Teaching about Ecosystems

Object of the ecology: ecosystem - biogeocoenosis (ecosystem)

- An ecosystem is a superorganism entity
- Ecosystem - association of certain species
- This term was introduced in 1935 by Dzh.Tensli.
- Biogeocoenosis - a portion of the biosphere with homogeneous topographic, microclimatic, hydrologic, and biotic conditions

Ecology (Oikos-home, logos-science)

- Integrated science that studies the laws of the functioning of living systems in their interaction with the environment and each other

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- ***Problems of ecology***:
- 1. Levels and laws of interaction of organisms with the environment.
- 2. The boundaries of the danger of anthropogenic impact on the biosphere.
- 3. Development of scientific advice to create a waste-free production, technologically literate ecosystems, using the principle of circulation of substances in nature.
- 4. The study of the laws of nature to prevent ecological crisis.
- 5. STORING gene pool of wildlife
- 6. STORING health and gene pool of mankind, the management of its ability to adapt.
- 7. Nature conservation, restoration of natural ecosystems.

Global problems

- 1. Thermonuclear catastrophe prevention
- 2. The depletion of fuel resources
- 3.Climate change on the planet.
- 4.Population increase.

Methods of Ecology

- 1.Field study
- 2.Natural conditions experiment;
- 3.Modelling of processes and situations that occur in populations and ecological communities.

Stages of development

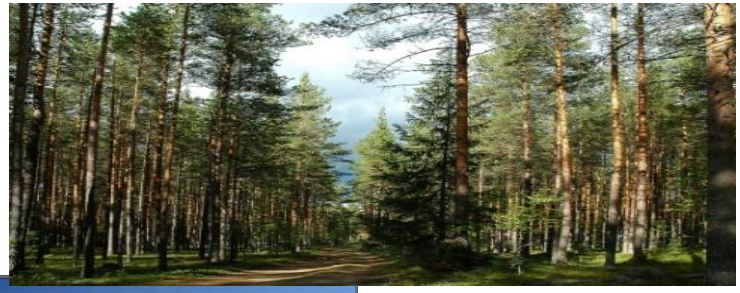
- 1.Period of "naive ecology" from antiquity to 1866. (Ends with the definition of "environment”);
- 2.Period from 1866 to 1935. - The period of factorial ecology; studies patterns of relationships of animals or plants in various environmental factors;
- 3.From 1936 to1970. - period of synecology; studies relationships of communities in ecosystems;
- 4. From early 70's to mid 80's demecology is actively developing that laid the foundations of the global environment;
- 5. From 89's to the present human ecology

From medical and biological points of view biogeocoenoses can be divided into 3 groups:

a) Natural – are little influenced by humans; have high biomass and low primary productivity

b) Arocenoses are characterized by low biomass and high primary productivity.

c) Urban and industrial ecosystems



By population ecosystems are divided into:

- ***Microecosystem*** *– a rotting trunk of a tree ... ..*
- ***Mezoecosystems*** **-** *forest, pond .....*
- ***Macroecosystems*** **-** *the ocean, the continent ....*
- ***Biomes*** *(tundra, taiga, steppe, etc.)*
- ***The global ecosystems*** **-** *the biosphere*

Terrestrial biomes

- ***Evergreen rainforest desert***
- ***Cheparal***
- ***Tropical savanna***
- ***The Barrens***
- ***Deciduous forest***
- ***Coniferous forest***
- ***Tundra***

Types of freshwater ecosystems

- Elt (standing water) – lake, pond
- Lothic (flowing water) - rivers, streams
- Wetlands - marshes, forest

Types of marine ecosystems

- **Open ocean - pelagic**
- **Coastal waters - continental shelf**
- **Areas of upwelling - fertile areas with productive fisheries.**
- **Estuaries - coastal bays, straits, rivers, etc**

The components of the ecosystem: ecotope and the biocenosis

- ***Biocenosis*** - a collection of all kinds of organisms that occur together.
- ***Ecotop*** - a collection of all the environmental factors in the environment.

The spatial organization of ecosystem structure

The structure of the ecosystem is divided into ***two tiers***:

- ***top*** **-** autotrophic (self-feeding) or "green belt" i.e. photosynthetic and chemosynthetic organisms.
- ***lower*** **-** heterotrophic (feeding others) or "***brown belt"*.**

- Biocoenosis ecosystem is inhabited by different kinds of communities of organisms that are similar in their biology. However, the number of different communities of organisms in an ecosystem characterized by biocenosis is various

Dominant types of ecosystems

- 5-10% make up the bulk of the biomass (4/5); they are the dominant species.
- They have a high density, as they have an optimal adaptation

Subdominant and decomposers

- ***Often these species are found in other ecosystems, but form a lower density of the population there – so called subdominant.***
- ***Or low density – so called decomposers***

ecological niche

- A species in the ecosystem is the complex of life forms that allow it to use certain properties of the medium and play a certain role in the ecosystem.
- Each species in the ecosystem occupies a certain ecological niche –a place in the ecosystem.

Law of Grigorieva - Budyko (law of periodicity)

- **With the change of physical and geographic zones of the Earth similar landscape zones and some general properties are periodically repeated .**
- **According to this law index of dryness (moisture) in nature (the universe) periodically changes - three times between the poles and the equator, and the same type of ecosystem in its composition and productivity changes three times .**

Zoning of macroecosystem

- Ecosystems are not scattered in disarray, but rather clustered in fairly regular zones, both horizontally and vertically - this is confirmed by the periodic law of A.A.Grigoreva - Budyko.

Geographic zoning

1. the Barrens

2.deserts of mild zone

3. subtropical steppe

----------equator----------

1.shrubby savannah (steppes)

2.subtropical deserts

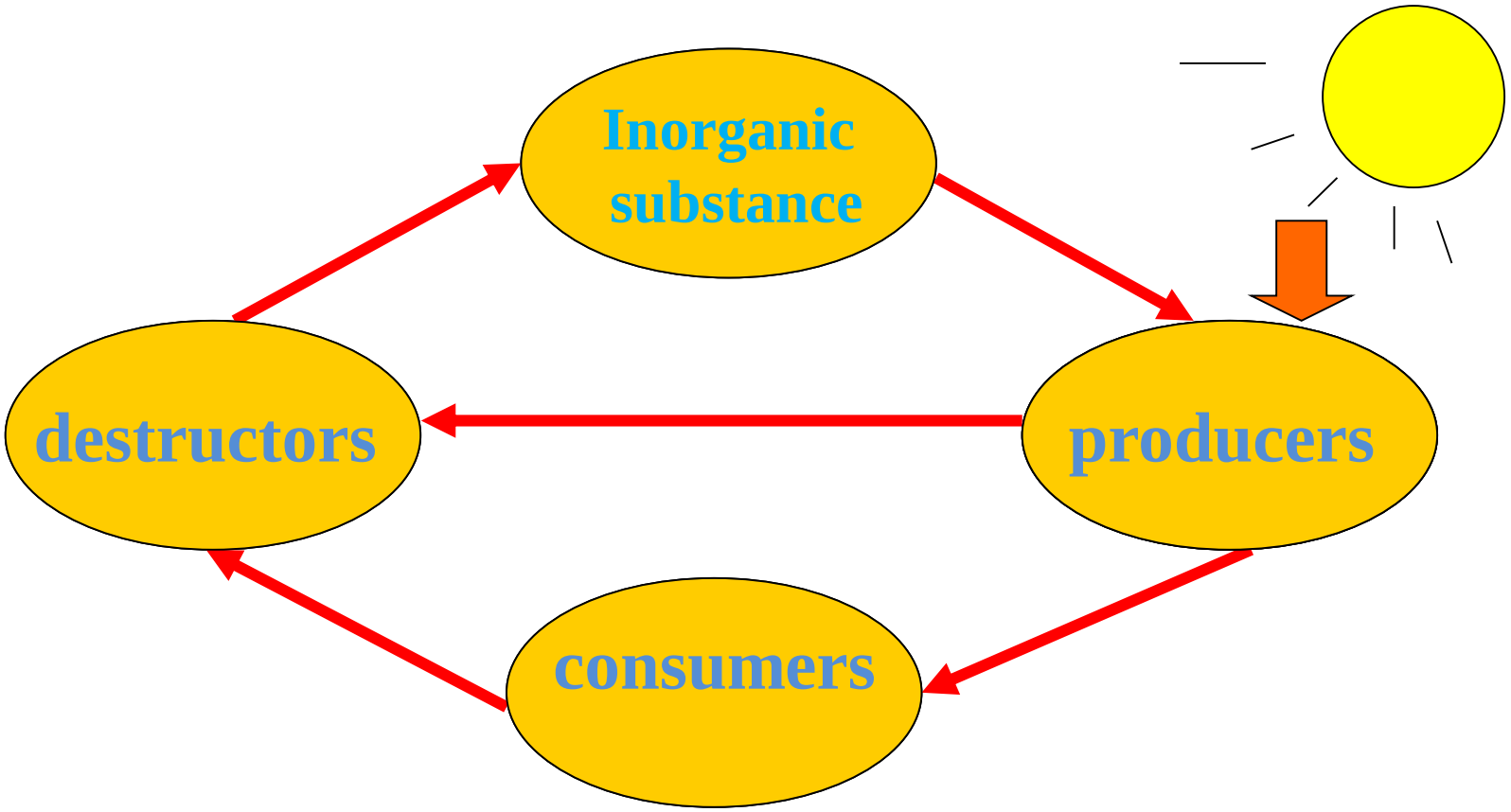
3.tropical desert

Characteristics of ecosystems from a biological point of view

Ecosystem has the following components:

- 1- inorganic substance (c, N, CO2, H2O, etc.);
- 2 - organic compounds (proteins, carbohydrates, and lipids);
- 3 -air, water and soil protection;
- 4 - producers which produce food by photosynthesis and chemosynthesis (autotrophs);
- 5 - consumers (phagotrophs);
- 6.- decomposers and destructors (heterotrophic).

Necessary components of an ecosystem



Ecosystem - biogeocoenosis (biocenosis + ecotope)

Consumers are divided into:

1. Consumers of first order - animals that feed directly on producers (phytophagan).

2. Consumers of second order - the animals that feed on herbivores (zoophages)

3. Consumers of third order - the animals that feed on herbivores and carnivores (secondary predators).

There are consumers of 4th and 5th order; the 5th as the maximum

the primary consumers

- Consumers feed on living (biofagous) or dead (saprophagous) organic substances.Among the biofagous there are phytophagous that feed on plants and constitute primary consumers.

secondary consumers

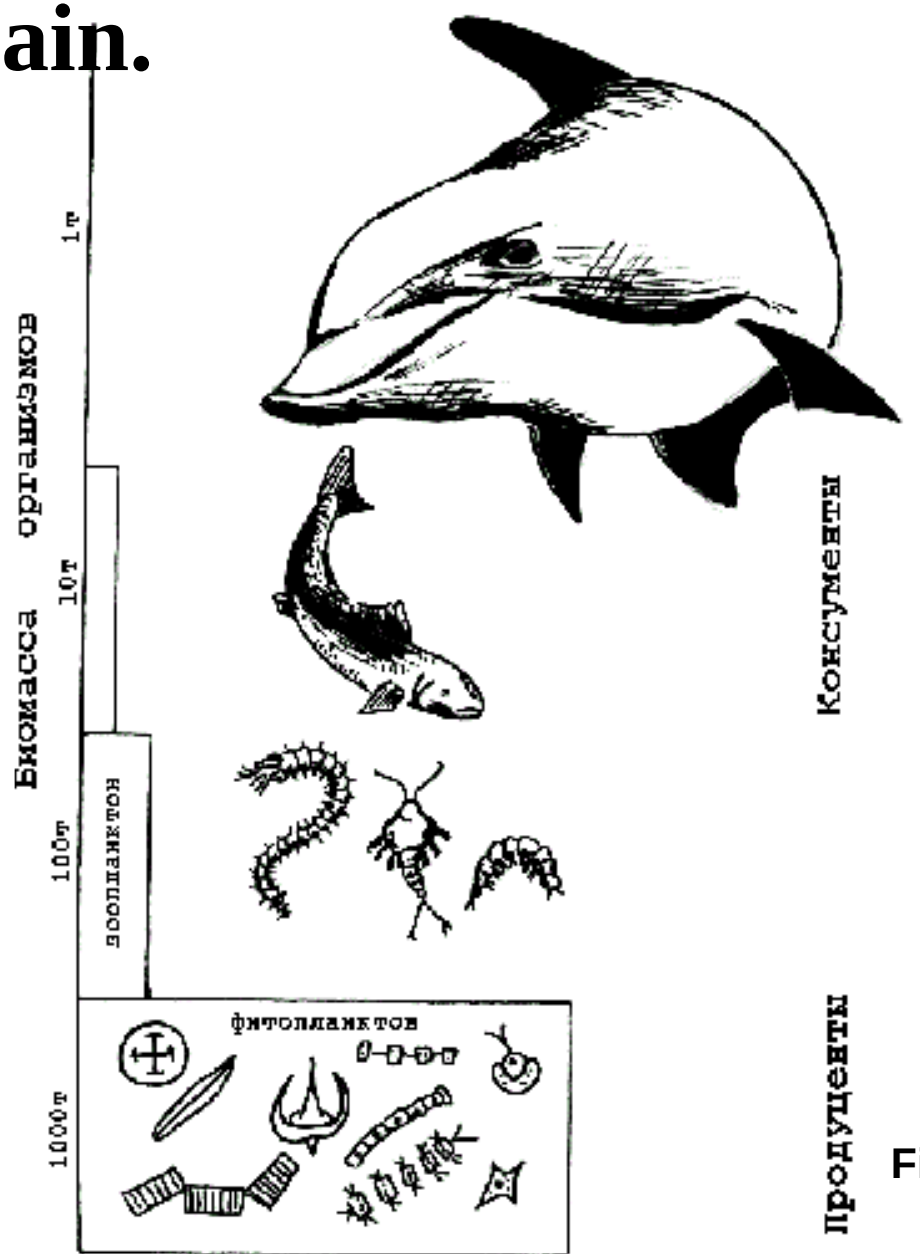
- Secondary consumers eat the phytophagous.
- They are parasites of primary consumers and final consumers.

tertiary consumers

- ***Tertiary consumers are apex predators***

ТИПЫ ПИТАНИЯ

The functional unit of biogeocoenose - food chain.



Food chain (supply chain) – transfers solar energy contained in food among organisms.

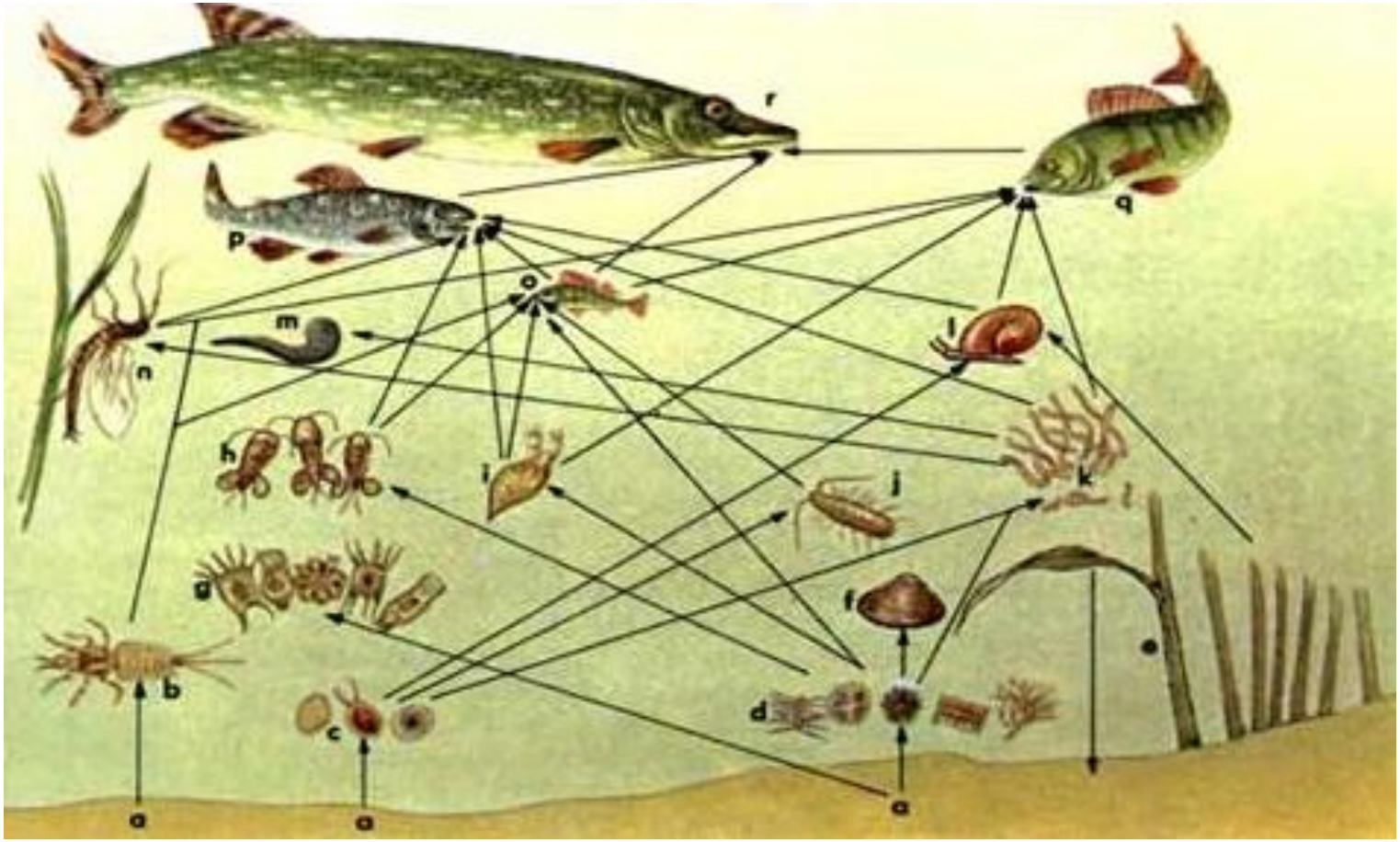
Ten percent rule - transition of 10% (7 to 17%) of energy from one trophic level to another (or substances).

Figure **Food pyramid of sea**

Links in ecosystems

- ***In ecosystems food and energy links between different categories of ecosystem are always objective and go in the direction from-to:***
- ***Autotrophs - heterotrophs***
- ***Autotrophs - consumers - decomposers***

Food chains in the ecosystem intersect, forming a complex food web (interlocking food chains) that is more stable.



food links

- **This is mechanism of energy transfer from one body to another:**
- ***Juice of roses - Aphid - Ladybug - spider - insect - predatory bird***
- **In this way energy is transferred through a series of organisms in an ecosystem - each subsequent feeds the previous one, it provides raw materials and energy - a sequence of energy transfer is called food (the food) chain or supply chain, and the place of each link in the food chain is a trophic level.**

The food chain of predators

- *It starts with plants and moves from small organisms to organisms of larger sizes (4-5 links)*
- *Nectar - fly - spider - shrew - Owl (consists of 5 levels)*

The parasitic system

The link goes from large organisms to small ones:

People - pork tapeworm

MAN -LAMBLIA

Grazing food chain

- ***Begins with photosynthetic organisms – grazing chain***
- ***PLANTS -hares- Wolves - LYNX***

Пастбищные и детритные пищевые цепи(цепи выедания или потребления)

Detrital food chain

- *Begins with dead plant remains, animal excrement and cadavers. This is the degradation chain.*
- *They play a special role in the deciduous forests.*
- *The leaves are crushed by bacteria and insects; further eaten by amphibians, earthworms:*
- *Leaf litter - bacteria and fungi - earthworm - blackbird - Hawk*

- **Part 2**

Cycle of matter and energy in ecosystems

Ecological pyramids

- Within each ECOSYSTEM food webs have a well defined structure that is reflected by ECOLOGICAL PYRAMIDS

Ecological pyramids are formed as a GEOMETRIC FORM

- *They are built as rectangles of the same width but their length should be proportional to the measured object.*

There are:

- *STRENGTH PYRAMIDS;*
- *Biomass PYRAMIDS;*
- *ENERGY PYRAMIDS.*

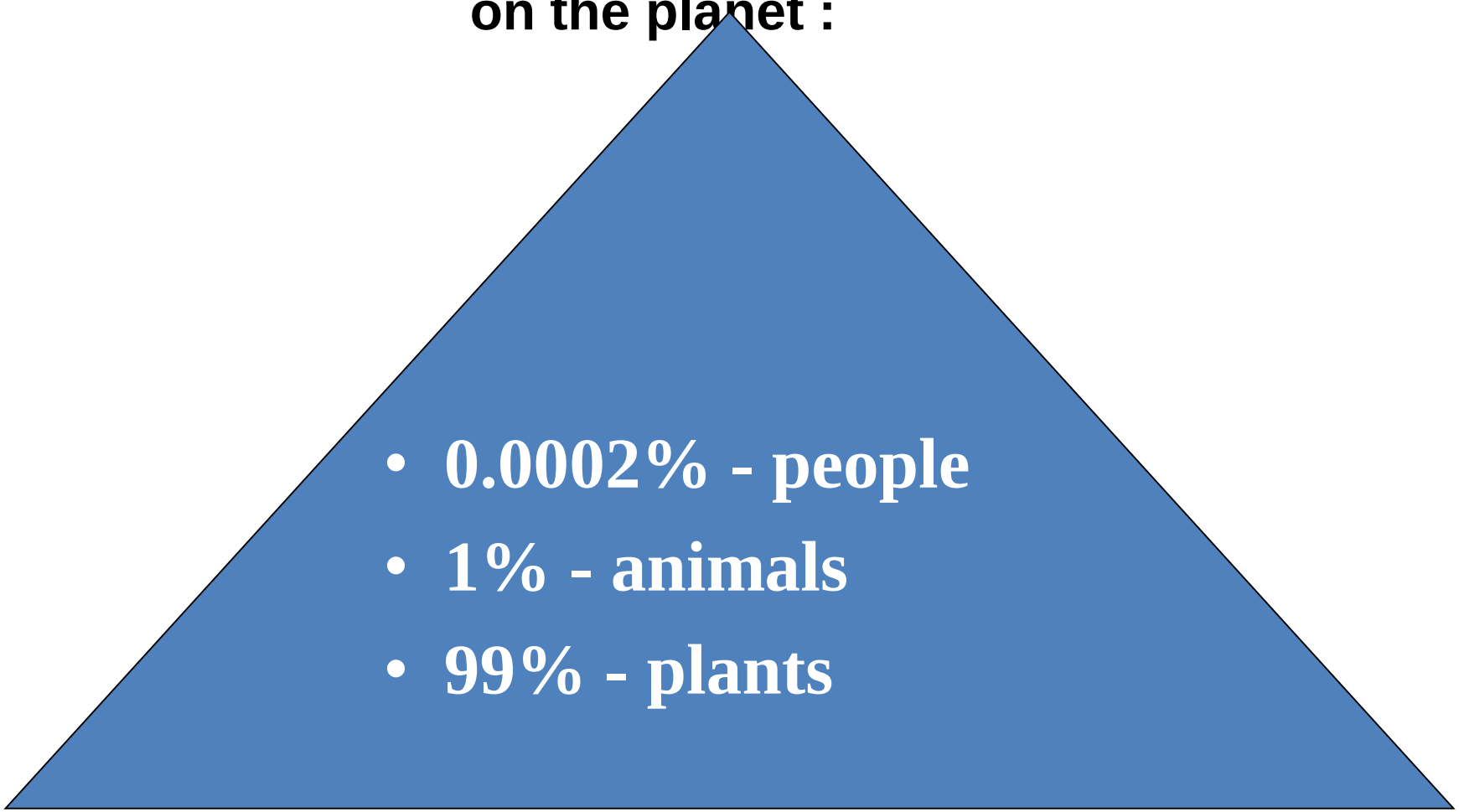
ecological pyramid

Ecological pyramids show trophic structure of ECOSYSTEM

- *HEIGHT of the ecological pyramid is in proportion to the food chain length, i.e. the number of its trophic levels*
- *Pyramid shape reflects the efficiency of energy conversion to another level*
- *Any ecosystem has more Plants THAN ANIMALS (herbivores) and more herbivores than carnivorous, as well as more insectivorous than birds*

The rule of the food pyramid

It is reflected in the ratio of plant and animal biomass on the planet :

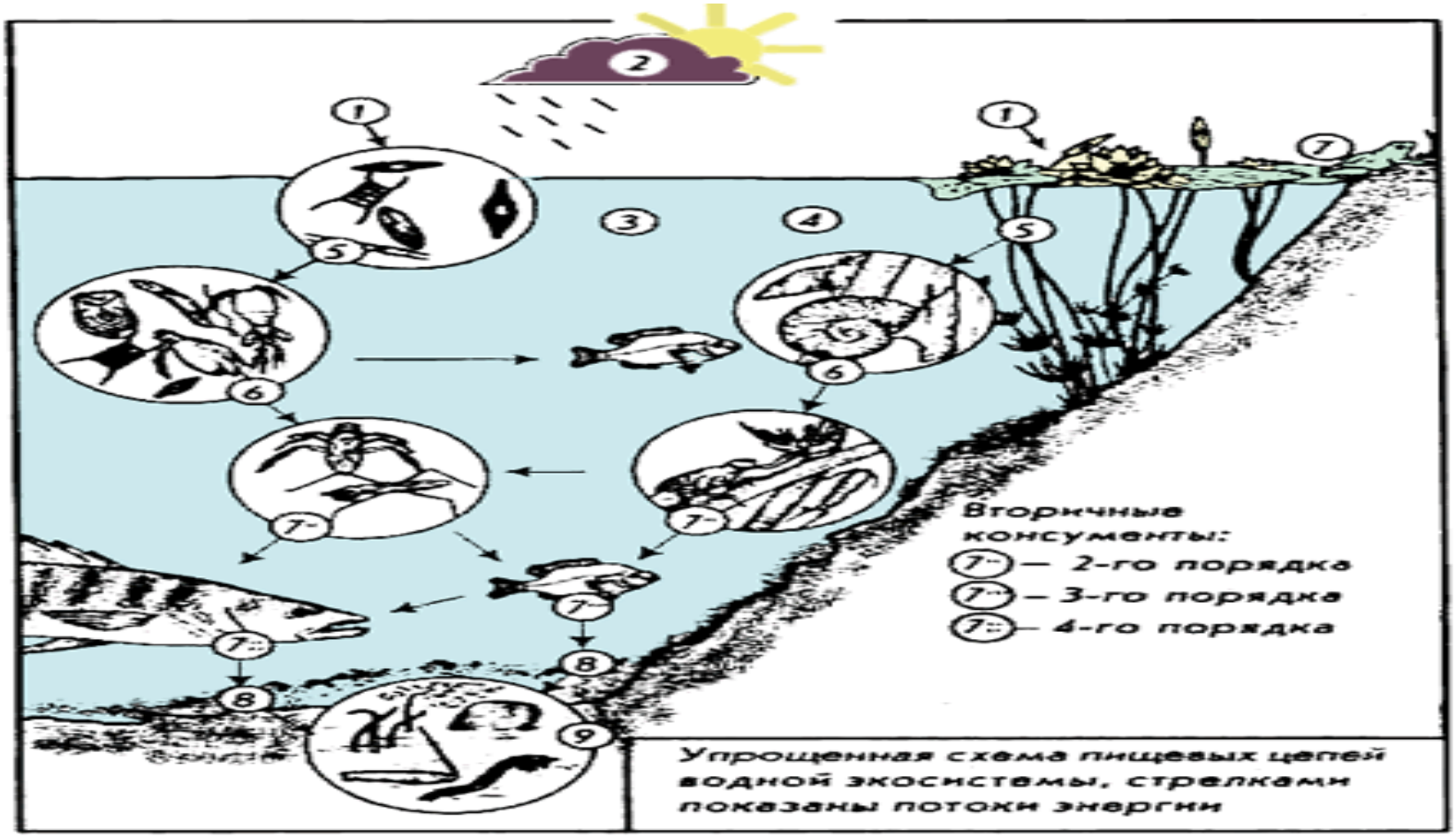


STRENGTH PYRAMID

REFLECTS density (number) of organisms at each trophic level).

PYRAMIDS are diverse and can often be reversed, FOR EXAMPLE: there are less trees in the forest than INSECTS

Energy flow in the aquatic ecosystem



POWER PYRAMID

It reflects the efficiency of

ENERGY CONVERSION and EFFICIENCY of FOOD CHAINS

They are built by counting the amount of energy (calories) to accumulate by the unit of surface in definite time which is used at each trophic level.

This makes it possible to determine the total amount of energy absorption at each trophic level.

PYRAMID OF BIOMASS

- *They take into account the total weight of the body (biomass) on each trophic level.*
- *This pyramid more fully reflects the feeding relationships in an ecosystem.*
- *Rectangles in the pyramid REFLECT the weight of each trophic level per area or volume unit*

The fate of the absorbed solar energy

30% of the solar energy is absorbed, 29% of it is spent on the exchange, respiration, and 1% is spent on the synthesis of its own organic substance.

Main source of energy in the ecosystem

The primary source of energy in the ecosystem

IS solar energy. The Sun sends to the EARTH OVER 20 MLN joules a year.

Only a quarter of that stream reaches the Earth (due to the sphericity of the planet). 70% of energy is reflected, is absorbed by the

atmosphere, emitted in the form of infrared radiation.

The earth's surface annually gets 1.54 million

jouls that 5,000 times more than all the energy of humanity.

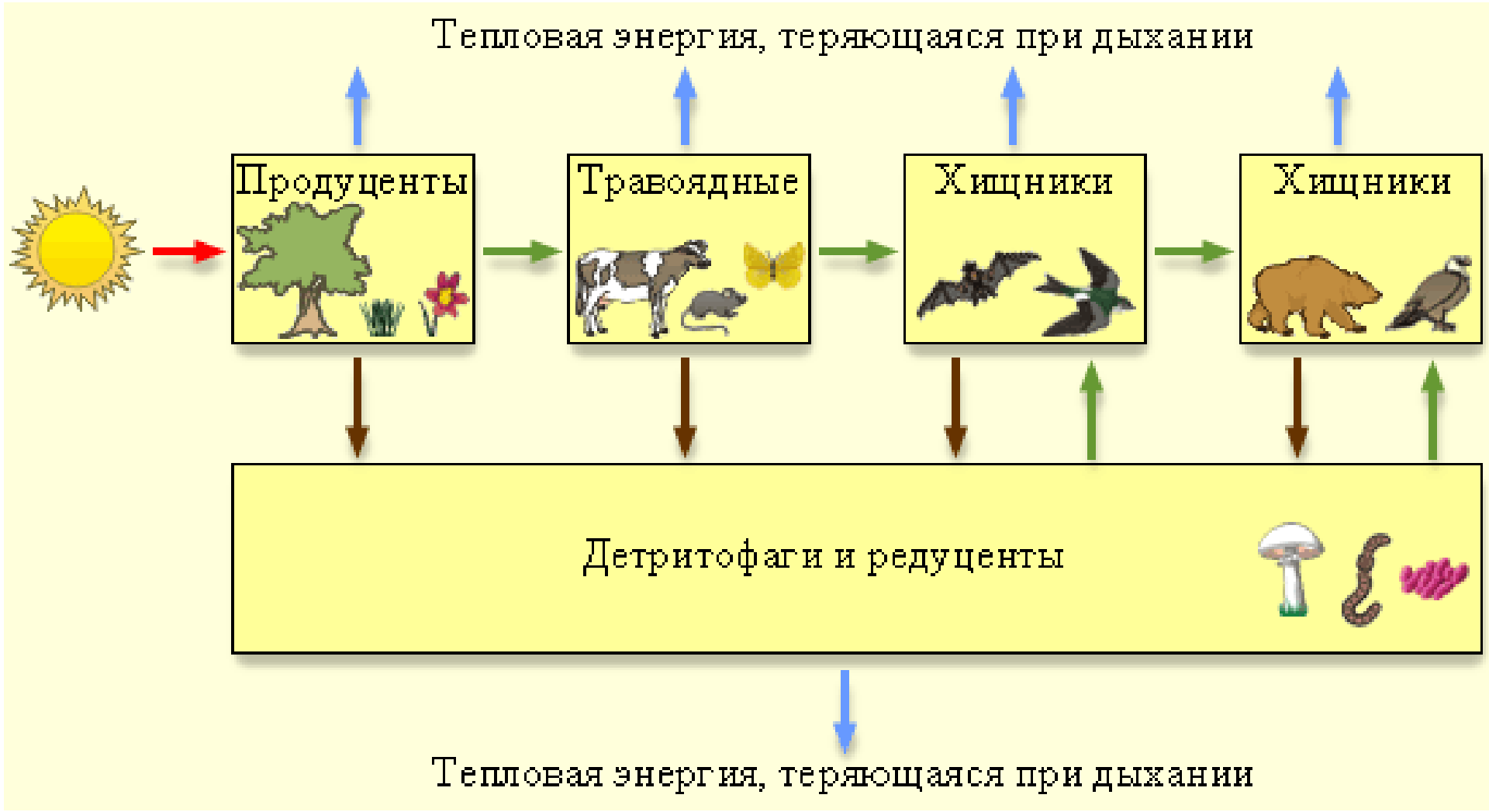
Main features of solar energy

- ***Persistence*** - will always be available in the same and infinite space.
- ***Eternity*** - the sun will go out in a few billion years, and for us it does not matter.
- But every 100 years, the flow of energy will reduce by 0.00001%.

Main features of solar energy

- ***Excess*** **-** Out of all the solar energy reaching the earth plants absorb only 0.5% ; so its amount is enough for mankind.
- ***Clean*** **-** clean energy, even though nuclear reactions occur in the interior of the sun, but this is 150 million km from the Earth (which distinguishes it from the energy of nuclear power plants)

thermal energy is lost while breathing



The fate of the absorption of solar energy

The energy is created by autotrophic organisms and they create substances that serve as food for the heterotrophic. However, the flow of energy that is expressed by quantity of assimilated substance in the food chain, decreases at each trophic level :

P1 > P2 > P3 > P4 > P5 and so on

Lindemann's law (the law of the pyramid of energy, the law of 10%)

On the average no more than 10% of energy passes from one trophic level of an ecological pyramid to another one, which explains the limited number of links in the food chain regardless of a particular ecological community.

The flow of energy in the ecosystem

Unlike substances that continuously circulate in different blocks of ecosystems and which can be reused or enter the circulation again, energy can be used only once i.e. there is a linear flow of energy through an ecosystem, as evidenced by laws of thermodynamics (energy can be converted from one form to another, there is a loss of the energy).

Changes in energy when it passes through the food chain

- *The solar energy accumulated by plants during photosynthesis in the form of carbohydrates creates gross primary production -* ***Pp***
- *Some carbohydrates go to build protoplasm and ensure the growth of plants as well as a part of their energy is spent on their metabolism: growth, development and breathing -* ***D1***

Net production

- Is the energy that can be used by the next trophic level organisms embedded in a net production:
- Net production= primary production - breathing
- ***Gross production***: net+ breathing

Transformation of organic matter through the food chain

A number of established producers (plants) provides food substance **(C)** for herbivores, and the remainder dies **(H)** and is processed by decomposers: Pp plants - goes to food **(K)** for the phytophagous and is assimilated by phytotrophs.

Food (K) goes partly to biomass formation of herbivores - **P2. (A2),** and some of its part dies **(H)** and is transferred by decomposers **(R)**.

Further transformation of substance

P2 (herbivores) (CREATE their own Biomass) - **(A2), some** of which is food and **K3** + **Э2-D2** (breathing herbivores) and **A2** + (excrement), etc.

The cycle of substance and energy

The sun runs 2 cycles in the biosphere:

- ***Large*** **- *geological***;
- ***Small*** **- *biological***, which develops on the basis of a large, but both are interrelated and represent the cycle of a single process.

Small cycle

- Evaporation of water from the ocean surface, condensation of water vapor in the atmosphere and precipitation on the ocean surface.
- 7/9 of the total rainfall falls over the oceans
- 2/9 falls over continents
- Water supply in the world's oceans and evaporation from its surface is 1260 mm. a year

КРУГОВОРОТ АЗОТА

КРУГОВОРОТ УГЛЕРОДА

Дрофа

Substance cycle

- ***Oxygen*** makes a complete cycle in ***2,000 years***.
- ***Carbon dioxide*** - in ***300 years***.
- ***The water*** is decomposed and formed again by photosynthesis and respiration in ***2 000 000 years.***

The water cycle

- This is the most significant in terms of energy circulation in the world. Every second it involves ***16.5 million*** *m3* of water, and spends ***40 bln.mvt*** of solar energy.

Biogeochemical cycles (biological)

- This flow of chemical elements from the soil, water and atmosphere in living organisms and their transformation into the new complex compounds, and then the return of organic matter back into the environment in the course of their life with annual leaf fall.

ecosystem dynamics

- Forming any ecosystem is a complex dynamic process of changes in the state and activity of the ecosystem members and the ratio of the population in it.

Types of dynamic changes in ecosystems

- Cyclical changes in communities reflect the daily, seasonal and multi-year periodicity of the external environment and of endogenous rhythms.

Long-term variability

- The amount of rainfall varies greatly from year to year: drought is alternating with periods of heavy rainfall and it has a significant impact on the flora and fauna of ecological community leading to a change of biocenoses.

Daily dynamics

- Is connected with natural phenomena rhythm

and is strictly periodic by its character: it is known that the life of the various

groups of organisms varies, some are active at daytime, while others at night, and therefore individual organisms switch off for some time from active life: the daily dynamics is typical both of plants and animals.

Seasonal variability

- It depends on the seasonal cycle of nature: hibernation, migration of animals during flowering, fruiting, strong growth, leaf fall and winter dormancy in plants. The individual tiers can disappear (annual herbivore tier).

The reasons for the change of biocenosis

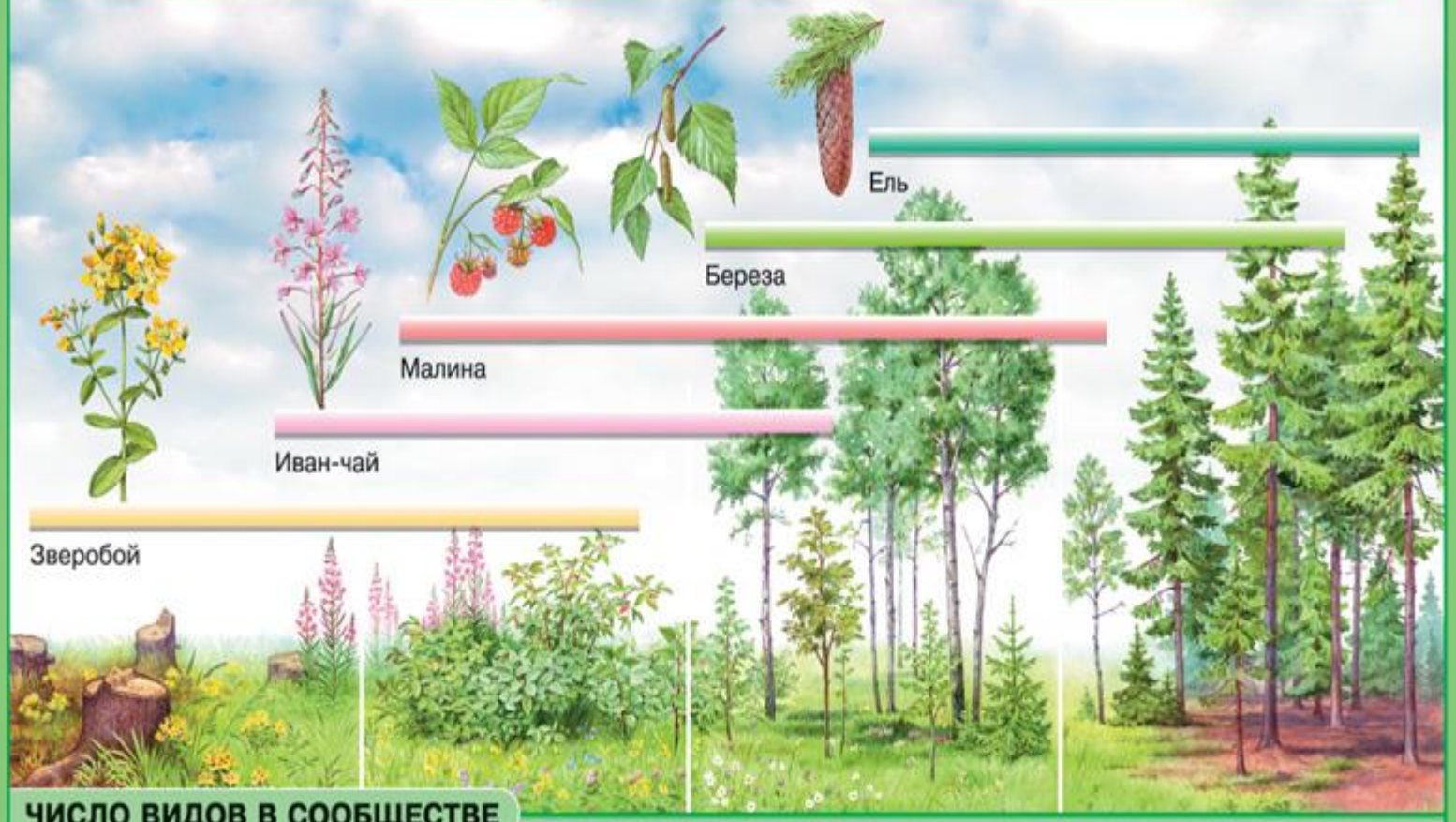
External. (Pollution of water bodies, increased grazing, plowing) - lead to exogenetic changes in biocenosis, often to simplification of the ecological community structure , the impoverishment of its composition, i.e. to the digressive changes .

Internal -during continued existence the populations in the biocenosis change their environment and their vital functions are changing the environment around them often unfavorably which leads to a endogenetic change of the biocenosis composition.

successions

- ***Sequential change of biocenosis is called ecological succession - the process of ecosystem self-development, which is peculiar to any community.***
- ***As a result, there is a change in the biocenosis species that is the prevailing rule of ecological redundancy.***

СУКЦЕССИЯ — САМОРАЗВИТИЕ ПРИРОДНОГО СООБЩЕСТВА



ЧИСЛО ВИДОВ В СООБЩЕСТВЕ

Дрофа

successional changes

- 1. In the process of succession species of plants and animals are continuously replaced.
- 2.Successional changes are always accompanied by an increase in species diversity.
- 3.Biomass of organic matter increases in the course of succession.
- 4.Decrease of community net production and increase of respiration rate.

Principles of ecosystems addition

- 1. The principle of ecological complementarity (optional);
- 2. The principle of environmental congruence (matching);

The principle of *ecological complementarity*

- No functional part of the ecosystem (environmental compl ement) can exist without the complementary functional parts

The principle of environmental congruence (matching)

- Functionally complementing each other live components of ecosystems produce appropriate tools coordinated with the terms of the abiotic environment and largely transformed by the same organisms so that we observe a double row of correspondence between organisms and their environment.

***therefore*:**

Prolonged organisms may exist within ecological systems, wherein components and elements complement each other and respectively adapt to each other.

Rule of ecological overlap in successive changes of biocenosis

The duration of the ecological community is possible only if the changes in the environment caused by the activities of some living organisms are favorable for the others, with opposite requirements. (E.g. overgrowing of a small lake - swamp formation, and then the forest).

Types of succession changes

- 1. involving autotrophic (plant) and heterotrophic (animal) population;
- 2. involving only heterotrophic.

Primary and secondary succession

Succession with the change of vegetation can be primary and secondary:

- ***Primary succession*** **is called a process of development and change in ecosystems at previously independent areas, beginning with their colonization and gradual evolution.**
- ***Secondary succession*** **- is the restoration of the ecosystem that already existed in the territory destroyed by volcanoes, fires, timber production and ploughing.**
- ***Secondary successions*** **do not repeat primary successions.**

Climax of ecosystems

Development of ecosystem succession ends when all species within an ecosystem by breeding preserve the relative size and composition so that it does not change in future - that balance is called climax.
Logically it is a climax ecosystem where the species maintain a relative constancy of the size and composition.
Major biomes of the earth are climax ecosystems.