Objectives:</u>

- to comprehend principal features which characterize the chordates;
- to get acquainted with a diversity of living vertebrates.

<u>Materials:</u> placards, skeletons, *plaster casts*, identification guide books.

<u>Characteristic Features of Chordates</u>

The chordates (phylum Chordates) are the best known and most familiar group of animals. There are some 42500 species of chordates.

Three principal features characterize the chordates: a) a single, hollow nerve cord, which runs just beneath the dorsal surface of the animal; b) a flexible rod, the notochord, which forms on the dorsal side of the primitive gut in the early embryo and is present at some stage of the life cycle in all chordates. The nerve cord is located just above the notochord. In adult vertebrates, as we will see, the notochord is replaced by a vertebral column that forms around it; c) pharyngeal slits. These connect the pharynx, a muscular tube that connects the mouth cavity and the esophagus with the outside. In most vertebrates, the slits do not actually connect to the outside and are better termed pharyngeal pouches.

<u>*Diversity of* Chordata</u>

There are three subphyla of chordates.

1. <u>Subphylum *Urochordata*</u>: tunicates (*Salpa maxima, Thalia democratica, Halocynthia roretzi,* etc). About 1250 species of marine animals.
2. <u>Subphylum *Cephalochordata*</u>: lancelets (*Branchiostoma lanceolatum, Br. belcheri* etc). About 23 species.
3. <u>Subphylum Vertebrata</u>. About 43700 species.

<u>General Characteristics of Vertebrates</u>

Vertebrates (subphylum *Vertebrata*) differ from other chordates in that they usually possess a vertebral column, for which the group is named. This column replaces the notochord to a greater or lesser extent in different members of the subphylum. The individual bony segments that make it up are called vertebrae. In addition, the vertebrates have a distinct head with a skull (cranium) and brain; as a result, they are sometimes called the craniate chordates. The hollow dorsal nerve cord of most vertebrates is protected within a U-shaped groove formed by paired projections from the vertebral column.

Diversity of *Vertebrata*

There are seven principal classes of living vertebrates.

1. Class *Agnatha.*

Agnathans; lampreys and hagfishes (*Myxine glutinosa, Petromyzon marinus* etc). Naked, eel-like, jawless fishes with a cartilaginous skeleton; the agnathans lack scales, bones, and fins. Parasites on other fishes, or scavengers. About 63 species.

2. Class *Chondrichthyes*

Sharks, skates, and rays (*Galeocerdo cuvieri, Torpedo marmorata, Chimaera monstrosa* etc). Almost entirely marine fishes with a cartilaginous skeleton, efficient fins, complex copulatory organs, and small, pointed scales (denticles); but lacking air bladders. About 850 species.

3. Class *Osteichthyes*

Bony fishes (*Huso huso, Cyprinus carpio, Esox lucius* etc). The members of this class, which are abundant both in the see and fresh water, have bony skeletons, efficient fins, scales, and usually air bladders (by means of which they regulate their density and therefore their level in the water). More than 18000 species (fig. 13.1).

4. Class *Amphibia*

Salamanders, frogs, and toads (*Salamandra salamandra, Triturus vulgaris, Rana ridibunda* etc). Tetrapod, egg-laying, ectothermic vertebrates that lack scales; amphibians respire with gills as larvae and with lungs as adults. They have incomplete double circulation. Amphibians were the first terrestrial vertebrates; they still depend on a moist environment for at lest a portion of their life cycles. About 2800 species.

5. Class *Reptilia*

The reptiles; lizards, snakes, turtles, and crocodiles (*Chamaeleo chamaeleon, Lacerta vivipara, Natrix natrix, Emys orbicularis, Crocodylus niloticus* etc). Tetrapod, ectothermic vertebrates with an amniotic egg; reptiles have lungs and are covered with scales; most are fully terrestrial, although some are aquatic. Reptiles have incomplete double circulation. The four legs are absent in snakes and some lizards. Nearly 6000 species (fig. 13.2).

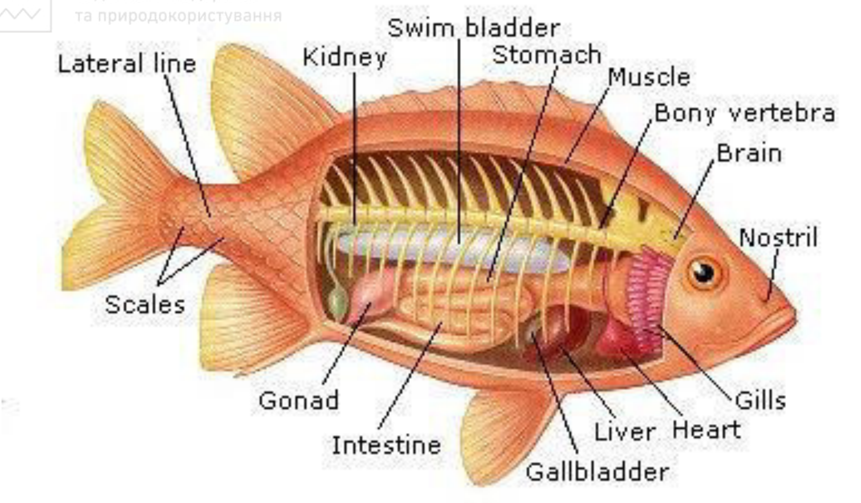

Fig. 13.1. Body Structure of Fish

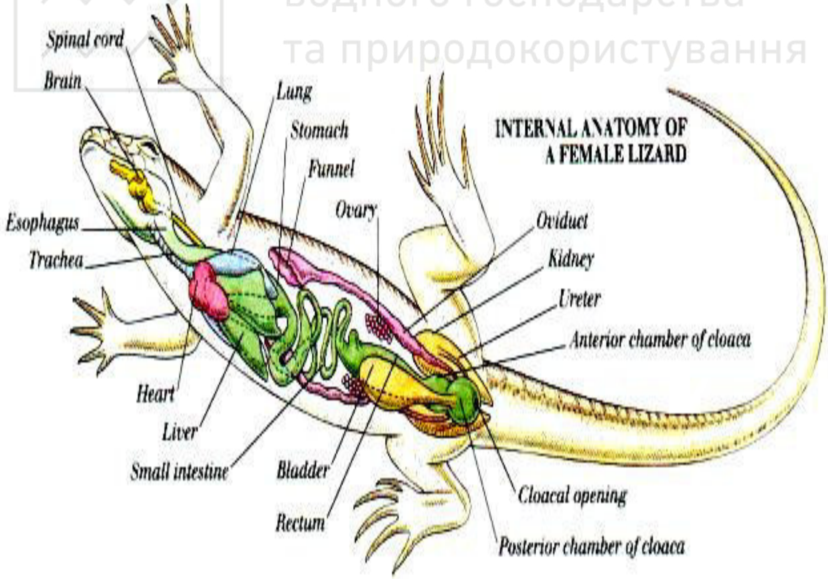

Fig. 13.2. Body Structure of Lizard

6. Class *Aves*

Birds (*Aptenodytes patagonica, Anser anser, Aquila chrysaetus, Picus viridis, Grus grus* etc). Tetrapod, endothermic vertebrates in which the forelimbs are modifed into wings; most are capable of flight, and all lay amniotic eggs. Birds have lungs and are fully terrestrial, although some live in water. They have complete double circulation; feathers are a characteristic feature of the class. About 9000 species.

7. Class *Mammalia*

Mammals (Tachyglossus aculeatus, Macropus major, Erinaceus europaecus, Vespertilio murinus, Bradypus tridactylus, Lepus europaecus, Castor fiber, Mus musculus, Balaenoptera musculus, Tursiops truncatus, Canis lupus, Odobenus rosmarus, Loxodonta africana, Camelus bactrianus, Sus scrofa, Equus caballus, Pan troglodytes etc). Tetrapod, endothermic vertebrates with complete double circulation and usually hairy skins. The forelimbs are modified into wings in bats, and all four limbs are modified into flippers in some aquatic mammals. Monotremes lay eggs; marsupials retain their young in a marsupium, or pouch, for a prolonged period; and the great majority of mammals – the placental mammals – nourish their young in the womb by means of a specialized structure, the placenta, modified from the amniotic egg characteristic of their ancestors (fig.13.3).

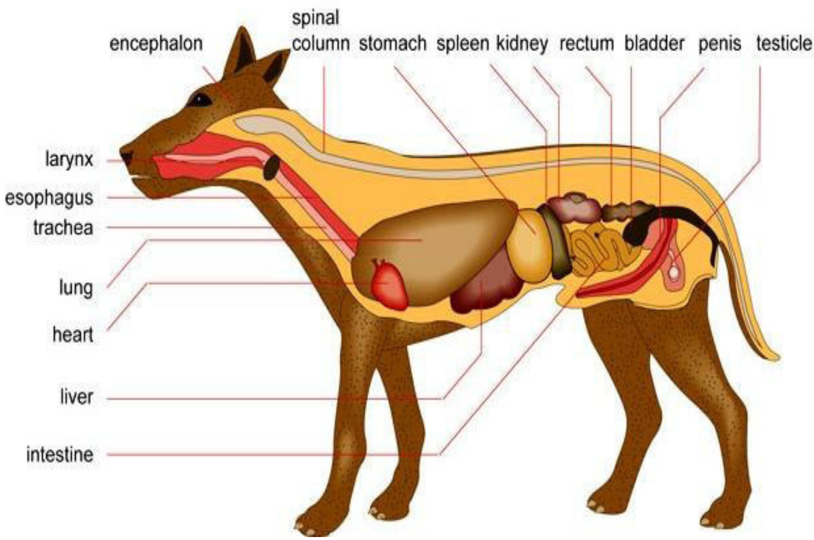

Fig. 13.3. Structure of Dog body (Class Mammals)

Placental mammales very successful group of a land animals. What does this success mean? It means that, taken as a group, mammals are able to occupy a flourish in a great range of physical and climatic conditions. They are found in the rarified atmosphere of high mountains ranges and also, like the whole when diving, several hundreds of feet below the surface of the sea. They can live in the permanent snows of the polar ice cap, or in steamy hot tropical rain forest. They can live permanently in fresh or salt water, are in regions where there is no fresh water at all. Together with the birds, the have become independent or external physical conditions to a grate extent than any other group of animals. About 4500 species.

Practice

1. Collect spawn in spring and study.
2. Make the comparative analysis of biological and ecological peculiarities of specimens from different classes of living vertebrates.
3. Fill in the table:

System	Functions	Components
Circulatory		
Digestive		
Endocrine		
Urinary		
Immune		
Integumentary		
Muscular		
Nervous		
Reproductive		
Respiratory		
Skeletal		

<u>Subject 14.</u> The study of peculiarities to organize the individual ecological groups of animals and their dependence on specific ecological factors

<u>Objectives:</u>

- to get acquainted with animals' ecological groups variety;
- to determine the organization peculiarities of different ecological group representatives;
- to analyze the dependence of these peculiarities on specific ecological factors.

<u>Materials:</u> placards, identification guide books.

<u>Basic principles</u>

Animals' ecological groups, like plants' are rather various and they are also singled out with respect to different ecological factors.

Sunlight is not so necessary factor for the animals, as for the plants. However, visible spectrums' part of solar radiation plays an important role in animals' life. Different species of animals need light of definite spectral composition, intensity and duration. Deviations from the standard depress their vital activity and cause their death.

With animals' respect to light two extreme ecological groups may be singled out – photophiles and photophobes.

Photophiles are photophilous animals for which light presence is a condition of their normal vital activity. As a rule, these organisms have a day mode of life, their organs of sight are well – developed and able to black-and-white and colour vision. Most of animals belong to this group. Photophobes are animals that, avoid bright light. Majority of cavernicolous, soil animals and those which lead an underground mode of life are members of them. Crepuscular animals also belong to this group. Photophobic animals either have not organs of sight in general or these organs are very reduced. These animals are not able to colour vision.

As for temperature ecological groups like cryophils and thermophils are single out. Cryophils are animals, able to keep their activity at cells' temperature up to -8…10^0 C. They are characterized by the definite chemical compound peculiarities of cells and physiological processes peculiarities of their organs. Thermophils are animals vital activity optimum of which lies in the field of high temperatures. The thermophilia is characteristic for nematodes, majority insects' larvas and other animals. They live in dry areas mainly or in organic remains that are self -warming.

According to their ability to keep their temperature, animals are divided into two groups: poikilothermal (cold-blooded) and homoiothermal (warm-blooded). Poikilotherm having a body temperature that varies with the temperature changes of the environment. A cold-blooded animal relies on heat from its environment to keep the right temperature for life processes. Most of animals belong to this group. Homoiotherms maintaining a nearly constant body temperature not influenced by the temperature of the surroundings. The warm-blooded animals make up two classes, birds and mammals. Both have internal systems and external coverings that help them generate and hold body heat. They also have the means to cool themselves by eliminating excess body heat. It is necessary to note that warm-blooded animals have high metabolism level and body temperature regulation takes place because of physical (alternation of heat exchange level), chemical (heat production increase) or behavioral mechanisms.

Practice

1. Having looked in the recommended books, get acquainted with animal ecological groups diversity.
2. Comprehend organization peculiarities of the given representatives from different ecological groups.
3. Fill in the table:

Ecolo-gical group	Ecological Peculiari-ties of Existence Conditions	Morpholo-gical and Anatomical Peculiarities of Species	Physiological and Other Peculiarities of Species	Species Name
1	*2*	*3*	*4*	*5*

TEST 2

Write the letter of the correct answer in the blank.

1. Protozoans are ____________, unicellular, heterotrophic organisms.
   a. warm-blooded; **b.** eukaryotic; **c.** gigantic; **d.** vertebral.

2. Malaria, caused by the infections by the __________, is one of the most serious diseases in the world.
   a. *Spirulina*; **b.** *Plasmodium*; **c.** *Paramecium*; **d.** *Aspergilus.*

3. Turbellarians are _____________flatworms.
   a. free-living; **b.** parasitic; **c.** unicellular; **d.** annelids.

4. One of the most familiar turbellarians is the freshwater genus *Dugesia*, the common __________, which is used worldwide in biology laboratory exercises.
   a. planaria; **b.** malaria; **c.** insect; **d.** spider.

5. Approximately 900000 species described and many more to be found – about two thirds of all the named species on earth – are members of _________ phylum.
   a. Vertebrates; **b.** Arthropods; **c.** Protozoans; **d.** Chordates.

6. The respiratory system of terrestrial arthropods consists of a network of tubes called ________that transmits oxygen from the outside to the organs.
   a. stomach; **b.** tracheae; **c.** glands; **d.** liver.

7. Subphylum Chelicerata: scorpiones, __________, mites and many others. About 60000 species.
   a. spiders; **b.** shrimps; **c.** centipedes; **d.** insects.

8. Subhylum Crustacea: crabs, lobsters, ____________, barnacles, beach fleas, and many others. About 35000 species.
   a. spiders; **b.** shrimps; **c.** centipedes; **d.** insects.

9. Subhylum Tracheata: insects, __________, and millipedes More than 800000 described species.
   a. spiders; **b.** shrimps; **c.** centipedes; **d.** turbellarians.

10. Three principal features characterize the _________: a single, hollow nerve cord, a flexible rod, the notochord, pharyngeal slits.

a. Protozoans; **b.** Nemathelminthes; **c.** Arthropods; **d.** Chordates.

11. Pituitary, adrenal, thyroid, and other ductless glands are the components of system.

a. circulatory; **b.** endocrine; **c.** integumentary; **d.** digestive.

12. Mouth, esophagus, stomach, intestines, liver and pancreas are the components of system.

a. circulatory; **b.** endocrine; **c.** integumentary; **d.** digestive.

13. Receives stimuli, integrates information, and directs the body are the major functions of system.

a. circulatory; **b.** endocrine; **c.** integumentary; **d.** nervous.

14. Photophiles are photophilous animals for which _________ presence is a condition of their normal vital activity.

a. light; **b.** water; **c.** wind; **d.** moisture.

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15. ____________ having a body temperature that varies with the temperature changes of the environment.

a. birds; **b.** mammals; **c.** poikilotherm; **d.** homoiotherm.

16. __________ maintaining a nearly constant body temperature not influenced by the temperature of the surroundings.

a. Protozoans; **b.** Nemathelminthes; **c.** poikilotherm; **d.** homoiotherm.

17. According to their ability to keep their _____________, animals are divided into two groups: poikilothermal (cold-blooded) and homoiothermal (warm-blooded).

a. pressure; **b.** light; **c.** temperature; **d.** water.

PART 3
AN INTRODUCTION TO THE ECOSYSTEM CONCEPT

Subject 15. The study of population characteristics and peculiarities of population structures. The concept of carrying capacity

Objectives:

- to comprehend the terms natality (birthrate), mortality (death rate), sex ratio, age distribution, growth rates, and spacial distribution;
- to analyze the peculiarities of population structures of given species;
- to determine what factors have an influence on structure of populations and how do they affect;
- to analyze the phases of population growth curve;
- to get acquainted with reproductive strategies.

Materials: placards, identification guide books, reference books.

Basic principles

A population can be defined as a group of individuals of the same species inhabiting an area. Just as individuals within a population are recognizable, populations have specific characteristics that allow them to be distinguished from one another. Some of these characteristics are natality (birthrate), mortality (death rate), sex ratio, age distribution, growth rates, and spacial distribution.

Natality refers to the number of individuals added to the population through reproduction. In human populations, natality is usually described in terms of the birthrate, the number of individuals born per one thousand individuals in the population per year. For example, if a population of two thousand individuals produced twenty offspring during one year, the birthrate would be ten per thousand per year.

It is important to recognize that the growth of a population is not determined by the birthrate (natality) alone. Mortality, the number of deaths per year, is also important. In human population studies, mortality is usually discussed in terms of the death rate, the number of individuals who die per thousand individuals in the population per year. In order for the size of a population to grow, the number of individuals added to the population by reproduction must be greater than the leaving it by dying.

A population's ability to grow by reproduction depends on its sex ratio and age distribution. The sex ratio refers to the number of males relative to the number of females in the population.

Populations can differ in age distribution, the number of individuals of each age in the population. Some are prereproductive juveniles, some are reproducing adults, and some are postreproductive adults.

The individuals of a population are arranged in different ways. They may be randomly spaced, evenly spaced, or clumped. Each of these patterns reflects the interactions between a given population and its environment, including the other species that are present.

One of the key characteristic of any population is its capacity to grow.

When discussing these matters, it is useful to consider the intrinsic rate of natural increase, or biotic potential, of a population, a term that refers to the rate in which a population of a given species will increase when there are no limits of any sort on its rate of growth.

Most populations tend to remain relatively constant in number, regardless of how many offspring the individuals produce.

The carrying capacity of a specific area is the number of individuals of a species that can survive in that area over time. In most populations, four broad categories of factors interact to set the carrying capacity for a population. These factors are: the availability of raw materials, the availability of energy, the accumulation of waste products and their means of disposal, and interactions among organisms. The total of all of these forces acting together to limit population size is known as environmental resistance, and certain limiting factors have a primary role in limiting the size of a population.

All species can be divided according to whether their reproductive strategy is a K-strategy or an R-strategy. K-strategists are usually large organisms that have relatively long lives, produce few offspring, provide care for their offspring, and typically have populations that stabilize at the carrying capacity. Examples of this kind of organism include deer, lions, swans, and other large animals. Generally, populations of K-strategists are limited by density-dependent factors. Density-dependent factors are those limiting factors that become more severe as the size of the population increases. For example, as a population of hawks increases, the hawks begin to compete for the available food, such as mice, snakes, and small birds. When food is in short supply, many of the young in the nest die, and population growth slows. They have reached the carrying capacity.

The R-strategist is typically a small organism that has a short life, produces large numbers of offspring, and does not reach a carrying capacity. Examples of this kind of organism include grasshoppers, gypsy moths, and some mice. Typically, these populations are limited by density-independent factors in which the size of the population has nothing to do with the limiting factor. Typical examples of density-independent factors are changing weather conditions that kill large numbers of organisms, the drying up of a small pond, or the death of entire populations due to the destruction of their food source.

Practice

1. To analyze the age structure of given populations and represent it in the form of age pyramid.
2. To analyze the sex structure of given populations and represent it in the form of sex-age pyramid.
3. To analyze the main types of the population growth curves of different species.
4. Divide given species according to whether their reproductive strategy.

Subject 16. The study of community composition and species diversity. Distribution of plant and animal species. Interactions between organisms within communities

Objectives:

- to comprehend the terms species, community, predation, commensalism, mutualism, parasitism, niche;
- to get acquainted with horizontal and vertical distribution of species in terrestrial community;
- to consider some of interactions between organisms within communities and analyze the peculiarities of interspecific interactions.

Materials: placards, identification guide books, reference books.

Basic principles

The unit composed of all the populations of living organisms inhabiting a common environment and interacting with one another is called as a biotic community.

A naturally occurring group of organisms living in a particular habitat, depending on and sustaining each other, is termed a biotic community.

A natural community is defined by the various species composing the community. But before we can discuss the composition of a community, we should define what we mean by species.

A species can perhaps be best defined as a group of individuals that are more or less similar in appearance and that are able to interbreed to produce fertile offspring in their natural environments.

What determines the composition of a particular community? The prevailing climate – temperature, moisture, wind – determines, to a large extent, what species will be present. An element of chance is also involved.

Natural communities have a tremendous number of living species (bacteria, fungi, plants, animals). When you attempt species identification on a field trip, you will soon realize that a feature of most communities is that there are very few species which are abundant and great many species which are rare. The few abundant species in community are called dominants. The dominant organisms, usually plants, influence the physical conditions for the other organisms and may, there for, determine their distribution.

The distribution of plant species in a terrestrial community can be described both vertically and horizontally. Ecologists have subdivided communities vertically into several layers which reflect the type of plants present in the community. The layer of stratum closest to the ground is called the ground stratum (average vertical height in a deciduous forest – 0,3 meters). It includes mosses, lichens, and herbs. The next layer above the ground stratum is called the shrub stratum (average vertical height in a deciduous forest – 1,8 meters). Shrubs and saplings are included in this layer. The uppermost layer is the tree stratum (average vertical height in a deciduous forest – 15 meters). These three layers are the main ones. In some cases more layers are required to describe a community: 1) the forest floor; 2) the herb layer; 3) the shrub layer; 4) the understory; 5) the canopy.

The stratification of the vegetation determines the stratification of the wildlife. Each stratum has its own characteristic animals, although considerable interchange does take place between the layers. As a result, a community that has the most layers generally has the broadest variety of wildlife. Not all communities are equally stratified. A natural forest community is more highly stratified than a grassland community. Most forests, therefore, have a great diversity of wildlife associated with them.

The individuals of plant species are distributed in a horizontal plane as well as in vertical one. Horizontal distribution may be regular (evenly), with individuals spaced at specific distances from one another. This occurs when a barren area is reforested with pines. Distribution may also be clumped, as often happens when seeds germinate under the parent plant. The most common type of distribution is, of course, random. Here the species shows no special pattern.

The distribution of species may be discontinuous or continuous from one community to another. Where the distribution of species is discontinuous, definite boundaries can be identified. A wheat field next to a fenced wood lot is an example of such distribution. Wheat plants are on one side of the fence and trees are on the other. However, most natural communities do not have distinct boundaries. They have a continuity of species between them. Some species are not as tolerant of the conditions in the neighboring community as they are of the conditions in their own. Other species may be more successful under the conditions in the neighboring community. As a result, the less tolerant species will be less plentiful or nonexistent in the neighboring community and the more tolerant ones will be more plentiful. This causes a gradual blending of the two communities.

The transition zone where two communities blend is called the ecotone. Generally, the variety and density of organisms is greater there than either of the two communities.

Here we will consider some of interactions between organisms within communities. Competition between individuals of two or more species for the same limiting factors, the direct effects of predation of one species on another, symbiosis are among the kinds of interspecific interactions.

More than 60 years ago, the ecologist G.F. Gause formulated what is called the principle of competitive exclusion. This principle states that if two species are competing with one another for the same limited resource, then one of the species will be able to use that resource more efficiently than other, and the former will therefore eventually eliminate the latter locally.

Predation describing an animal that lives by killing and consuming other animals. Prey – an organism eaten by another organism.

Symbiosis – the living together in close association of two or more dissimilar organisms. The major types of symbiotic relationships include: 1) commensalism, in which one species benefits while the other neither benefits nor is harmed; 2) mutualism, in which both participating species benefit; 3) parasitism, in which one species benefits but the other is harmed.

Examples of symbiosis include lichens, which are associations of certain fungi and green algae or cyanobacteria; are those between flowering plants and their animal visitors, including insects, birds and bats. Such symbiotic relationships can be observed all around us.

Habitat – the environment of an organism; the place where it is usually found.

A niche may be defined as the way in which an organism interacts with its environment. The fundamental niche (theoretical niche) of an organism is the niche that it would occupy if competitors were not present. The realized niche (actual niche) is the niche that it actually occupies under natural circumstances.

Gause's principle of competitive exclusion can be restated, in terms of niches, as follows: no two species can occupy the same niche indefinitely. Certainly species can and do coexist while competing for the same resources. Nevertheless, Gause's theory predicts that when two species do coexist on along-term basis, one or more features of their niches will always differ; otherwise the extinction of one species will inevitably result.

Practice

1. To analyze the types of biotic interactions between organisms within communities.
2. To distribute plant species of deciduous forest vertically into several layers which reflect the type of plants present in the community using reference books and your own life practice.
3. To indicate the type of interactions between organisms within community for given pair organisms.
4. To substantiate the interconnection between species biodiversity and biotic interactions variety with concrete examples.

<u>Subject 17.</u> The study of the biotic structure of an ecosystem

<u>Objectives:</u>

- to comprehend the terms ecosystems, autotroph, heterotroph, gross primary productivity, net primary productivity, biomass, producer, consumer, omnivore, decomposer, detritovore, trophic levels, food chain, food web;

- to get acquainted with the food relationships within a community;
- to consider how do different kinds of living things get energy.

Materials: atlases, placards, reference books, identification guide books.

Basic principles

Ecosystems are complex associations of plants, animals, fungi, and eukaryotes that interact with their nonliving environment in such a way as to regulate the flow of energy through them and the cycling of nutrients within them. Ecosystems are the most complex level of biological organization.

An ecosystem includes autotrophs and heterotrophs. An autotroph is an organism that is able to synthesize all the organic molecules it requires from simple inorganic substances and energy source. Plants, algae, and some bacteria are autotrophs. A heterotroph is an organism that cannot derive energy from photosynthesis or inorganic chemicals, and so must feed on other plants and animals, obtaining chemical energy by degrading their organic moleculs. Animals, fungi, and many unicellular organisms are heterotrophs (fig. 17.1).

Looking at an ecosystem as a whole, we define its gross primary productivity as the total amount of energy that is converted to organic compounds in a given area per unit of time. The net primary productivity of the ecosystem is the total amount of energy fixed per unit of time, minus that which is expended by the metabolic activities of the organism in the community. The total weight of all of the organisms living in the ecosystem, its biomass, increases as a result of its net production.

The producers (green plants) of the ecosystem are the organisms that produce their own food in the process of photosynthesis (they use the light energy to form high-energy organic compounds such as glucose from the basic inorganic compounds, water and carbon dioxide) or chemosynthesis.

The consumers of the ecosystem are heterotrophes that derives their energy from living or freshly killed organisms or parts thereof. Among the consumers, several different levels may be recognized. The primary consumers, or herbivores (dairy cow, deer, rabbits and others), feed directly on the green plants. Secondary consumers, carnivores (barn owl, frog, snake and others) and parasites of animals, feed in turn on the herbivores.

Humans are omnivores, organisms that can eat both plants and animals. Other omnivores include bears and raccoons.

Another group of organisms common to all ecosystems are the decomposers – organisms (bacteria, fungi) that break down organic material into smaller molecules, which are then recirculated.

Detritivores – organisms that live on dead organic matter; are included large scavengers, smaller animals such as earthworms, and some insects, and decomposers (bacteria and fungi).

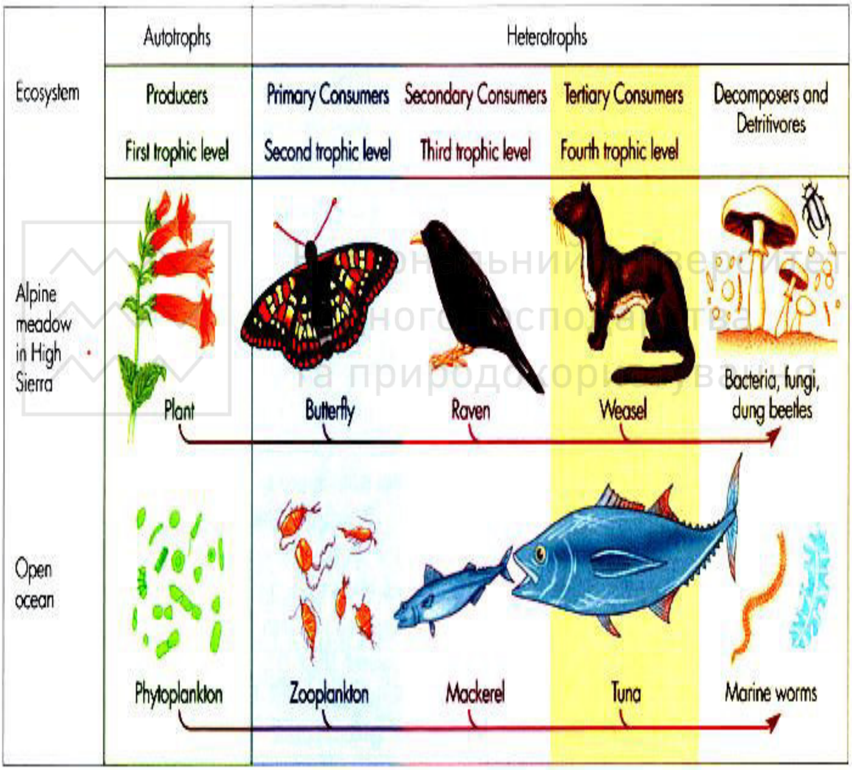

Fig. 17.1. Trophic structure of Land and Aquatic Ecosystems

All of these levels, and probably additional ones, are represented in any fairly complicated ecosystem. They are called trophic levels, from the Greek word "*trophos*", which means "*feeder*". Organisms from each of these levels, feeding one another, make up a series called a food chain (Clover → Rabbit → Fox; Wheat → Mouse → Owl). The length and complexity of food chains vary greatly. In real life, it is rather rare for a given kind if organism to feed on only one other kind of organism; usually each will feed on two or more other kinds, and in turn will be fed on by several other kinds of organisms.

A food web is a network of interrelated food chains in an ecological community (the food relationships within a community). A food web is more complicated than a food chain. A food chain shows one population that eats or is eaten by another population. A food web shows how one population can be part of more than one food chain (fig. 17.2).

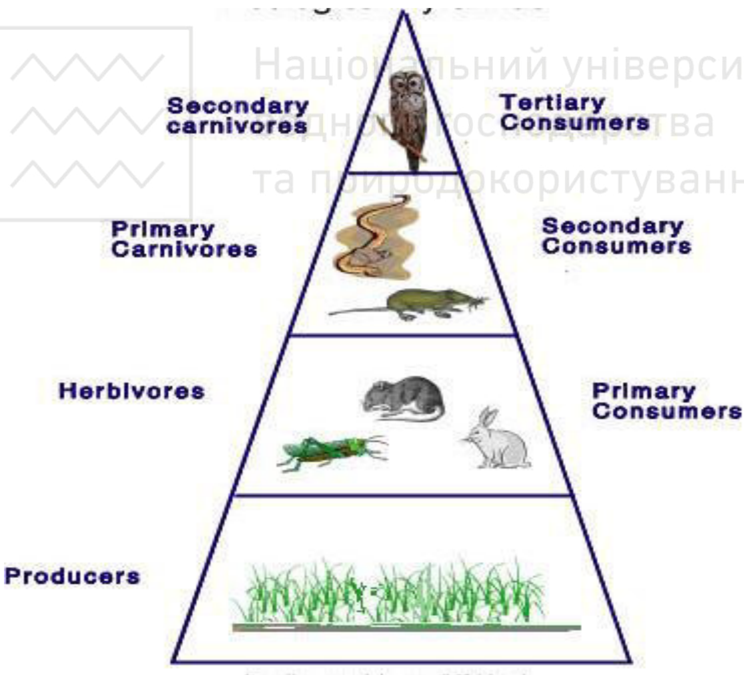

Fig. 17.2. Ecological pyramid

Practice

1. To comprehend the role of every trophic level in a common food chain of an ecosystem trophic structure.
2. To distribute given organism species into the trophic levels – producers, primary consumers, secondary consumers, decomposers.
3. To construct ecological pyramid for steppe ecosystem.
4. To calculate utilization efficiency of feed resourses for different trophic levels in a common food chain based on energy consumption of biomass growth.

TEST 3

A. Write the letter of the correct answer in the blank.

1. An artist went to a field and sketched everything she observed. She drew the sky with clouds, grasses with insects, soil with rocks, and hawks soaring to find field mice. A scientist would say that she drew the ________.

   a. community; **b.** ecosystem; **c.** biome; **d**. population.

2. A __________ shows one population that eats or is eaten by another population.

   a. decomposer; **b.** food chain; **c.** food web; **d.** parasitism.

3. __________ is the number of organisms that could be supported in a population under ideal conditions.

   a. K-strategists; **b.** biotic potential; **c.** R-strategists; **d.** carrying capacity.

4. When the food supply for the wolves in an area increases, what is likely to happen to the number of wolves in an area?

   a. increase; **b.** decrease; **c.** remain the same; **d.** no way to predict.

5. Large communities of specific organisms in a particular area with a distinct climate make up a(n) _________.

   a. biome; **b.** environment; **c.** ecosystem; **d.** population.

6. Water, light and temperature are important parts of the ________ in an environment.

   a. respiration; **b.** abiotic factors; **c.** ecosystem; **d.** biotic factors.

7. Scientists have calculated that Earth can successfully support about 5,3 billion people. This is the _________ of Earth for people.

   a. carrying capacity; **b.** reproductive strategy; **c.** environmental resistance; **d.** biotic potential.

8. By what process does carbon become bound into compounds that are food for consumers ?

   a. photosynthesis; **b.** decay; **c.** respiration; **d.** decomposition.

9. The physical environment of a meadow and all the living things living

in it is known as the _________ .

a. biosphere; b. biome; c. habitat; d. ecosystem.

10. Suppose two organisms interact so that one is helped and the other is neither helped nor hurt. The relationship is called ____________ .

a. commensalism; **b.** parasitism; **c.** mutualism; **d.** predation.

11. The total factors acting together to limit population size is known as _________.

a. carrying capacity; **b.** reproductive strategy; **c.** environmental resistance; **d.** biotic potential.

12. A turtle lives in a pond. The pond is called the turtle's ___________.

a. food chain; **b.** niche; **c.** habitat; **d.** biome.

13. A group of organisms of the same species that live in the same area is called a(n) ___________.

a. ecosystem; **b.** population; **c.** community; **d.** biotic factors.

14. Grasses grow in soil. A mouse eats grass. A hawk eats the mouse, and when the hawk dies it is eaten by decomposers. This is the example of ___________.

a. symbiosis; **b.** a food chain; **c.** mutualism; **d.** a food web.

15. Suppose two organisms interact so that in such relationship one species benefits while the other is neither benefits nor is harmed. The relationship is called ____________.

a. commensalism; **b.** parasitism; **c.** mutualism; **d**. predation.

B. Write the letter of the phrase on the right that matches each term on the left

1. community; 2. energy pyramid; 3. habitat; 4. producer;	a. the place where a population lives; b. an organism that eats only plants; c. series of interlocking food chains; d. specific interaction between two species over a long time;

5. food web; 6. consumer.	e. all the populations living together in an area; f. shows the amount of energy flow in an entire food chain; g. organism that eats other organisms (plant or animal); h. makes its own food by photosynthesis.

DISCUSSION

1. Which community do you think would have the greater species diversity: a desert or a tropical rain forest, a grassland or a deciduous forest?

2. What are the three types of horizontal distribution of species? Which type is most frequent in nature?

3. Classify the following symbiotic relationships as to whether they are commensalism, mutualism, or parasitism: ants on the acacia tree, dodder and host plant, sea anemones and anemone fish, ants and aphids, lice and birds, lichens, legume root nodules, flea and humans.

4. Is the term niche synonymous with the term habitat? Why or why not? How does an organism's theoretical niche differ from its actual niche?

5. Some of the most important organisms in a community are rarely seen and recognized. These are the scavengers and decomposers. Explain what these organisms do and how this is important to the community as a whole.

6. Where do producers fit in a food chain?

7. Where do herbivores fit in a food chain?

8. Where do carnivores and omnivores fit in a food chain?

9. How do different kinds of living things get energy?

PART 4
MAJOR BIOMES OF THE PLANET

Subject 18. The study of ecological existence conditions and species variety in Arctic and Alpine Tundra

Objectives:

- to get acquainted with the abiotic and biotic factors in Arctic and Alpine Tundra;
- to analyse the dependence of species variety in Arctic and Alpine Tundra on ecological existence conditions

Materials: placards, identification guide books, geographic atlas, herbarium.

Abiotic factors

The climate of the Arctic tundra is characterized by low temperatures and cold, dry winds. Even the wettest months in summer yield only about an inch of precipitation. The light winter snowfall is difficult to measure because the snow is swept into shifting drifts by the winds. Since the sun's rays strike this region of the earth's surface at a very low angle, the radiant energy received by the tundra is never very intense, despite the lengthy summer days. The long winters are extremely cold. The soil is completely frozen. In fact, the entire growing season lasts only about 60 days. During the short spring and summer interval the surface of the soil thaws to a depth which varies from a few centimeters in some localities to half a meter in others. Below this lies the permafrost, soil which never thaws. This permanently frozen layer is 610 m deep in spots, preventing proper drainage of the water produced by melting snow in the spring. It is interesting to note that a corresponding biome does not exist in the Southern Hemisphere. North of the icefields of Antarctica, most of the land surface within latitudes where climate could produce tundra is covered by ocean (fig. 18.1). However, similar abiotic factors have established separate "islands" of tundra on mountains in high alpine regions. In this Alpine tundra, permafrost, exists only at very high altitudes and on northern mountain ranges. The growing season is brief, as in the Arctic, but the Alpine tundra is not subjected to the same extreme change in photoperiod. Although summer days are shorter in the mountains, the light intensity is much higher in the thin atmosphere. The clouds and fog which often hide the mountain tops yield more precipitation to the Alpine tundra. The low density of air

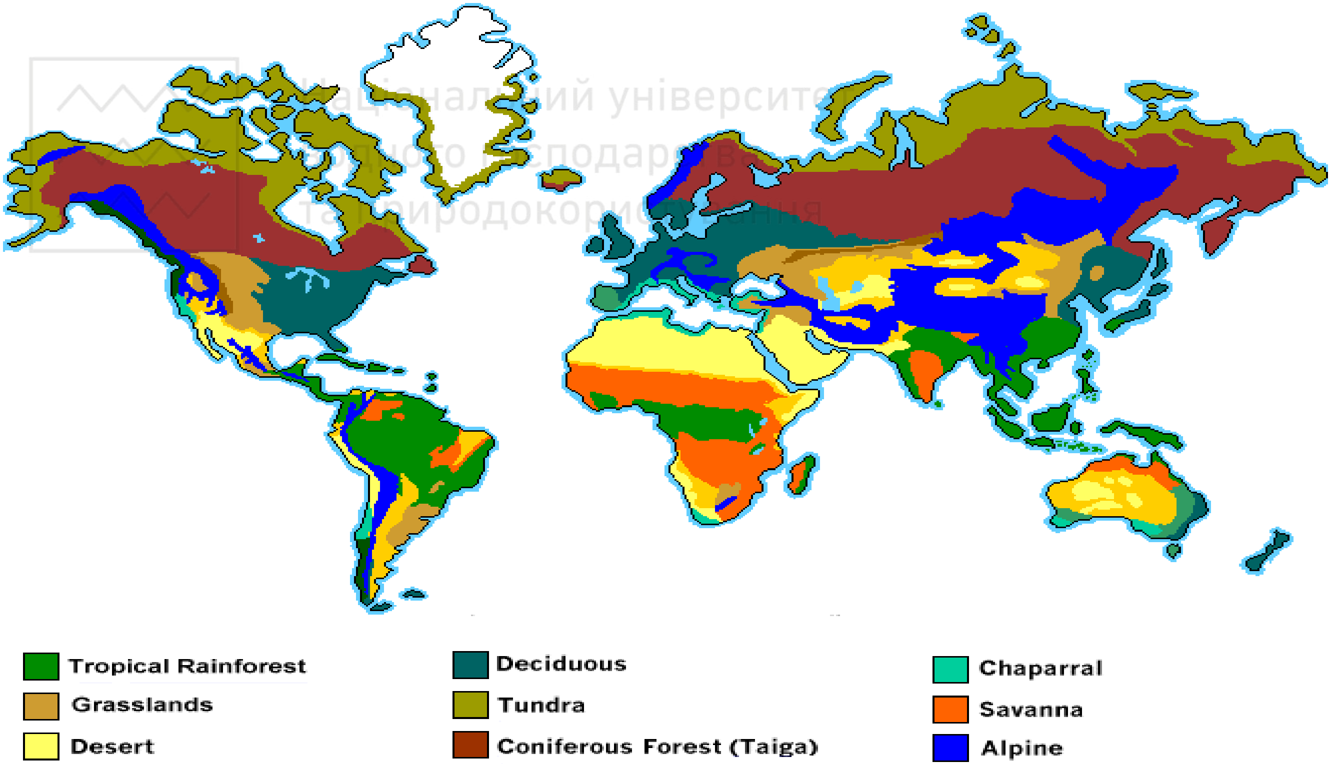

Fig. 18.1. Major biomes of the planet

(and, hence, reduced concentration of oxygen) is a feature unique to the Alpine tundra.

Biotic factors

Life in both the Arctic and alpine tundra presents a fascinating study in adaptation. The temperature factor alone greatly limits the number of organisms which can adapt and survive in this biome. This makes basic relationships, such as food chains and food webs, simple and easy to determine.

Vegetation. At first glance, the summer landscape of the Arctic tundra resembles a grassy plain. Closer examination reveals a complex pattern of, vegetation. Grasses, sedges, and herbs stretch between the areas of fine, well-drained soil with woody shrubs such as birch, willow, and heath. Mounds of earth are covered by lichens and blueberry. Wetter hollows are filled with sedges and reeds, typical marsh plants. Clumps of cotton grass rise above a carpet of sphagnum moss, covered with dwarf shrubs. A rich growth of taller shrubs and grasses is found on the steeper southern slopes of hilly areas and in river bottoms. Every nook and cranny which offers shelter is invaded by some vegetation.

Despite a similar environment, Arctic and Alpine tundra have considerably different vegetation. One important cause of this difference is the photoperiod. Arctic species are long-day plants. They are adapted to lower light intensity, but they need longer periods of daylight than alpine plants for proper photosynthesis. Alpine plants are adapted to the high light intensity of the thin mountain atmosphere. The growth of an Arctic tundra plant, transplanted to an alpine location, would be measurably retarded by the shorter photoperiod, despite the stronger sunlight.

During the short growing season, Arctic tundra plants must photosynthesize and store enough food to last the entire year. The production of flowers and seeds consumes a great deal of energy. Therefore most tundra plants are perennials. They must grow for several seasons before they have stored enough energy to flower. To attract the limited number of insect and bird pollinating agents, flowers tend to bloom in clusters. These blossoms appear conspicuously large in contrast to the tiny plants which produce them. Different species of herbs generally bloom in succession as if trying to minimize competition with one another. Yet even if pollination does occur, the resulting seeds have little chance of germinating in this hostile terrain. Thus vegetative propagation is predominant among plants of the Arctic tundra. In contrast, Alpine tundra plants tend to reproduce by seedlings.

Photosynthesis in alpine, vegetation is not limited by low light intensity as in the Arctic. The Alpine tundra is also characterized by cushion-forming plants which hug the soil. This blanket of vegetation traps heat and moisture to provide a microclimate for pollinating insects and, possibly, shelter for germinating seeds. Some alpine species are self-pollinating. Others have seeds which begin germination before they are released from the parent plant.

Animals. These include the Arctic hare, gray wolf, collared lemming, Arctic fox, and even a few bird species – willow and rock ptarmigans and the snowy owl. In the spring, many of these animals change to darker colors that provide better camouflage in the summer. How do animals of the tundra endure the severe cold of winter? The larger mammals and permanent bird residents develop an insulating layer of fat. They also have air pockets trapped within long, dense fur or plumage. Ptarmigans and snowy owls grow extra feathers on their legs and tarsi. Yet, consider the exposed body features of such animals – their nostrils and feet.

How do smaller organisms survive the winter since refuge below the frost line is limited to such isolated spots? Most invertebrates winter in the larval or pupal stage which resists freezing. Spiders, beetles, and a few other species survive in adult form. Aquatic organisms such as rotifers and midgefly larvae can be frozen in the ice for months or even years. Yet they become active as soon as they thaw.

Tundra food chains are remarkably short in winter. They lengthen during the productive summer period, but the total number of species involved remains low. Reptile and amphibian life is rare. Even the insect population is relatively limited, although a plague of mosquitoes, black flies, and deer flies emerges from the swamps. Bumblebees are plentiful, yet the highly adaptable ant is scarce. Songbirds live on seeds, insects, and the August berries. Larger birds of prey seek rodents. Ducks, geese, and shorebirds comprise most of the tundra bird life. These frequent the coast or take advantage of the many ideal nesting sites beside freshwater ponds and lakes, even though the limited period of thaw results in low productivity in these bodies of water. The largely migratory fish are more numerous in the rivers.

Except for the caribou and pipit, animal species of the Alpine tundra are very different from those of the Arctic tundra. Mammals of the northern mountain ranges include the collared pika, hoary marmot, singing vole, mountain goat, Barren Ground caribou, and Dall's sheep.

The common pika, yellow-bellied marmot, and mountain sheep are limited to southern mountain tundra. Bird life is represented by the white-tailed ptarmigan, water pipit, and finches. Reptiles and amphibians are rare. Unlike the Arctic tundra, flies and mosquitoes are also rare. Yet there is an abundance of certain insects – grasshoppers, butterflies, spiders, ants, leaf-hoppers, springtails, mites and ground beetles.

The low oxygen concentration of the Alpine tundra affects homoiothermic mammals the most. Birds are adapted to fly at high elevations. Invertebrates and plants have a much lower metabolic rate and, hence, a lower oxygen requirement. Increased heart beat and respiration rate can temporarily adjust mammals, including man, to the rarefied atmosphere. But the animals permanently adapted to this high altitude have larger lungs and hearts. They also have an increased number of oxygen carrying red blood cells.

In summary, both Arctic and Alpine tundra provide a rigorous environment for plant and animal alike. Yet life has adapted and thrives in seasonal abundance, governed by the laws of nature.

Practice

1. To comprehend the geographical location of Arctic and Alpine Tundra using geographic atlas.
2. To analyze the peculiarities of physical and geographical conditions of the area occupied by Arctic and Alpine Tundra using geographic atlas and guides.
3. Describe typical flora and fauna of Arctic and Alpine Tundra using different sources of information.
4. To single out the most topical ecological problems which threaten to existence of Arctic and Alpine Tundra natural complexes; to note plants and animal species which liable to protection.
5. Suppose measures as for preservation of Arctic and Alpine Tundra biodiversity.

Subject 19. The study of ecological existence conditions and species variety in the Coniferous forest

Objectives:

- to get acquainted with the abiotic and biotic factors in the Coniferous forest;
- to analyse the dependence of species variety in the Coniferous forest on ecological existence conditions

Materials: placards, identification guide books, geographic atlas, herbarium.

Abiotic factors

Lying closer to the equator, this region receives more of the sun's radiant energy than does the tundra. Average monthly temperatures are higher, ranging from a winter low of -30° C to a summer high of 20° C. The extended growing season varies from 60 to 150 days. Summer days are shorter but warmer than farther north. More important, the ground thaws completely. The winters are not as long or severe and few areas within this biome are without sunlight. Snowfall is heavier than in the tundra. Yet total precipitation, although greater than in the tundra, is still low. Annual measurements vary from 38 to 90 c. Summer rains provide most of the moisture (fig. 18.1).

Biotic factors

As in the tundra, the plant and animal communities of the coniferous forest have more limited structures and relationships than those in warmer regions. One major factor which we should investigate is the dominance of coniferous trees throughout this biome.

Vegetation. The plant life of the boreal forest must cope with a combination of poor soil, low temperatures, and limited rainfall. Although the soil contains enough moisture to support tree growth, it is frozen during much of the year. Boreal vegetation must be able to tolerate long dormant periods and use to full advantage the available moisture. *Conifers* (cone-bearing trees) thrive in this environment because they are well adapted to dry conditions. Their leaves are modified into needles or scales wrapped in a thick cuticle. This waxy outer skin greatly restricts water loss by evaporation from the inner leaf cells. These needles can also withstand freezing. Such protection helps a conifer survive periods of frost and drought. Douglas fir, Sitka spruce, Tamarack, Jack pine, White spruce, Balsam fir, Red pine, White pine, Hemlock, White cedar are the common trees of the coniferous forest.

The forest floor lies in almost perpetual shade under the dense evergreen canopy. Here vegetation is largely restricted to shade-loving plants like ferns, mosses, and a few herbs. In the absence of earthworms and effective bacterial action, fungi are vital decomposers.

Animals. Animals of the boreal forest are adapted in structure and behavior to survive the long, cold winter when snow blankets the frozen ground. Foxes, wolves, and moose, wearing thick winter fur, remain active even when the temperature dips to -45° C. Like its tundra cousin, the varying hare's coat develops a snow-white camouflage. Here lemmings, voles, and other rodents are active throughout the winter, dining on grasses, mosses, and herbs. Chattering red squirrels shatter the silence of the winter forest as they scamper about in search of hoarded food supplies. Their main diet is conifer seeds, obtained by stripping away cone scales. This activity is very time-consuming.

The choice of food in the coniferous forest is greatly limited, regardless of the season. Only about 50 species of birds can feed on the tough, resinous conifers. Most seed-eaters have strong jaw muscles which control short, sturdy beaks fitted with sharp cutting edges. Some birds have an added advantage. For example, finches do not have to wait for the cones to open because their strong beaks are well designed for extracting the seeds.

Very few insect species can feed on coniferous growth. But those which thrive in this habitat virtually rule the northern forest during the summer. Larger animals are driven to distraction by hordes of flies and mosquitoes. Moose escape by submerging in lakes and marshes where they browse on aquatic plants. But more important, every inch of a coniferous tree is prone to attack by some type of insect. Forest areas dominated by one or two tree species are especially vulnerable.

Insects have two main seasons – a short active summer of reproduction and a long dormant period when they winter as larvae or nymphs in bark crevices and beneath the soil. Insect-eaters such as chickadees, woodpeckers, and shrews manage to winter in the forest. Others, such as warblers and bats, migrate until spring.

The birds of prey which patrol the forest sky are equipped with keen vision, deadly talons, and strong, hooked beaks. The owls are silent night hunters which use their sensitive hearing to detect the activity of smaller birds and rodents. Owls have the widest field of binocular vision of all the birds of prey. Some can discern objects in light 100 times less intense than humans require. Hawks, falcons, ospreys, and eagles hunt by day, usually along the forest edge because their large wingspan makes flying difficult in dense forest. Hawks are best adapted. Their rounded wings enable them to hover and turn sharply in pursuit of birds flushed from the treetops.

The smaller carnivores of the boreal forest: minks, martens, weasels, and wolverines – all belong to the weasel family. They hunt rabbits, rodents, birds, and insects. They will also eat most other types of food when the need arises. Since their prey is widely scattered, these predators claim unusually large hunting territories.

Like the lemming in the tundra, the varying hare plays a major role in the coniferous forest food chain. It eats broad-leafed plants, grasses, herbs, and mosses, as do most of the other herbivores of the coniferous forest.

Practice

1. To comprehend the geographical location of Coniferous forest using geographic atlas.
2. To analyze the peculiarities of physical and geographical conditions of the area occupied by Coniferous forest using geographic atlas and guides.
3. Describe typical flora and fauna of Coniferous forest using different sources of information.
4. To single out the most topical ecological problems which threaten to existence of Coniferous forest natural complexes; to note plants and animal species which liable to protection.
5. Suppose measures as for preservation of Coniferous forest biodiversity.

<u>Subject 20.</u> The study of ecological existence conditions and species variety in the Temperate deciduous forest

<u>Objectives:</u>

- to get acquainted with the abiotic and biotic factors in the Temperate deciduous forest;
- to analyse the dependence of species variety in the Temperate deciduous forest on ecological existence conditions.

<u>Materials:</u> placards, identification guide books, geographic atlas, herbarium.

Abiotic factors

This region is largely restricted to the eastern half of the continent where the mean annual precipitation varies from 75 to 125 cm. The four seasons are, well developed and precipitation is fairly evenly distributed throughout the year. The winter snow is not as deep or enduring as that of the boreal forest. The climate is moderate. From north to south the temperature ranges from a January high of -12° C to 15° C to a July high of 21° C to 27° C. Relative humidity is high during the growing season, which may last for more than six months.

The shorter winters are cold enough to reduce greatly both growth and photosynthesis. To increase efficiency, deciduous trees enter a dormant period, shedding their frost-intolerant leaves. A single acre of forest floor may be carpeted with more than 10 million leaves each fall. Along with other decaying matter, the leaves rapidly decompose on the moist ground to produce a rich layer of humus. Typical deciduous woodland soil is called "brown earth". It is formed where the downward drainage of rain water (percolation) is balanced by the upward movement of water (capillarity). Capillarity replaces evaporating surface moisture. Therefore, instead of being leached from the soil, nutrients are circulated. Rocky or porous soils support shrubs or conifers. Bogs form in areas where the soil is waterlogged and acidic (fig. 18.1).

Biotic factors

Vegetation. The long, warm growing season, abundant moisture, and rich soil support a variety of plant species which grow to different levels, or strata, within the forest. The taller trees form an upper canopy which receives the full strength of the sun. The broad deciduous leaves permit maximum absorption of light energy. A small oak tree with a trunk diameter measuring 60 cm produces more than 100000 leaves. Their total surface area is about the size of two tennis courts. These thin leaves still allow some sunlight to filter through to smaller "understory" trees. Beneath these, a shrub layer grows. And finally, at ground level, ferns, mosses, and other small plants compete for the remaining light. The floor of an oak forest receives only about 6 % of the noonday sunlight. Hence most of the smaller plants, growing close to the soil, flower very early in the spring before air temperatures farther above the ground increase enough to stimulate new leaf growth on the trees. By the time a new upper canopy has blocked off the sunlight, these ground plants have stored photosynthesized food in roots or underground stems. After releasing seeds, these plants become dormant until the following spring.

In autumn, a host of creatures feast upon the fruiting bodies of fungi growing on tree stumps and damp soil. Fungal spores and underground fungal filaments also nourish many soil inhabitants.

European beech, Norway maple, Red oak, Black willow, Trembling aspen, Shagbark hickory, Sycamore are the common deciduous trees.

Animals. Forest animals are adapted in structure, function, and behavior to live among trees. Here they find shelter, protection, and nesting sites. From the branches they can sight enemies and proclaim territorial boundaries. Many dwell in the rich humus beneath the trees. Others simply take advantage of the shade, moderate temperatures, and higher humidity of the forest.

Tree-dwellers are well equipped for climbing. Squirrels and woodpeckers have sharp claws with opposing toes for balance. Some squirrels even have a built-in parachute as well as a bushy tail for balance. Tree frogs cling to the bark using suction discs on their toes. Snails and slugs adhere with slimy feet. White-footed mice and opossums use their tails for climbing and grasping, much as monkeys do.

Unlike conifers, deciduous trees are a major source of food which supports a large number of consumers. The largest herbivores include the wapiti (elk) and deer. The most concentrated protein is stored in the buds and seeds of trees. These provide a year-round source of food for finches and other animals. Buds are most valuable during the winter and early spring when other nourishment is unavailable. Autumn produces a rich harvest of seeds which persist far into the winter in the form of berries and nuts. Acorns are a delicacy for larger birds such as jays and wood-peckers.

Rabbits and little rodents form an important link in the forest food chain. Cottontails nibble at herbs, tree bark, and small plant growth along the forest edge. In winter they dare not venture far from the seclusion of the woods. Deer mice are agile climbers which forage in smaller trees or surface litter for buds and seeds to store in their nests.

While larger animals generally cause little damage to deciduous foliage, two major groups of insects are highly destructive. The leaf-chewers, such as caterpillars and beetle and fly larvae, use biting jaws to devour al1 of the leaf tissue. Some will attack any tree, but most are specialists which strip only trees of a particular specie. The army of caterpillars provides a tasty meal for many forest dwellers such as birds, tree frogs, and insect parasites. Shrews, mice, and toads feast upon those caterpillars which drop to the soil to pupate.

Some of the birds, such as chickadees and nuthatches, remain. They eat insect pupae, insect eggs, and, in some cases, seeds. Their specialized food preferences allow several wintering species to share the same area without competition. But most birds migrate south to regions of insect activity. Amphibians and reptiles lapse into a hibernating coma when the cold weather arrives. In contrast, the tiny shrew cannot afford to sleep through a single winter day. It must constantly scrounge dormant insects from the soil litter in order to survive.

The shrew is not the only hunter on the forest floor. The yearly blanket of fallen leaves, combined with other organic waste, supports a multitude of plants and animals in warmer months. Essential nutrients, locked in dead cells, are recycled by decomposer fungi and bacteria. The products of decay and the agents themselves are consumed by soil organisms such as rotifers and roundworms. Earthworms and other herbivores are constantly preyed upon by the faster, more agile carnivores like centipedes. One square kilometers of soil litter may be home to more than 300 different species of invertebrates, each one a specialized eater. The surface is alive with a hungry army of spiders, beetles, snakes, toads, and small mammals – all links in complex food chains.

Forest activity reaches a peak during the spring and early summer when most of the animals breed. Some, such as deer and bats, mate in the fall. Owls and some squirrels wait until winter. At any time of year, the great diversity and abundance of life in this biome presents a complex study of interrelationships. Yet the same basic principles which govern a simpler biome like the tundra can be applied to deciduous forests to understand and preserve this environment.

Practice

1. To comprehend the geographical location of temperate deciduous forest using geographic atlas.
2. To analyze the peculiarities of physical and geographical conditions of the area occupied by Temperate deciduous forest using geographic atlas and guides.
3. Describe typical flora and fauna of Temperate deciduous forest using different sources of information.

4. To single out the most topical ecological problems which threaten to existence of Temperate deciduous forest natural complexes; to note plants and animal species which liable to protection.
5. Suppose measures as for preservation of Temperate deciduous forest biodiversity.

Subject 21. The study of ecological existence conditions and species variety in the Grasslands

Objectives:

- to get acquainted with the abiotic and biotic factors in the Grasslands;
- to analyse the dependence of species variety in the Grasslands on ecological existence conditions.

Materials: placards, identification guide books, geographic atlas, herbarium.

Abiotic factors

This region lies between the same latitudes as the deciduous forest. Hence, the seasonal changes and radiant energy supply are similar, although both seasonal and daily temperature fluctuations are more pronounced in the prairies. The critical factor in the drastically altered vegetation is the diminished rainfall. The continental pattern of air circulation from east to west produces decreasing and irregular precipitation combined with an increasing rate of evaporation from the soil surface. The annual rainfall, 25-75 c, is sufficient for many grass species but is too low for tree growth. Nor can trees survive the frequent droughts which can be severe and prolonged. The intermittent fires kill seedling trees but grasses quickly recover.

The chernozem soils, characteristic of the prairies, are the most fertile in the world. The short-lived grass plants contribute large amounts of organic material to the soil each year. Rapid decay forms a deep layer of humus. Thus, prairie soil is much darker than that of the forest. Evaporation causes an upward movement of water which deposits calcium and potassium in the upper soil, leaving it rich in nutrients (fig. 18.1).

Biotic factors

Vegetation. The gradient in rainfall produces three distinct types of grassland. Rich soil and moderate rainfall make a tall-grass zone. Here, tall bluestem soars as high as 2,4 m, supported by roots buried 1,8 m in the soil. These "sod former" plants develop a solid mat over the ground. Species of mid-grasses grow from 60 to120 cm high. Most are "bunch grasses" which grow in well-spaced clumps among other species. In the arid region of high winds and low humidity, the sod-forming short grasses grow no more than 40 cm high. Their shallow roots absorb moisture from the upper soil layer but do not penetrate the permanent dry zone beneath.

Throughout the grasslands, herbs and legumes (nitrogen-fixing plants) flourish among the grasses.

There are three strata in grassland vegetation: the roots, the "understory" growth at ground level, and the taller foliage. The deep root layer is very prominent. At least half of the total growth of each plant lies beneath the soil. The roots of healthy plants weigh several times more than the portion above the surface. Many plants also develop underground stems called rhizomes which are used for vegetative propagation and food storage. During the growing season, the plants at ground level are shaded from the sun and sheltered from winds by the taller grasses. A layer of dead vegetation called mulch collects on the surface. This mulch must contact the mineral soil before rapid decomposition can begin. As this decaying layer deepens, it soaks up moisture. This creates favorable conditions for the bacteria which convert the mulch to humus. During the growing season, the leaves of grasses continually grow from their bases. As the grass tops are consumed, the crop is renewed.

Animals. Grassland creatures exhibit many fascinating adaptations to the open country they inhabit. Long distance vision is very important for both predator and prey. The eyes of grazing animals are usually located well above the snout to enable the animal to gaze above the grass while feeding. Smaller creatures such as the ground squirrel stand up on their haunches to peer over the vegetation. Others, like the kangaroo rat hop up and down on well-developed hind legs. There are no trees for concealment or escape. Some animals rely on camouflaging coloration. Sensing danger, they remain motionless in the deep grass to escape notice. If the enemy approaches too closely, these creatures suddenly flee by running, hopping, or flying. By temporarily startling the predator with this flurry of motion, the would-be victim gains a head start. Many prairie animals are built for speed, which they rely on to survive. The pronghorn has sturdy legs, large lungs and windpipe, and a heart double the expected size. A number of creatures elude predators by diving into underground burrows. These shelters also protect their smaller, temperature-sensitive residents from the surface heat and cold.

Prairie dwellers seem to believe there is safety in numbers. Life within a herd or colony is typical. Any alarmed member can alert the others to danger. Grassland birds must be strong fliers to combat the high winds which sweep the prairies. In the absence of trees, many birds attract mates with flight songs delivered from high in the air. Nests are concealed in the tall grass. The abundant insect population and bounty of seeds attract a variety of birds – sparrows, meadowlarks, longspurs, lark buntings, bobolinks, grouse, and prairie chickens.

The grasslands abound with insect life, notably grasshoppers and their relatives. As farming began, these insects easily adapted to eating cultivated crops. Extensive crop damage has resulted during years when insect populations have reached plague proportions. Ants are also abundant in the drier grasslands. They replace earthworms in the important role of mixing and aerating the soil.

In winter, the grasslands are almost deserted. Although the snowfall is not heavy, it is blown into deep drifts by strong prairie winds. Bison used to move south along with migrating birds. Pronghorns shelter in woodlands and mountain foothills or forage on exposed grass. Many creatures hibernate – rodents in burrows and groups of reptiles in deep holes below the frost line. Most insect life winters in the egg stage or in a dormant, immature form.

The grasslands are vitally important to man. Yet probably no other biome has received greater abuse. Thousands of acres are still being converted into barren desert through man's failure to understand or respect the ecology of this area.

Practice

1. To comprehend the geographical location of Grasslands using geographic atlas.
2. To analyze the peculiarities of physical and geographical conditions of the area occupied by Grasslands using geographic atlas and guides.

3. Describe typical flora and fauna of Grasslands using different sources of information.
4. To single out the most topical ecological problems which threaten to existence of Grasslands natural complexes; to note plants and animal species which liable to protection.
5. Suppose measures as for preservation of Grasslands biodiversity.

<u>Subject 22.</u> The study of ecological existence conditions and species variety in the Desert

<u>Objectives:</u>

- to get acquainted with the abiotic and biotic factors in the Desert;
- to analyse the dependence of species variety in the Desert on ecological existence conditions.

<u>Materials:</u> placards, identification guide books, geographic atlas, herbarium.

<u>Abiotic factors</u>

The range of latitudes produces two different types of desert within this biome. The average annual temperature of the more northern "cool" deserts of the Great Basin is about 10° C, but it is over 20° C in the "hot" southwestern desert. If these values seem low, you may be forgetting the winter season which brings snow and cold weather to both types of desert. Summer temperatures in Death Valley have soared as high as 57° C – in the shade. But the real impact of temperature lies in the tremendous fluctuations during each 24-hour period. The desert sands receive almost 90% of the total available solar radiation because there are no clouds, water vapor, or canopies of vegetation to absorb the sunlight. But at night, temperatures drop rapidly as 90 % of this accumulated surface heat is lost by radiation.

Yet lack of water, rather than heat, produces deserts. They are generally found in regions receiving less than 25 c of yearly rainfall or where a greater rainfall is sporadically distributed. Long periods of drought are common. Then the rainfall supply for an entire year may fall in one great deluge! This unpredictable moisture usually arrives in the form of thunderstorms or cloudbursts. The ground surface, baked hard by the sun, does not absorb much moisture. Earthworms, which render soil loose and absorbent, cannot endure the dry desert. Many burrowing rodents, which stir up the earth creating underground pathways for water, have been exterminated by pest-control programs. In addition, the scanty desert plant life does not provide a spongy layer of decaying vegetation. Hence, most of the torrent is swept away in surface runoff. The little moisture which does penetrate is quickly evaporated by the hot sun. The relative humidity of desert air averages less than 30% at midday. At times, rain, pouring from black storm clouds, evaporates rapidly as it falls through the blanket of hot, dry air above the sands – and not a single drop reaches the thirsty desert below (fig. 18.1).

Biotic factors

Water is the key to desert life. Many plants and animals have endured because they are able to develop and reproduce rapidly during any period of rain. Recent studies suggest that dew formation, common even in the hottest deserts, may provide an important source of moisture for many forms of life.

Vegetation. There are three main types of desert plants – annuals, succulents, and desert shrubs. Annuals are plants which live only one season. Hence each generation must produce enough successful seeds to ensure the next generation of the species. Annuals exist as dormant seeds during dry weather. These seeds will only germinate when enough moisture is available to enable the plant to quickly grow, flower, and produce more seeds. The desert brightens with colorful blossoms after the winter and summer rains.

Succulents, or "juicy" plants such as cacti, can survive long droughts by storing water. Most cacti have a rounded shape which minimizes the surface area exposed to the hot, dry air. Some are folded like an accordion and can quickly expand by soaking up rain water. As this stored water is gradually used up, the plant shrivels back to its former shape. Most green plants lose water through the stomata in the leaves. Cacti do not. They are leafless evergreens (the spines are thought to be the remnants of what were leaves in the early stage of the evolution of cacti). Their green stems perform the functions of leaves, notably photosynthesis. A thick, rubbery cuticle covers the stem to further protect stored water. Animals seeking the juicy cactus pulp must first maneuver past the sharp, protruding spines. This prickly network also helps to shade the cactus from the direct rays of the sun and reduces water evaporation by surface air currents.

Desert shrubs bear small, thick leaves, many with sunken stomata.

Waxy leaf cuticles reflect heat and retard water loss. During dry spells, these leaves are shed to help conserve plant moisture, but photosynthesis continues in the chlorophyll-containing stem cells.

The desperate competition for water keeps desert plants well spaced. Most send out shallow, widely branching roots which rapidly soak up any traces of moisture. Others, such as the mesquite, develop long tap roots which reach underground water sources, sometimes more than 30 m deep. The roots of the creosote bush produce toxins which kill any competing plants invading its growth site. The pungent, distasteful juice of this plant also discourages browsing animals.

Yet some plants are actually dependent on animals for their propagation. In June, birds digest the sweet fruit of the saguaro cactus and eliminate the unharmed seeds. Dropping to the shaded ground beneath the nesting sites, these seeds are protected until the next rain stimulates germination. Before the flinty seeds of the mesquite will sprout, they must be eaten. The hard seed covering is removed by animal digestive juices. Moisture can then penetrate and growth begins, after egestion, within the nutrient-rich animal manure.

Animals. The animals of a desert must also cope with the problems of a limited water supply. Desert creatures are adapted to conserving body moisture, which may be lost in any of the following ways: a) evaporation from the surface of the body; b) exhalation from the lungs during respiration; elimination through excretion of body wastes.

One obvious precaution is to avoid the intense daily heat. Thus many desert creatures are nocturnal – they confine their activity to the cool desert nights. Some are physically equipped to burrow. Desert scorpions have enlarged digging claws. Certain snakes and lizards treat sand like water, diving head-first through the surface. Their nostrils are upturned or fitted with valves to keep out the sand. A burrow has many advantage? The surface of the desert sand might register a scorching 65° C, but an animal burrow only 45 cm beneath the surface would remain a cool 16° C. At night, when surface temperatures drop measurably, the insulating air in the burrow maintains a fairly constant temperature in the underground residence. Moisture from the animal's breath raises the relative humidity in the dwelling. This greatly reduces water loss from the body surface of the inhabitant. Burrows also provide a cool storage site for food and a retreat from many enemies.

Animals which cannot burrow seek refuge from the hot sun in any shady patch. The reptiles and scorpions are suited with a nearly impermeable outer covering to minimize surface evaporation. Lizards and snakes have no glands in their skins. Hence, there is no water loss similar to sweating in mammals. Many desert spiders and insects are protected by a waxy exoskeleton. All desert creatures try to minimize contact between their bodies and the hot sand. While hunting insects during the day, lizards use their legs to lift their bodies and tails off the surface. Some can even stride for short distances with only their hind feet on the ground.

When warm-blooded animals sweat or pant, they are simply using a built-in cooling system to keep their body cells at a functional temperature. If mammals become severely dehydrated in hot, dry air, they suffer "explosive heat death". Body moisture, lost by sweating, is replaced by water from the blood. Eventually the blood becomes so thick that it cannot circulate fast enough to transfer metabolic heat to the skin surface. Soaring body temperature causes rapid death. The body temperature of many animals is regulated by their surroundings rather than by an internal mechanism. Such creatures are often called "cold-blooded" – a highly misleading term. A lizard, basking on a desert rock measuring 38° C, has anything but "cold" blood. To keep body cells at a functional temperature, such animals must alternate from sun to shade. Most lizards collapse if their body temperature rises above 40° C. Ten minutes of direct exposure to the hot desert sun can kill a rattlesnake.

Birds are the most active creatures during the day. Perching above the ground, they can easily escape the hot surface as they seek food. During flight, a stream of air cools their bodies. Feathers provide good insulation from the hot rays of the sun, and birds have no sweat glands in their skin.

Since most birds have higher body temperatures – between 40° C and 43° C – they can withstand the heat more readily. However, they lose more moisture through panting than small mammals do. Birds of prey and insect-eaters regain considerable moisture from their food. But many desert birds, especially seed-eaters, must remain within flying distance of surface water. Certain birds, such as swifts and nighthawks, have an added defense against desert rigors. If wind or rain reduces their insect diet for several days, these birds face starvation. To conserve energy, they become torpid – sluggish and inactive – until conditions improve.

Many of the smaller animals use a similar defense during the hottest season when water is desperately scarce. To conserve body moisture, the pocket mouse and ground squirrel enter a deep summer sleep called estivation. The animal's body temperature remains just slightly above that of the moist burrow. Larger creatures must simply endure the days, resting as motionless as possible in any spot of shade, until sunset brings relief from the burning heat. Many have conspicuously large ears. Nocturnal hunters and their prey rely upon their hearing for survival. But heat can also be radiated from the body through the many blood vessels in the ears.

Most desert dwellers pass body wastes in a highly concentrated form to further minimize loss of body moisture. The waste product of protein is poisonous and must be eliminated in the form of urea or uric acid. Birds, insects, and most reptiles excrete crystallized uric acid using minute amounts of water. But mammals and some reptiles produce urea which must be dissolved in water before excretion. Some desert mammals have far more concentrated urine than non-desert species. Mammals which eat meat and insects have a high protein diet. They lose more water through excretion than do vegetarian mammals which consume mainly sugars and starches. Thus, insect-eating bats must drink water daily while seed-eating rodents need not do so.

The kangaroo rat is a perfect example of adaptation. On long hind legs, this agile little rodent can spring across the sand like a miniature kangaroo, barely touching the hot surface. The short forelegs dig the burrow used to escape the heat. These remarkable characters live on a diet of dry plant food – and never take a drink. The body mechanism breaks down the food to yield water for the animal. They have no sweat glands and their urine is highly concentrated.

The rainy season brings water. And water brings life to the face of the desert. A throng of hatching insects clamors among the blossoming plants. Birds hasten to mate and rear their young while food and water are plentiful. It is a time of birth for many desert creatures. Nursing mothers must obtain enough moisture to replace the fluid lost in milk production for their offspring. Even tadpoles and shrimp abound in scattered waterholes! All life struggles to perpetuate itself in this endless cycle of moisture and drought. And so life flourishes, even in the face of death, throughout the desert biome.

Practice

1. To comprehend the geographical location of Desert using geographic atlas.
2. To analyze the peculiarities of physical and geographical conditions of the area occupied by Desert using geographic atlas and guides.
3. Describe typical flora and fauna of Desert using different sources of information.
4. To single out the most topical ecological problems which threaten to existence of Desert natural complexes; to note plants and animal species which liable to protection.
5. Suppose measures as for preservation of Desert biodiversity.

TEST 4

Write the letter of the correct answer in the blank.

1. The climate of the Arctic tundra is characterized by _________ temperatures and cold, dry winds.

 a. annual; **b.** middle; **c.** high; **d.** low.

2. In fact, the entire growing season in the Arctic tundra lasts about ______ days.

 a. 100; **b.** 60; **c.** 160; **d.** 180.

3. The low density of air (and, hence, reduced concentration of oxygen) is a feature unique to the __________.

 a. Arctic tundra; **b.** Alpine tundra; **c.** Desert; **d.** Grasslands.

4. The temperature factor alone greatly limits the number of organisms which can adapt and survive in ____________ biome.

 a. Temperate deciduous forest; **b.** Grasslands; **c.** Arctic tundra; **d.** Coniferous forest.

5. Arctic _________ are adapted to lower light intensity, but they need longer periods of daylight than alpine plants for proper photosynthesis.

 a. mammals; **b.** species; **c.** fish; **d.** birds.

6. Alpine plants are adapted to the _________light intensity of the thin mountain atmosphere.

 a. annual; **b.** middle; **c.** high; **d.** low.

7. Douglas fir, Sitka spruce, Tamarack, Jack pine, White spruce, Balsam fir, Red pine, White pine, Hemlock, White cedar are the common trees of the ______________.

 a. Temperate deciduous forest; **b.** Grasslands; **c.** Arctic tundra; **d.** Coniferous forest.

8. Like the __________ in the tundra, the varying hare plays a major role in the coniferous forest food chain. It eats broad-leafed plants, grasses, herbs, and mosses, as do most of the other herbivores of the coniferous forest.

 a. hemlock; **b.** lemming; **c.** kangaroo; **d.** fox.

9. European beech, Norway maple, __________, Black willow, Trembling aspen, Shagbark hickory, Sycamore are the common deciduous trees.

a. White spruce; **b.** Jack pine; **c.** Sitka spruce; **d.** Red oak.

10. The chernozem soils, characteristic of the prairies, are the most ___________ in the world.

a. fertile; **b.** light; **c.** dranaged; **d.** poor.

11. The short-lived grass plants contribute large amounts of organic material to the _________ each year

a. forest; **b.** bog; **c.** soil; **d.** cell.

12. The relative humidity of __________ air averages less than 30 % at midday.

a. Temperate deciduous forest; **b.** Grasslands; **c.** Desert; **d.** Coniferous forest.

13. Succulents such as cacti, can survive long ___________ by storing water.

a. droughts; **b.** wind; **c.** light; **d.** rain.

DISCUSSION

1. Alpine sorrel is a plant found in both the Arctic and Alpine tundra. The Arctic growth shows adaptive differences from the alpine growth. Using your knowledge of these two regions, explain each of the following:

a) The Arctic growth reaches a maximum rate of photosynthesis at a lower temperature than alpine growth.

b) Alpine growth requires a hig*her,* light intensity than Arctic growth.

c) The Arctic growth requires a longer photoperiod.

d) The alpine growth produces a greater number of flowers.

e) The Arctic growth develops more rhizomes (underground stems used for food storage).

f) The alpine growth reproduces by seedlings: Arctic growth relies on vegetative reproduction.

g) Roots of the Arctic growth are short and quickly replaced; alpine growth develops deep, long-lived roots.

2. Many birds return each spring to nest in the Arctic tundra.

a) What special problems do they encounter?

b) What type of bird life would find the tundra most favorable? Why?

c) Why do many Arctic species lay a larger than average number of eggs?

d) What other adaptations do these summer residents exhibit?

e) Compare the Arctic and Alpine tundra as a habitat for birds.

3. Soil organisms are essential for the recycling of plant nutrients. What type of decomposers can exist in the Arctic tundra? How do they survive the long, frozen periods?

4. Conservationists throughout the world fear permanent ecological damage as a result of the development of oil and other natural resources in the Arctic tundra. What are the major problems created by crews surveying or drilling in the tundra? Why is an oil pipeline considered to be an environmental hazard? Compare this hazard to that of huge oil tankers traveling along the Arctic coastline.

5. a) construct a series of food chains for biome you have studied. Consider both the daily and nocturnal activity within each community as well as any seasonal changes in animal populations; b) combine these food chains to form seasonal food webs for biome.

6. At what continent can you find coniferous forest (taiga) biome?

7. Each of the different strata within a deciduous forest supports a certain segment of the animal community. At which level would you expect to find the greatest diversity of wildlife? Explain.

8. Compare a coniferous and a deciduous forest with respect to each of the following abiotic factors (consider seasonal changes in your explanations):

a) Light. Which type of canopy allows greater light penetration to the forest floor? Select the period of greatest illumination for each forest type.

b) Temperature. Where is the highest and lowest daily temperature located within each type of forest? Would this temperature profile change during the night? Explain.

c) Relative humidity. The highest relative humidity is found near a forest floor. Why? Where is the lowest relative humidity found? Is the relative humidity within a forest higher at night or during the day? Explain.

d) Rainfall. During a light rain, leaves tend to capture water which gradually drains down the branches and trunk as "stemflow." This moisture enters the soil around the base of the tree. Which type of forest growth would result in greater "stemflow"? Explain. How would this affect the growth of shade-loving plants colonizing at the foot of larger trees?

e) Wind. Which type of forest would serve as a more effective windbreak? Explain.

9. Compare a coniferous and. a deciduous forest as a wildlife habitat. Consider seasonal changes in each forest type and include the following factors:

a) availability and diversity of food;

b) protection from predators;

c) shelter from the elements.

10. a) construct a series of food chains for biome you have studied. Consider both the daily and nocturnal activity within each community as well as any seasonal changes in animal populations; b) combine these food chains to form seasonal food webs for biome.

11. By researching animal populations, past and present give the true extent of man`s impact on grasslands wildlife.

12. Humans sometimes have a rather drastic effect on Earth`s biomes. Describe some of the ways in which plants, animals, and soils have been affected by human activities in the grasslands.

13. Desert animals demonstrate many remarkable adaptations. Investigate the habits of some of the following and explain how they are suited to the desert.

a) The kangaroo rat. Why are these creatures so important to the life of the desert?

b) Desert birdlife. What types of birds are found in the desert? Where do they nest? Does the climate affect their breeding habits?

c) Desert snakes. When are they most active? How do they locate and capture their prey?

Recommended Readings

1. A Guide to the Study of Environmental Pollution by W.A. Andrews et al. – Prentice-Hall, 1973.
2. A Guide to the Study of Soil Ecology by W.A. Andrews et al. – Prentice-Hall, 1973.
3. A Guide to the Study of Terrestrial Ecology by W.A. Andrews et al. – Prentice-Hall, 1973.
4. Biodiversity by Edward O. Wilson, Frances M. Peter. – National Academies, 1988.
5. Biological Science by Scott Freeman, Warren Burggen. – Prentice Hall, 2002.
6. Biology: The Study of Life by William D. Schraer, Herbert J. Stoltze. – Cebco, 1990.
7. Ecology: Principles and Applications by J. L. Chapman, M. J. Reiss. – Cambridge University Press, 1999.
8. Environmental Biology by Mike Calver, Alan Lymbery, Jennifer McComb. – Cambridge University Press, 2009.
9. Environmental Biology by Michael Reiss, Jenny Chapman. – Cambridge University Press, 2000.
10. Laboratory investigations for biology by Jean Dickey. – The Benjamin/Cummings Pub. Co., 1995.
11. Teacher's Planning Guide. Earth's Ecosystems by Mary Atwater, Prentice Baptiste and others, Macmillian / McGraw-Hill School Publishing Company, 1993.
12. Teacher's Planning Guide. The Animal Kingdom by Mary Atwater, Prentice Baptiste and others, Macmillian / McGraw-Hill School Publishing Company, 1993.
13. Teacher's Planning Guide. The Plant Kingdom by Mary Atwater, Prentice Baptiste and others, Macmillian / McGraw-Hill School Publishing Company, 1993.
14. Teacher's Planning Guide. Changing Earth by Mary Atwater, Prentice Baptiste and others, Macmillian / McGraw-Hill School Publishing Company, 1993.
15. The science of ecology by Paul R. Ehrlich, Jonathan Roughgarden, Joan Roughgarden. – Macmillan, 1987.

TERMINOLOGICAL GLOSSARY

abiotic factors – the nonliving parts of an ecosystem such as soil and light

active transport an energy-requiring process which a substance can move through a cell membrane from an area of low concentration of that substance to an area of-high concentration of that substance

adaptation a trait that increases the ability of an organism to survive in its environment

aerial root a root that grows above ground from the stem of a plant

amphibian a cold-blooded vertebrate that has a moist skin with no scales and lives part of its life in water and part on land and beets

angiosperm a seed-bearing plant that produces seeds inside a fruit; flowering plant

annual plant a plant that grows, reproduces, and dies within one growing season

apical meristem a mass of cells at the tip of a root and shoot that divide and cause growth of the root or shoot

aquaculture – the raising of aquatic animals and plants, such as shellfish or seaweed, for food; underwater agriculture

arthropod an animal that has jointed legs, an exoskeleton, and a segmented body

asexual reproduction the production of offspring from only one parent cell

axon a nerve fiber that-carries impulses from the cell body of one neuron to the next

behavior the reaction of an organism to its environment

biennial plant a plant that produces leaves and food in one year, and reproduces and dies in the second year

biome – a complex community of plants and animals living in a particular geographical area with a particular climate

biotic factors the living parts of an ecosystem such as plants and animals.

biotic potential the number of organisms that could be produced under the best possible conditions

bird a warm-blooded vertebrate with wings, a beak, two legs, and a body covered with feathers

bone a hard substance containing calcium and phosphorous that makes up the skeletal system

book lung a breathing structure of an arachnid that consists of their leaves of tissue that resemble pages of a book through which air passes

cambium a growth tissue that gives rise to new xylem and phloem cells

canopy the layer of the tropical rain forest 30-40 meters above the ground. Trees are so closely intertwined that there is little space between them

carnivore an animal that feeds on plant-eating animals and other carnivores

carrying capacity the number of individuals of a population that an environment can support

chlorophyll a pigment that causes a plant to appear green; chlorophyll absorbs visible light from the sun to provide the energy for photosynthesis

chloroplast a disk-like structure in plant cells that contains chlorophyll

cilia similar hairlike structures on certain cells, such as paramecia, that move to and fro allowing the cell to move

circulatory system transport system made up of the blood, blood vessels, and heart that circulates blood throughout die body

climate the typical weather conditions of a particular place or region, usually considered in terms of average temperature. humidity, rainfall, and wind conditions

climax community the final stage in the ecological development of a given community of plants, animals, and other organisms, in which species are stable and appetite themselves as long as the same ecological conditions persist

closed circulatory system transport system in which the blood remains inside blood vessels that circulate it throughout the body; see also open circulatory system

cnidarian a hollow-bodied animal with stinging cells

cold-blooded having a body temperature that varies with the temperature changes of the environment

comensalism a relationship between two organisms of different kinds in which one is benefited and the other is neither benefited nor harmed

communication the exchange of signals or messages such as flashing lights, odors, bright colors, or sounds performed by one animal that informs or influences another animal

community all the animals, plants, and other organisms that live in a certain area and interact with each other, considered as a group

complete metamorphosis development in animals that involves a process consisting of four stages egg, larva, pupa, and adult

conditioning training to cause a response to a stimulus that does not normally-cause that response

consumer organisms, usually animals, that feed on another organisms.

cortex root cells that store food

cotyledons the seed leaves in the embryo of a seed

cross-pollination pollination between two plants

crown fire an extremely hot, rapidly burning forest fire that destroys all organisms in its wake, commonly occurs in forests that have had recent ground fires

cuticle a waxy layer that covers the epidermis of some leaves and reduces water loss

deciduous forest a forest primarily of trees that lose their leaves seasonally

deciduous tree a tree that loses all its leaves at the end of each growing season

decomposer an organism, such as a bacterium, that breaks down dead plant and animal matter into simpler substances that be used by other organisms

dendrite a branch of a neuron that receives stimuli

desert a sandy or rocky region with very little rainfall, having little or no vegetation

diaphragm a sheet of muscle across the bottom of the chest cavity that expands and contracts to move air into and out of the lungs

diffusion the movement of particles from areas where they are more concentrated to where they are less concentrated

digestive system a group of organs that act together to take in food and change it to a form cells of the body can use

dominant species those species that most strongly affect the community

dormancy a period of time when the plant embryo is in a resting stage

dormant seed a seed that has not yet germinated but still has the potential to germinate

echinoderm a marine animal that has a mineral skeleton with spines

ecology a branch of biology that deals with the relationships of living things to their surroundings and to each other

ecosystem all the living things within a particular area and their relationship to each other and to their physical environment

emergent layer trees in the tropical rain forestthat stand 10 to 20 meters above the canopy layer

endoskeleton a skeleton located inside the body

enery pyramid a diagram that shows the flow of energy through a food chain with producers at the base and consumers in the upper levels

environmentalist a person who is concerned about the quality of the environment, especially about the effects of pollution of Earth's air, land, and water and the exhaustion of Earth's air, land, and water and the exhaustion of Earth's natural resources

epidermis the surface layer of a leaf that protects the inner parts of the leaf.

estuary the place where a body of fresh water meets the ocean

evergreen tree a tree that loses its leaves gradually. Itnever is completely without leaves, therefore it appears ever green

excretory system a group of organs that act together to eliminate pastes from the body

fertilization the process in which a male gamete and a female gamete combine to form a zygote

fibrous roots clusters of roots that are made up of many small, branching roots that grow near the top level of soil

fish a cold-blooded vertebrate that lives in water and obtains oxygen from the water by using gills

fixed action pattern a complicated series of movements

flagella long whiplike tails or parts that enable certain cells, bacteria, and protozoa to move

flatworm a simple animal that has a flat, legless body with an identifiable head and tail

food chain a sequence of the living things of a community, in which each plant, animal, or other organism in the sequence feeds upon the one below it

food web a network of interrelated food chains in an ecological community.

fruit the ripened ovary of a flower that contains one or more seeds

germination the early growth of a plant from a seed

gestation the time, between fertilization and the birth of an offspring

gill an organ found in fish used to obtain oxygen from water and-release carbon dioxide from the blood into water

grassland an area of irregular rainfall where varieties of grasses are the primary plants

guard cells cells that surround a stoma and control its size

gymnosperm a seed-bearing plant that produces seeds not protected by a fruit

habitat that area or region in which an animal or plant naturally lives or grows

herbaceous stem a soft, green stem; xylem and phloem are arranged in bundles

herbivore an animal that eats only plants

herbivore any animal that feeds chiefly on plants

incomplete metamorphosis development in animals that involves three stages egg nymph and adult

innate behavior a behavior that an animal is born with, which is passed on from generation to generation

insight the ability to reason and respond to a situation

latitude the distance north or south of the equator, measured in a unit called a degree

learned behavior abehavior that is taught through experience or training

limiting factor a condition in the environment that stops a population from increasing in size

mammal a warm-blooded vertebrate that has hair and produces milk to feed its young

mantle a fold of tissue in mollusks that makes the shell. marsupial mammal whose young complete their development in the mother's pouch

meiosis a method of cell division in which sex cells are produced

metamorphosis the transformation from larva to adult form that many invertebrates and amphibians undergo

mitosis the process in which a cell's nucleus divides forming two new celts with identical genetic material

mollusk soft-bodied invertebrates that live on land or in fresh or saltwater

muscular system a group of organs that acl together to allow for movement of an animal

mutualism a symbiotic relationship between two different kinds of organisms that benefits both of them

nervoussystem a group of organs that act together to regulate-and control the activities of an animal

niche status or role of an organism within its community

nonvascular plant plant that does not contain xylem and phloem tissue

omnivore an animal that feed on both plant and animal material

open circulatory system a system of transport in which blood is not contained in vessels but circulates freely through the body surrounding the cells

osmosis the diffusion of water through a membrane

palisade cells a layer of loosely packed cells just below the upper epidermis of a leaf that contain chloroplasts

parasitism relationship in which one organism lives on and may harm another organism called a host

perennial plant a plant that lives from one growing season to another; includes all woody stem plants

petal the brightly colored leaflike part of flowers that surrounds the reproductive parts

petiole a leaf stalk that attaches a leaf blade to the stem

pheromone a chemical that conveys information to other members of a species

phloem a plant tissue made up of tube-like cells that transports food from the leaves to other parts of the plant

photoperiodism the flowering response of a plant to the change in the length of the day

photosynthesis the process in which plants use carbon dioxide and water with light energy to produce food and oxygen

pigment a substance that absorbs light

pioneer community the first community to appear after a community has been disrupted

pioneer species the first organism to grow in an area

pistil the female reproductive organ of an angiosperm

placenta sack that grows into the wall of the uterus through which food, oxygen, and wastes move back and forth between mother and developing young

plant behavior the response of a plant to astimulus

pollination the movement of pollen grains from an anther of a flower by wind, water, or animals to a stigma of a flower

population all the organisms of one species in a community

population density the number of individuals per unit of living space in an environment

predation when one organism hunts and eats another

primary succession the formation of a community in an area where no previous organisms existed and involves the formation of soil

producers organisms, such as plants, that use inorganic substances to make food

prop root an aerial root that helps support a plant

protist a one-celled organism with both plant-like and animal-like characteristics

puberty the stage of development during which the body becomes physically able to reproduce

radula a tongue-like organ of some mollusks, which has rows of teeth for tearing and scraping food

reflex an automatic response to a stimulus

regeneration the regrowth of lost or damaged tissues and organs.

regurgitate to rush, pour, or flow back, as liquids, gases, or undigested food

reptile a cold-blooded vertebrate that has scales, breathes air, and lives mainly on land

respiration the process by which cells release energy from food molecules

respiratory system a group of organs that act together to bring oxygen into the body and expel carbon dioxide from the body

response a change in behavior as a result of a stimulus

rhizoids long, single cells that attach liverworts and mosses to the ground and absorb water and dissolved nutrients from the soil

root cap a dome-shaped mass of cells that protects the root as it grows and pushes its way through the soil

root epidermis the outside covering of a root that comes in contact with the soil water and dissolved nutrients are absorbed across the root epidermis from the soil

root hair a single, threadlike cell that is an extension of the root epidermis; root hairs increase the surface area of the root available for absorbing water and dissolved nutrients

rotifer any of a large group of many-celled microscopic animals found in ponds and puddles, having a ring of cilia at one end that is used for locomotion and feeding

rundworm a worm that has a round, tube-like body tapering to a point at each end

scavenger an animal, such as a vulture or hyena, that feeds on decaying plant or animal matter

secondary succession the process that occurs when an existing community is disturbed

seed a plant embryo, stored food, and seed coat

seed coat me tough outer layers of a plant ovule

seed dispersal the process of moving plant seeds away from the parent plant

segmented worm a worm that has a tube-shaped body divided into segments that are similar in structure

selfpollination transfer of pollen grains from stamens to pistils of the same flower or from one flower to another flower of the same plant

sepal a leaflike part of a flowering plant that protects the flower when it is a young bud

sexual reproduction the production of offspring using sex cells

skeletal system a group of organs that act together to provide support and protection to the body and allow the body to move

society a group of animals of the same species that interact together

sponge the simplest kind of animal, having no definite shape and living attached to one spot

spongy cells loosely packed cells just inside the lower epidermis of a leaf; they contain chloroplasts

stamen the male reproductive organ of angiospenns

stimulus something outside of a in its environment that affects the plant's behavior

stomata the slit - like openings or pores in the epidermis of leaves

succession process of gradual change in a community in which different species become dominant

symbiosis the close association of two living things that are not alike.

synapse the space between neurons

taiga any of the northernmost forests of cone-bearing trees in North America, Europe, and Asia

taproot type of root in which food is stored in a long, thick, main root, such as in carrots

territory area that an animal or group of animals defends against others of its species

transpiration loss of water by a plant by outward diffusion through the stomata of leaves

trial and error a type of conditioned learning in which an animal develops a behavior by learning to avoid mistakes

tropical rain forest a hot, humid forest found in low-laying areas near the equator

tropism a plant response that involves a change of position by growing toward or away from a stimulus

tundra a vast, treeless plain in the northernmost parts of Asia, Europe, and North America, having an arctic or subarctic climate and a layer of permanently frozen soil several inches below the surface

understory the layer below the canopy in the tropical rain forest where the plants either need filtered light or are struggling to reach the canopy layer

vascular plant a plant that contains xylem and phloem tissue

veins the bundles of xylem and phloem that run through leaves

warm-blooded maintaining a nearly constant body temperature not influenced by the temperature of the surroundings

woody stem a hard, rigid stem; the xylem and phloem are arranged in two separate rings-the xylem rings inside the phloem rings

xylem a plant tissue made up of vessels that transport water and dissolved nutrien

zygote a single cell produced by fertilization that grows by cell division to become a complete organism

ENGLISH-UKRAINIAN GLOSSARY

1. accurance – наявність
2. age distribution – розподіл за віком, вікова структура
3. alfalfa – конюшина
4. algae – водорость
5. alkoline vegetation – лучна рослинність
6. angiosperms – покритонасінні рослини
7. annual – однорічний
8. availability – доступний
9. biennual – дворічний
10. birch – береза
11. bloom – цвітіння
12. boundary – межа (границя)
13. budding – брунькування
14. bush – чагарник
15. canopy – найвищий ярус дерев
16. carnivores – твариноїдні
17. cell – клітина
18. ciliates – війчасті клітини
19. clumped – плямистий
20. community composition – склад угруповання
21. competitive exclusion – конкурентне виключення
22. compound – сполука
23. cover slips – покривне скельце
24. cycling – кругообіг
25. cyst – циста
26. decomposes – редуценти
27. detritivore – детритофаг
28. digestion – засвоєння, травлення
29. disease – хвороба
30. drought-tolerant – посухостійкий
31. egestion – виділення
32. extinction – зникнення
33. family – родина
34. filamentous – нитчасті (форми)
35. flagellum – джгутик
36. foetus – плід

37. food chain – ланцюг живлення
38. food web – трофічні відносини
39. fungi – гриби
40. genus – рід
41. glass slides – предметне скло
42. growth rates – темпи росту
43. gymnosperms – голонасінні рослини
44. habitat – місцеіснування
45. habitat – середовище існування
46. herb vegetation – трав'яниста рослинність
47. herbivores – травоядні
48. ingestion – захоплення їжі
49. interbreed – схрещуватися
50. interspecific interactions – міжвидові взаємовідносини
51. intestine – кишечник
52. intrinsic rate – швидкість експоненціального росту
53. layer – ярус
54. lichen – лишайник
55. mire vegetation – болотна рослинність
56. mortality – смертність
57. moss – мох
58. multicellular – багатоклітинні (форми)
59. natality – народжуваність
60. nucleus – ядро
61. nutrient – поживні речовини
62. oak – дуб
63. offspring – потомство
64. omnivore – всеядний
65. organic matter – органічна речовина
66. pea – горох
67. peculiarities – особливості
68. perennual – багаторічний
69. pests – шкідники
70. plentiful – рясний, багатий, пишний
71. pollen – пилок
72. population – популяція
73. productivity – продуктивність
74. randomly spaced – випадковий

75. rare – рідкісний
76. root – корінь
77. saplings – молоді деревця, підріст
78. saprobe – сапробіонт
79. scavenger – організм, що живиться падаллю
80. seed – насіння
81. sex ratio – чисельне співвідношення статей
82. shadeenduring – тіневитривалий
83. shope – форма
84. shrub vegetation – чагарникова рослинність
85. sleeping-sickness – летаргічний енцефаліт
86. soil – грунт
87. spacial distribution – просторовий розподіл
88. species – вид
89. species diversity – видове різноманіття
90. stem – стебло
91. storage – запас
92. stratification – ярусність
93. stratum – ярус
94. terrestrial – надземний
95. texture – будова, структура
96. timber – деревина
97. trophic – трофічний
98. under story – підлісок (рідколісся)
99. unicellular – одноклітинні
100. vegetation – рослинність (рослинний покрив)
101. weight – маса
102. wild life – жива природа
103. woody vegetation – дерев’яниста рослинність