

MODULE 14 - ENERGY FLOW IN ECOSYSTEM

OBJECTIVES

After going through this, student will be able to understand:

1. Interaction between biotic and abiotic components.
2. Biotic community and its components.
3. Utilization of solar energy.
4. Trophic level.

SUMMARY

An ecosystem is any unit that includes all the organisms i.e. the communities in a given area, interacting with the physical environment so that the flow of energy leads to clearly defined trophic structure, biotic diversity and material cycle such as exchange of materials between living and non-living components takes place within the system. In biological world energy flows unidirectional from the sun to plants and then to all the heterotrophic organisms such as micro organisms, animals and man.

TRANSCRIPTION

Introduction

As far as known, earth is considered as the only planet of universe, which carries life. The existence of life is dependent on the availability of factors like air, water and food, these factors are important components of the environment. If we will see environment from a closer distance we will find that there is interaction between abiotic and biotic components. This interaction is responsible for the existence of an ecosystem and ecosystem there is always a flow of material and energy.

Plants, animals and microorganism together make a biotic community. Biotic communities always coexist with abiotic factors. Matter and energy are the two main components of Aiotic factors.

Water, Salt, Minerals and Gasses are the matter whereas light, temperature and energy bound chemicals serve as different forms of energy.

Biotic Community

The biotic community is divided into two main components as per their nutritional relationship

1. Autotrophic
2. Hetrotropic

The organisms of Autotrophic components are known as producers and are capable of producing their own food with the help of some microbes and chlorophyll. Green plants contain certain chemosynthetic microbes, which include in these groups.

The organisms of Hetrotropic components have 2 groups:

1. the consumers
2. the decomposers

- 1- Consumers: animals and parasitic plants
- 2- Decomposers: major groups of fungi and bacteria

Consumers consume the matter built up by the producers. These consumers are herbivores, carnivores and omnivores.

Herbivores like rabbit, deer, and mouse are known as primary consumers sine they feed on plants. These herbivores are eaten by flesh eating carnivorous animals or secondary consumers such as birds, snakes, lizards, etc. Further the top carnivorous animals feed on small and weak carnivores. These are tertiary consumers like tigers, lion, hawk, etc. Man eats flesh and plants both and is known as omnivores. Finally after the death of these organisms' saprophytes and other decomposers feed on them by decomposing the complex substance of body into simpler forms and then energy is released along with minerals and gasses.

The food which man or any other animals obtain from plants is a converted form of sun's energy.

Utilisation of Solar Energy

Now the question is how is this solar energy trapped by plant and further used by animals.

Sun is the only source of energy in the universe. Enormous amount of energy is released at every moment from the sun and is spread throughout the space. Just 1% i.e. about 3000 Kcal of the total energy reaches the earth and the remaining energy does not, because of the components of atmosphere like clouds, smoke and dust particles which change the nature of the solar radiation. Some of the energy, which reaches the earth, goes back to the nature. Just a small quantity falls on the plants.

Green plants have chlorophyll that traps sun's energy. Only chlorophyll has the property to convert solar energy into chemical energy. During this conversion

rearrangement of molecules of water and carbon dioxide takes place to produce oxygen and sugar. This is known as photosynthesis.

It is estimated that during photosynthesis plants use only one-tenth part of 1% of the energy. This potential energy which is present in the form of food passes through the sequence from producers to consumers. These sequential events in our ecosystem, of eating and of being eaten with the transfer of energy, are known as the food chain.

Every organism may be a member of more than one food chain and in this way; the organism can serve as a link between various food chains. All these overlapping and the short cuts in a biotic community make a food web.

The food chain and the food web maintain a delicate equilibrium in the nature. Any disturbance in a food chain or the organisms of the food chain may disturb the whole ecosystem; here we can see the example of export of frogs in Calcutta which led the spread of Malaria because frogs eat mosquitoes.

Tropic level

Each energy level or the link of food chain is called a tropic level. Energy flow is greatly reduced at each successive tropic level from producer to consumer.

Now let us consider the tropic level and the total energy flow through these boxes. These boxes represent the tropic levels and the pipes show the energy flow in and out at each level. Plants are the first tropic levels. Thus, from the 3000 Kcal of total light about 50% or 1500 Kcal energy is absorbed by the plant and only 1% or 15 Kcal is converted at the first tropic level. Productivity of the second and the third level is only 10% or (1.5 and 0.3 Kcal respectively). Some time it may be higher up to 20% in top carnivores.

If we calculate this energy and plot it in the shape of a pyramid, then the figure will be like this. In this pyramid the first tropic level of biotic community serves as the base. Then an upright pyramid will be obtained at each tropic level therefore less energy is available to the top most consumer. So that is why lions and tigers are less in number. This means that energy at producer level will always be more than energy at consumer level.

The energy flow in the universe is the cause for all creation and the cycle of all small and big materials on our planet.

Tropic level part 2

At every level organism make use of energy due to which life activities occur. Whenever an organism does any work then potential energy is transformed to chemical energy or ATP.

Actually energy remains enclosed in high-energy bonds of ATP. ATP is produced energy during oxidation of food in respiration and is utilized for various syntheses of various molecules necessary for growth and development.

Even the movement of molecules across the cell membranes is also governed by energy. The Cellular energy in the form of ATP is changed into heat energy to maintaining the temperature of body of living organisms.

ATP is used for muscular contraction, movement of cilia or flagella etc. Electrical energy is generated to imitate and conduct the nerve impulses. Light energy is used in some insects and other animals for bioluminescence. In this way transformation and flow of energy provides dynamism to an organism.

It is true that the entire living organism require energy for their survival. But it is also true that energy flow in the environment is a must to meet the energy requirements of the whole biotic communities. Any change in the environment, which alters or influences the normal energy flow, may disturb life. Therefore being the most developed creature of this Planet it is his moral responsibility to maintain the normal energy flow the environment. We can do this by conserving and protecting the components of environment weather they are living or non living.

GLOSSARY

- a. Abiotic – The non-living or physicochemical portion of an ecosystem.
- b. Autotrops – An organism that obtains its energy from sun, as opposed to a hetrotrops, which is an organism that obtains its energy from the tissues of other organisms. All green plans are autotrops.
- c. Biotic – Pertaining to living organisms or the products of living organisms.
- d. Community – Populations of various species living and interacting in a given area.
- e. Conservation of Energy – A law that states that energy may be transformed from one form into other but is neither created nor destroyed.
- f. Consumers – Organisms that cannot produce their own food but consume other organisms for their energy requirements.
- g. Decomposer – Fungi and bacteria that break complex organic matter into simpler molecules and ultimately into inorganic substances.
- h. Ecosystem – Biotic community and its local non-living environment which function together as one unit.
- i. Food Chain – a sequence of organisms through which energy is transferred from the green plants through eating and being eaten.

- j. Heterotrophs – Organisms that can't synthesize its own food and derives its nutritious by feeding on others.
- k. Food Web – A complex interlocking series of food chain.
- l. Trophic level – A group of organisms with similar food habits form a trophic level in an ecosystem such as plants as producers trophic level, plant eating herbivores as herbivore trophic level.

F.A.Q.'s

1) Which is the main source of energy in the ecosystem?

Ans. Sun is the main source of energy in the ecosystem.

2) How is the vast reserve of solar energy tapped by nature?

Ans. Nature taps or harness solar energy through plants which are aided by mainly the green colored pigment called chlorophyll.

3) What happens during photosynthesis?

Ans. Rearrangement of molecules of carbon dioxide and water and their combination with the loss of oxygen and production of sugars.

4) What is food chain?

Ans. The patterns of eating and being eaten forms a linear chain beginning with producers which trap radiant energy of the sun is called food chain.

5) How does energy flow through ecosystem?

Ans. Through the food chain.

6) What is the characteristic feature of flow of energy?

Ans. Flow of energy in an ecosystem is unidirectional that it passes to the next trophic level but does not revert back to source.

7) What is a food web?

Ans. Overlapping food chains and short cuts in a biotic community form food web.

8) What happens to energy at each trophic level?

Ans. There is progressive loss of energy at each trophic level.

9) What is A.T.P?

Ans. Adenosine triphosphate, a with three phosphate groups, a potential energy carrier.

10) What is trophic level?

Ans. Each energy level or the link of food chain from producers to consumers, detritus feeders etc are the trophic levels of a food chain.

11) Does the detritus food chain also form a part of energy flow model?

Ans. Along with the grazing food chain the detritus food chain is an important part of energy flow model.

12) What is grazing food chain?

Ans. This type of food chain starts from the living green plants, goes to grazing herbivores and on to the carnivores.

13) What is detritus food chain?

Ans. Energy contained in detritus i.e. organic wastes, exudates and dead matter derived from the grazing food chain are a source of energy for detritivores and the energy is not lost but passes to the soil or atmosphere forming the detritus food chain.

14) Are there any energy flow models? What are they?

Ans. There are three types of energy flow models they are –

Single channel energy flow model

Y-shaped or double channel energy flow model

Universal energy flow system

15) What is single channel energy flow system?

Ans. It is a type of model where energy flows in a unidirectional manner with progressive decrease in energy at each trophic level.

16) How is energy conserved in an ecosystem?

Ans. Energy is conserved in an ecosystem through the energy flow pathways of both the grazing and detritus food chains

17) What is Y-shaped energy flow system flow model?

Ans. As proposed by H.T Odum in 1956 it takes into account both the grazing and detritus food chains confirming the basic satisfied structure of ecosystem without isolating any particular pathway.

18) What is universal energy flow model?

Ans. The model as given by E.P. Odum which clearly states the gradual loss of energy at each trophic level and its reutilization in nature.

19) According to nutritional relationship what are the main components of biotic community?

Ans. The main components are autotrophs and heterotrophs.

20) What are autotrophs?

Ans. Autotrophs are also called as producers as they can produce their own food in the presence of sunlight and photosynthetic pigments.

21) What are hetrotrops?

Ans. Organisms which are consumers i.e. depending upon producers or green plants or other consumers and decomposers i.e. detritus or waste feeders are hetrotrops.

22) Does the unidirectional or one way flow of energy in ecosystem follow thermodynamic laws?

Ans. Yes, all the laws i.e. on conservation of energy and its transformation are followed in the ecosystems.