English for **Environmental Science**

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UNIT 6 Flows of energy and matter

WARM-UP

Task 1. The title of Text 1 (see page 78) is Ecosystem ecology. What in your opinion does the author mean by this? Have you ever come across these words together (a "collocation" of words)? What context was this collocation used in?

TUNE-IN

Task 1. Split into groups. Within your group discuss the questions below. Share the opinion of your group with others.

1. What are the fundamental concepts when speaking about ecosystems? Explain the role that *primary producers* and *consumers* play in a simple food web.

2. What are the processes that take place in ecosystems? Describe each process.

3. How is the solar energy taken up by the ecosystem distributed?

Task 2. Watch the episode and choose the best answer:

1. The episode speaks about
   a. herbivores and carnivores
   b. flow of energy and matter in ecosystem
   c. sedimentation and algal drift

2. In the episode ecosystem is viewed as
   a. a simple food web
   b. complex interaction between algal, soft bottom and pelagic systems
   c. the process of detritus decomposition

3. The data show that ecosystem takes up
   a. less than one per cent of solar energy
   b. more than one per cent of solar energy
   c. less than fifty per cent of solar energy

STUDY

Task 1. Read Text 1 and say what is true:

1. The text is about:
   a) the use of energy on the whole.
   b) the role of animals and plants in energy flow and circulation of the matter.
   c) the role of nutrients in aquatic ecosystems.

2. The author comes to the conclusion that:
   a) animals living on plant biomass are called grazers or herbivores.
   b) the decomposers are in many ways the most important organisms in the ecosystem.
   c) re-circulation of nutrients and other substances is essential to all ecosystems.

for your notes

Text 1. ECOSYSTEM ECOLOGY

Ecosystem ecology, sometimes referred to as *system ecology*, is concerned with the flow of energy and circulation of matter in a whole ecosystem, that is, how the whole system functions. The intimate couplings between the environment and the species living there will influence the balance of the ecosystem and the living conditions for its members. It is only by knowing how the whole system works that we are able to understand how changes in abiotic factors, that is environmental impacts, will affect a community of organisms.

Energy and biomass in an ecosystem – flow of energy and circulation of matter.

Organisms can use energy in several forms. Depending on the form of "food" they use, the systems contain several categories of plants and animals.

The majority of plants obtain their energy directly from sunlight using green chlorophyll and sometimes additional pigments (like the brown and red algae). Plants are the *primary producers* of the ecosystem. In their *photosynthesis*, they convert the energy from sunlight into energy stored in carbohydrates (sugar, starch, cellulose etc.) and other organic compounds. They build *biomass* in the form of roots, stems and leaves. In addition to sunlight they need water, carbon dioxide from the air and nutrients such as nitrogen, potassium and phosphorus from the ground.

Animals living on plant biomass are called *grazers or herbivores*. They fill the role of *consumers, or primary consumers*, in the ecosystem.

Those animals that live by catching other living animals are *predators, or carnivores*, also called *secondary consumers*.

Finally, bacteria, and other organisms living on dead organic matter, *detritus*, are called *decomposers*. Soil animals, such as earthworms make up the first stage in the decomposition of detritus, while fungi and bacteria take care of the final decomposition. By decomposing the organic matter they return the nutrients to mineral form and the organically bound carbon to carbon dioxide. The roots of plants can then again capture the mineral nutrients, and the circulation of chemical matters is closed. The decomposers are in many ways the most important organisms in the ecosystem. Plant growth in most terrestrial ecosystems is limited by the lack of nitrogen and in aquatic ecosystem often by lack of phosphorus. If the decomposers did not effectively re-circulate these nutrients, primary production would soon cease. Re-circulation of nutrients and other substances is thus essential to all ecosystems.

"I saw the boundless, omniscient and almighty God from the back, as he went forward, and I felt excited! I followed his footprints over nature's domain and noticed from each one, even those that I could hardly make out, an unlimited wisdom and power, an unfathomable perfection. I saw there how all the animals are maintained by the plants, the plants by the soil, the soil by the Earth; how the Earth revolved day and night around the sun, that gave it life".

Carl Linneaus. Systema naturae, 1745.

for your notes

GOT IT?

Task 1. Find the following words in Text 1 and specify their meaning using the glossary (see page 90):

- photosynthesis
- grazers (herbivores)
- predators (carnivores)
- biomass
- detritus
- decomposers

for your notes

Task 2. Choose the best variant to complete the sentences:

1. The majority of plants obtain their energy directly from .....
   a) water
   b) sunlight
   c) fertilizers

2. Ecosystem ecology is concerned with .....
   a) waste disposal
   b) decomposing organic matter
   c) flow of energy and circulation of matter in a whole ecosystem

3. Plants are .....
   a) the primary producers of the ecosystem
   b) the primary consumers of the ecosystem
   c) the secondary consumers of the ecosystem

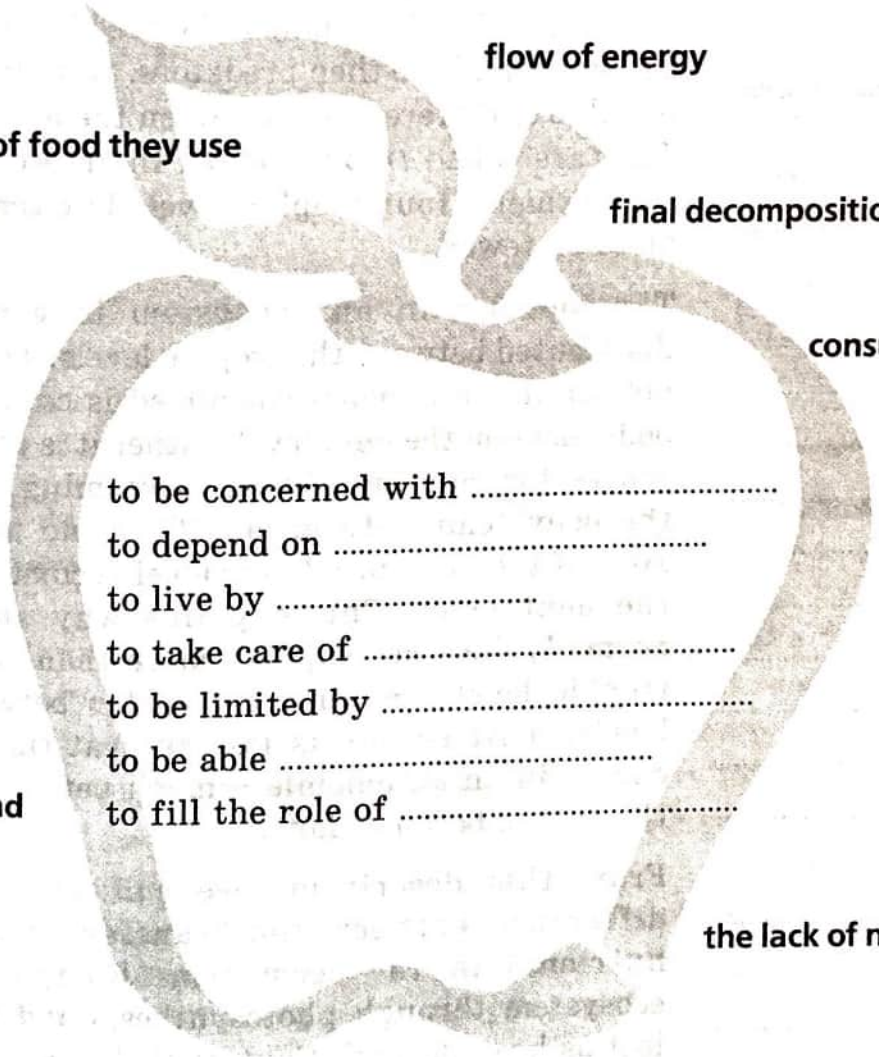
Task 3. Turn the following verbs into nouns with the help of suffix *-(t)ion*.
Model: to convene – convention

to circulate .....
to add .....
to produce .....
to relate .....
to decompose .....
to convert .....
to eutrophicate .....
to explain .....

Task 4. Complete the following collocations basing on Text 1 and suggest some more where possible:

living c.....	to obtain e.....
primary p.....	to need w.....
environmental i.....	to capture n.....
dead organic m.....	to influence b.....
organic c.....	to affect c.....
terrestial e.....	to convert e.....

Task 5. Finish the phrases



Task 1. Work in pairs. Read Text 2 as quickly as possible and put down as many terms as you can. Compare them with your partner's. Try to explain to your partner what they mean. Consult the glossary to check the meaning.

Text 2. FOOD CHAINS AND FOOD WEBS

A feeding relationship in an ecosystem is called a *food chain*, while the totality of the chains constitutes a *food web*. Often the food webs are quite complex with many different feeding relationships. In addition to primary producers, herbivores and carnivores, *omnivores* are common in some ecosystems. Many bird species, such as finches and sparrows are examples of omnivores. In autumn they feed on seeds and are herbivores, but in summer they feed their offsprings on insects and are then predators. However, it is often possible to differentiate between the levels described. They are called *trophic levels*. In an ecosystem there are normally four trophic levels but there might be more or fewer.

The biomass in an ecosystem is very unevenly distributed between the trophic levels. This is because not all of the biomass consumed is converted to the body mass on the next level; rather it is used as energy source for running, flying, swimming, for keeping the body temperature, etc. Thus, no more than 1-10% of the mass of a lower level becomes biomass on the next level. This explains why an ecosystem normally does not support more than three or four trophic levels. So in the transfer between trophic levels, most energy is lost as heat (much like the engine in an automobile – much petrol is wasted as the engine becomes hot).

From this description we can see the distinct difference between the transfer of energy and nutrients in the ecosystem. Energy enters the ecosystem through photosynthesis and is gradually lost as heat through the trophic levels.
Nutrients circulate from plants to consumers and decomposers and back to plants. An important

for your notes

environmental issue is how closed this circulation is. With excessive addition of fertilizers to arable land and by nitrogen added as an air-borne pollutant, the plants may be unable to take up all nutrients, and excess nutrients is then leaking to soil water. This water ends up in rivers and lakes and leads to eutrophication of these and, finally, of the Baltic Sea.

Human use of ecosystem resources, for instance by agriculture, forestry or fishing has had dramatic effects on energy flow, nutrient circulation and biological diversity, locally as well as globally. *Sustainability* has been suggested as an overall aim for environmental protection work. This implies that our use of ecosystems should not jeopardise central ecosystem functions in the short or long run. The role of the ecologists is to try to establish levels of resource use, for instance fishing quotas that lead to sustainable use of the ecosystems.

To really know if human use of ecosystems is sustainable we need *environmental monitoring.*

This means that we carefully measure long-term changes in species diversity, nutrient levels and vital ecosystem functions.

for your notes

Task 2. Read the text again and decide whether the following statements are true (T) or false (F).

T F

1. A feeding relationship in an ecosystem is called a food web.
2. Food webs may include a number of different food chains.
3. Any ecosystem does not normally support many trophic levels because the biomass in an ecosystem is distributed unevenly.
4. Plants may be unable to take up all nutrients due to lack of fertilizers in arable lands.
5. Agriculture, forestry, fishing or other uses of ecosystem resources cause damage to biological diversity on local level.
6. Sustainability is the only way for central ecosystems to survive.
7. Environmental monitoring implies thorough studies of possible changes in vital ecosystem functions.

Task 3. Fill in the missing prepositions:

1. ..... addition ..... primary producers omnivores are common ..... some ecosystems.
2. The biomass ..... an ecosystem is very unevenly distributed ..... the trophic levels.
3. Nutrients circulate ..... plants ..... consumers and decomposers and back ..... plants.
4. The role ..... the ecologists is to try to establish levels ..... resource use, ... instance fishing quotas that lead ..... sustainable use ..... the ecosystems.
5. So ..... the transfer ..... trophic levels , most energy is lost ..... heat.
6. Human use ..... ecosystem resources, ... instance ..... agriculture, forestry or fishing has had dramatic effect ..... energy flow.
7. ..... excessive addition ..... fertilisers ..... arable land and ..... nitrogen-added ..... an air-borne pollutant, the plants may be unable to take ..... all nutrients.

Task4. Fill in the table where possible. The first one is done as a model.

Verb	Noun	Adjective
Total	*totality*	*total*
Differentiate	.....	.....
.....	.....	distinctive
Circulate	.....	.....
.....	diversity	.....
.....	.....	sustainable
.....	.....	environmental
.....	description	.....
Distribute	.....	.....
.....	addition	.....

Task 1. Read Text 3. Work in two groups. Choose two of the four ecological principles for sustainability. Agree on what you are going to choose. Ask each other questions to specify these principles.

Text 3. ECOLOGICAL PRINCIPLES OF SUSTAINABILITY

for your notes

The study of ecology gives us an understanding of which basic principles man has to observe in order to create a society that is in the long term in harmony with the environment.

We might summarise four ecological principles for sustainability to be used as guidelines in environmental protection work:

1. For sustainability, ecosystems dispose of wastes and replenish nutrients by recycling all elements.

This rule is today violated by the extensive use of artificial fertilizers as well as all other linear waste flows in society that leads to the growing waste dumps, on land, in water and in the atmosphere.

2. For sustainability, ecosystems use sunlight as their source of energy.

In ecosystems sunlight is used by the primary producers to synthesize carbohydrates, used by the rest of the ecosystems. Human society uses today a large amount of fossil fuel, which leads to massive environmental impact.

3. For sustainability, the size of consumer populations are maintained so that overgrazing or over-use does not occur.

Today the size of the human population is increasing rapidly and overexploitation of natural resources, such as fishing, occurs. At some point the population increase will have to halt, and use of natural resources must be balanced.

4. For sustainability, biodiversity is maintained.

Today the rate of species extinction is very large and we are losing biodiversity at a high rate. This is a loss of a future resource and is damaging the environment.

Task 2. Replace the words in italics with the words used in the text:

1. Today the size of human population is *growing* rapidly and overexploitation of natural resources occurs.
2. We may *sum up* four ecological principles for sustainability to be used as guidelines.
3. Man has to observe basic principles in order to *set up* a society that is in harmony with the environment.
4. At some point the population increase have to *stop*, and use of natural resources must be balanced.
5. The violation of the basic principles will *bring us* to pollution.
6. This rule is *infringed* today by the extensive use of artificial fertilisers as well as other linear waste.

Task 3. Form new words using prefixes *de-, re-, over-* where possible. Consult the text to check the meaning.

exploitation .....
grazing .....
gradation .....
production .....
population .....
nourishing .....
cycling .....
use .....

CHECK POINT

Task 1. The following verbs can describe adding (+) and deduction or dividing (–). Group them according to meaning.

catch lack add obtain capture lose take up leak decompose store

+	–
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....

Work in pairs. Use these words in the sentences of your own. One of you suggests the sentences with "+-verbs", the other with "– -verbs".

Task 2. Identify the words by their synonyms or definition. Remember in what context they were used.

- the complex of a community and its environment functioning as a unit in nature;
- dead organic matter;
- animals living on plant biomass;
- organisms living on dead organic matter;
- animals that live by catching other living animals;
- decay, deterioration, becoming worse;
- spillage, (sth.) passing out of a container;
- a feeding relationship in an ecosystem

PRESENT	PAST	FUTURE
I. can(n't) *do* am/is (are) able *to do* am/is (are) unable *to do*	could(n't) *do* was (were) able *to do* was (were) unable *to do*	will be able *to do* # will be unable *to do*
II. may (not) *do* am/is (are) allowed *to do*	might (not) *do* was (were) allowed *to do*	will (not) be allowed *to do* #
III. must *do* have *to do*	had *to do* had *to do*	will have *to do* #
IV. should(n't) *do*	should(n't) have *done*	#

Task 1. Refer the modal verbs to the past and future where possible:

a) Model: Organisms can use energy in several forms. – Organisms could use energy in several forms. Organisms will be able to use energy in several forms.

1. The roots of the plants then can capture the mineral nutrients.
2. They can fill the role of consumers, or primary consumers, in the ecosystem.
3. From the description we can see the distinct difference between the transfer of energy and nutrients in the ecosystem.
4. It can be no surprise to find the nitrous compounds in ecosystems.
5. Animals are able to receive their nitrogen through the food.

b) Model: We may also discuss the whole system involved in material flows. – We might also discuss the whole system involved in material flows.

1. We may summarise four ecological principles for sustainability.

2. The plants may be unable to take up all nutrients.
3. There may be more or less than four trophic levels in an ecosystem.
4. It may seem strange to focus on such a heterogeneous area as the Baltic Sea.
5. Selection may be used to improve the genetic properties of domesticated plants and animals.

c) *Model: The use of natural resources must be balanced. – The use of natural resources had to be balanced. The use of natural resources will have to be balanced.*

1. At some point the population increase must halt.
2. Much impact must be limited to the region.
3. A first step must follow and "harvest" the wild herd.
4. We have to make both continental and global comparisons whenever this is relevant.
5. Such systems have to be researched today.

d) *Model: Our use of ecosystems should not jeopardise central ecosystem functions in the short or long run. – Our use of ecosystems should not have jeopardised central ecosystem functions in the short or long run.*

1. However, it should be pointed out that nitrogen was present as ammonium.
2. Phosphorus should be another element essential to living cells.
3. Man shouldn't increase the sulphur flow by burning fossil fuels.
4. The varieties should be protected by patent rights.
5. It should be possible to improve control.

GLOSSARY

en·vi·ron·ment
1: the circumstances, objects, or conditions by which one is surrounded
2 a: the complex of physical, chemical, and biotic factors (as climate, soil, and living things) that act upon an organism or an ecological community and ultimately determine its form and survival
b: the aggregate of social and cultural conditions that influence the life of an individual or community
en·vi·ron·men·tal en·vi·ron·men·tal·ly

graze
: vb grazed; grazing: feed on herbage or pasture — graz·er n

pho·to·syn·the·sis
: the process by which green plants and some other organisms use sunlight to synthesize foods from carbon dioxide and water. Photosynthesis in plants generally involves the green pigment chlorophyll and generates oxygen as a by-product.

bio·mass
: the total quantity or weight of organisms in a given area or volume. Organic matter used as a fuel, especially in a power station for the generation of electricity.

de·tri·tus
1: loose material (as rock fragments or organic particles) that results directly from disintegration
2: a product of disintegration, destruction, or wearing away

her·bi·vore
: a plant-eating animal

pred·a·tor
1: one that preys, destroys, or devours
2: an animal that lives by predation

car·ni·vore
1: any of an order (Carnivora) of typically flesh-eating mammals that includes dogs, foxes, bears, raccoons, and cats; broadly: a carnivorous animal
2: a carnivorous plant

de·com·pos·er
: any of various organisms (as many bacteria and fungi) that return constituents of organic substances to ecological cycles by feeding on and breaking down dead protoplasm

food web
: the totality of interacting food chains in an ecological community

om·ni·vore
: an animal or person that eats food of both plant and animal origin.

troph·ic lev·el
: Ecology each of several hierarchical levels in an ecosystem, consisting of organisms sharing the same function in the food chain and the same nutritional relationship to the primary sources of energy.

fer·ti·liz·er
: a chemical or natural substance added to soil or land to increase its fertility

bio·di·ver·si·ty
: the variety of plant and animal life in the world or in a particular habitat. A high level of biodiversity is usually considered to be important and desirable.

phos·pho·rus
: the chemical element of atomic number 15, a poisonous, combustible nonmetal that exists in two common allotropic forms, *white phosphorus*, a yellowish waxy solid that ignites spontaneously in air and glows in the dark, and *red phosphorus*, a less reactive form used in making matches. (Symbol: P)

ni·tro·gen
: the chemical element of atomic number 7, a colorless, odorless unreactive gas that forms about 78 percent of the earth's atmosphere. *Liquid nitrogen* (made by distilling liquid air) boils at 77.4 kelvins and is used as a coolant. (Symbol: N)