Chapter 10

Environmental Knowledge

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Introduction

In our world where change is inevitable, besides the positive results of the variations that arise, negative situations can also be encountered. The most universal situation in which these negativities affect everyone without discrimination is environmental problems. People are getting worse day by day by using nature rudely and consuming it without thinking (Atasoy, 2015), and their living spaces are exposed to strong environmental problems with vital effects (Duan et al., 2018). The impact of education in understanding, preventing and solving environmental problems has been known internationally since 1970 (Shobeiri et al., 2006). Education has a great importance in the construction of a future different from the present (Colebrook, 2017) and environmental issues have started to gain a more important place in education (Gola, 2017). Environmental education directs individuals to raise awareness about the environment and to take beneficial actions (Stevenson, 2019).

In this context, environmental education has three main aims (Geray, 2002):

1. To enable people to understand the environment and their place in it,
2. To develop the necessary attitude for individuals to live in peace with the world,
3. To be able to act with a sense of responsibility towards the environment and to protect the environment.

The first article in these aims of environmental education is very important. It is possible for individuals to get to know the environment and to understand all the concepts and variables related to it. Environmental knowledge, which also creates environmental awareness and can be accepted as the first step in the formation of environmental awareness, is the basic step of environmental education. Knowing ecological concepts will support the formation of attitudes and behaviors will provide an effective understanding of the ecological threat that affects all humanity, regardless of country, race and religion. A branching environmental knowledge education is required at the origin of the definition of the environment.

Environment

Although the concept of environment has abstract or subjective connotations in the

minds, it is a deeper concept than this. The environment can have definitions that are specialized in different areas and it has a complex structure that we directly experience. It is formed by environmental conditions (İncedayı, 2002) and shaped by the interaction between biotic and abiotic factors (Rosalino et al., 2014). In other words, the environment is the habitat in which biotic and abiotic factors interact and balance (Figure 1). The environment, which has conditions that surround and affect living things in many ways (Sharma, 2012), makes these systematically occurring conditions a part of their development (Lewontin & Levins, 1997).

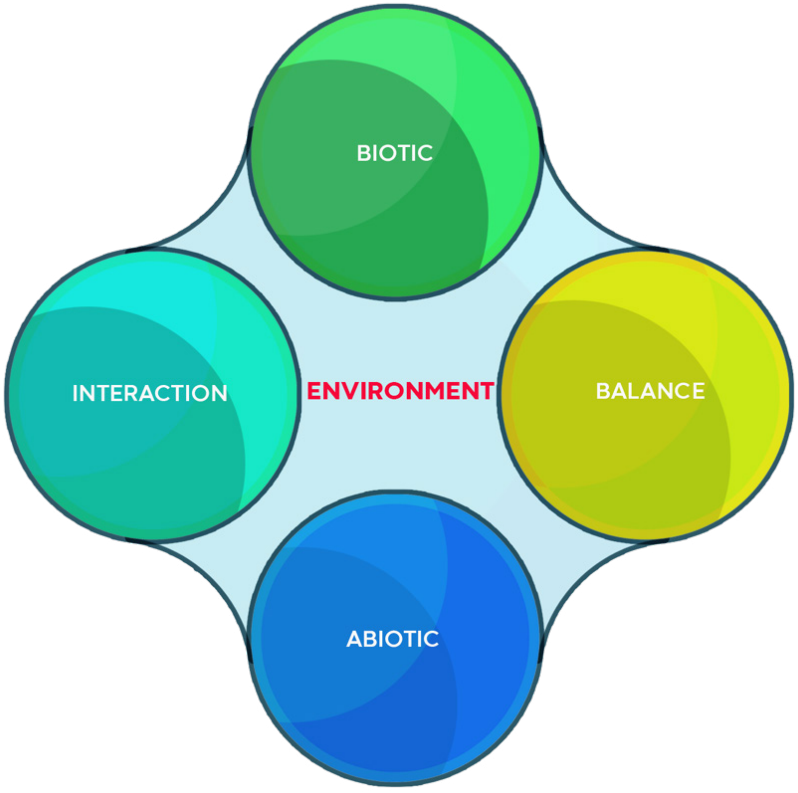


Figure 1. Environment

There is a physical world outside of organisms, and this world goes through certain transformations that are autonomous. Volcanoes erupt, the earth moves on its own axis of rotation. However, the physical world is not an environment, only the conditions under which environments can be created. The environment is divided into two as artificial and natural environment. While the natural environment defines an unmodified environment without human intervention, the artificial environment defines the environment created by interventions throughout human history (Görmez, 2015).

Basic Concepts of Environment

Ecology

The concept of ecology was used in 1866 by the German biologist Ernst Haeckel in his book *Generelle Morphologie der Organismen*. It is derived from the Greek words oikos (home, residence, family) and logos (language, language of mind) (Schwarz & Jax, 2011). Haeckel is accepted as the founder of ecology (Egerton, 2013) and is defined as the study of animals' interrelationships with their environment. Tansley (1935), who made a broader definition, stated that ecology is the science that studies the function of living things in their natural habitats. One of the most accurate definitions of ecology is that it is a science that provides a more intense explanation of the relationship between human and nature and aims to preserve the balance and integrity of the environment. It can be diversified such as physiological ecology, physiographic ecology, ecological phytogeography, as well as branching out such as population ecology, forest ecology, chemical ecology by taking the research object as a forename. Ecology types are grouped into 4 groups by Dodson (1998):

1. Types of ecology defined by subject or approach (such as landscape, ecosystem, physiologist, behaviorist, socialist)

2. Types of ecology defined by living things (Plant, animal, lichen, human, deer, tree etc.)

3. Types of ecology defined by habitat (such as land, lakes and rivers, ocean, rainforest, city)

4. Types of ecology defined by practice (such as theorist, management, reclamation)

Ecosystem

The ecosystem, which has common aspects with the definition of the environment, is defined as the whole formed by the living things living in a certain area and constantly interacting with each other, and their inanimate environment. The key phrase here is "a specific area". This situation, which expresses limitation, is decisive for the ecosystem. Ecosystems can be very large or small scales. Earth ecosystem and Sahara Desert ecosystem can be given as examples.

Biosphere

The concept of the biosphere, which was first mentioned in the work of biologists Lamark and Geologist Suess in the 19th century, took a wide place in the studies of the 20th century (Budyko, 1986). The biosphere is one of the components that make up the climate system. The biosphere can be expressed as the layer where life on earth is. It includes biotic life. At the intersection of the atmosphere, lithosphere and hydrosphere is the biosphere. The atmosphere, lithosphere and hydrosphere are abiotic while the biosphere is biotic.

Community

Community, which means the unity of life in the ecosystem, is a concept that includes living things. There is a balanced interaction among the living things in the community. Sharing the same physical environment is one of the defining features of the community.

Population

There are many approaches to describe the population (Berryman, 2002). It is possible to have different ecological and evolutionary perspectives, and population is at the basis of ecology (Waples & Gaggiotti, 2006). In the simplest sense, organisms of the same species living in a particular area are called population. People in Ohio and apple trees in Cambridge are examples of populations. The most important factor affecting the population size is the face measurement in which they are defined.

Species

As in all ecological concepts, there are definitions for the species that vary with different perspectives and there are many different perspectives (such as biological, racial, morphological). From a biological point of view, the definition of a species can be defined as a community that occupies a certain place, reacts equally to common chemical and physical conditions, and can produce fertile offspring among themselves under natural conditions (Demirsoy, 2018). Although the number of defined species is 1.4 million, it is thought that there are 12 million species excluding microorganisms (Swanson, 1997). People, deer, larch are examples of species.

Organism

A living being is called an organism. It is a biotic structure that shows physical, biological and chemical activities.

Dominant species

The species that stands out in terms of number and action in the community is called the dominant species.

Habitat

The place where a species lives is called habitat. Its “address” is where the species will be found when searched. Just like Columbia is the address for coffee trees.

Ecological Niche

The responsibility and role of the organism in the ecosystem is called the ecological niche. The ecological niche is also concerned with the communication of the species

with the region in which it lives. The ecological niche model, which sheds light on the possible location and density of the species as a model, has an important place in ecology.

Flora

It refers to the plant species in the ecosystem.

Fauna

It refers to the animal species in the ecosystem.

The image explaining this basic concept of environment is in Figure 2.

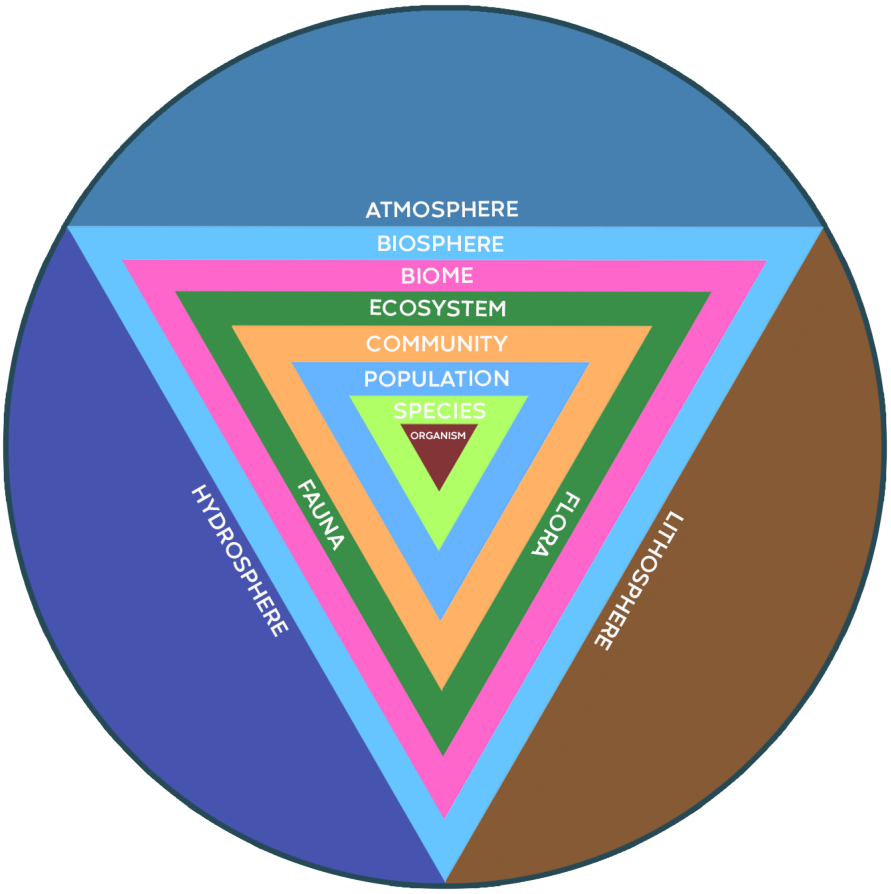


Figure 2. Basic Concepts of Environment

Biotic

The concept of biotic, which is one of the main dimensions of the environment, can be approached from two different perspectives. The first of these is the taxonomy of living things. The second is nutritional relationships. Biotic factors can be examined as shown in Figure 3.

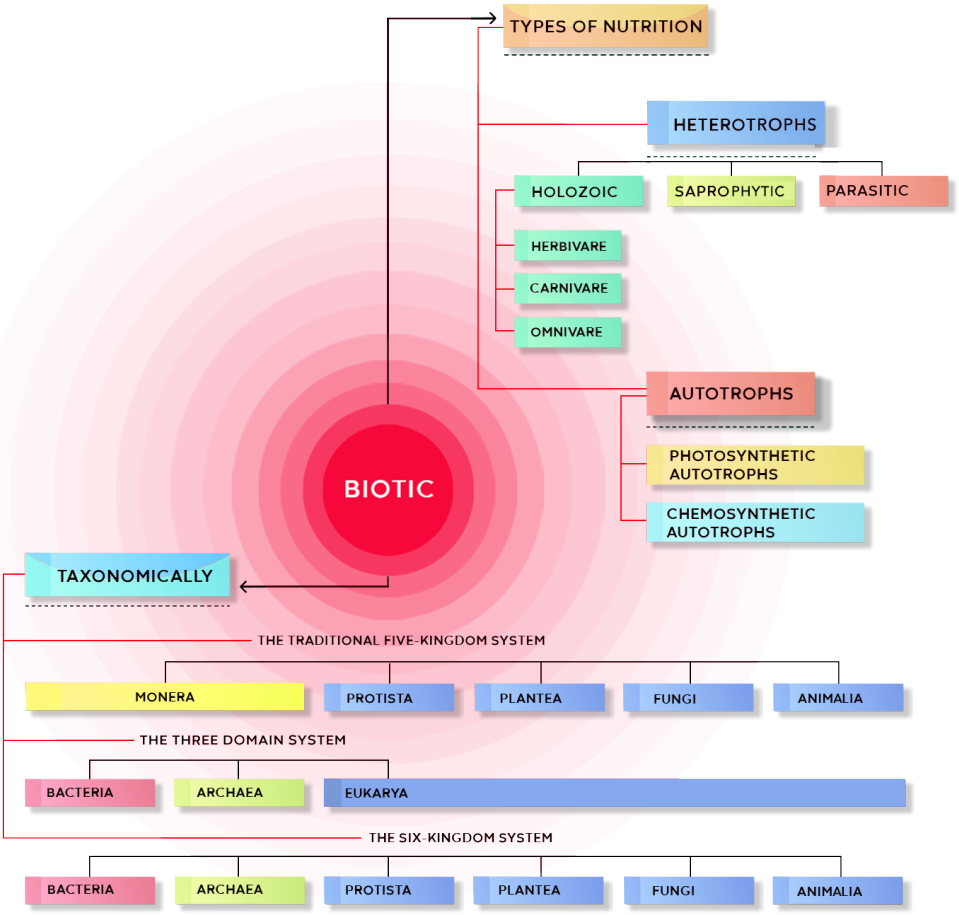


Figure 3. Biotic Factors

Taxonomy

The basis of taxonomy, which is the classification of living things, is based on ancient Greece, and Linnaeus' binary classification has been used for 250 years, which is still valid today (Godfray, 2002). In the process, living things were categorized by two, three and four classifications (The two-kingdom system of classification of Linnaeus, The three-kingdom system of classification of Haeckel, The four-kingdom system of classification of Copeland) (Verma, 2016). This classification is based on characteristics such as physiological, morphological, ecological, ethological or geographical. With The Five Kingdom System Ecologist Whittaker (1969), tries to eliminate the question marks in the previous classifications by categorizing living things according to their diet, cell structure, phylogenetic, body organization and reproduction systems (Verma, 2016). According to this classification, living things are examined in five realms. These are Monera, Protista, Fungi, Plants and Animals.

With the advances in molecular biology, the determination of DNA sequences has revealed new features (Nicol & Prosser, 2016) and some disadvantages have emerged in

the Five Kingdom System classification. Woese et al. (1990) developed a three domain system that regulates biodiversity through evolutionary relationships. According to this system, living things are divided into domains as Archaea, Bacteria, and Eucarya and classified by the six-kingdom system. The concept of domain is hierarchically superior to the concept of kingdom.

Nutritional Relationships

Nutritional relationships emerge when biotic factors that affect the environment (or ecosystem when we limit it to an environment) are categorized according to their ecological niches. According to their nutritional relationships, living things are classified as autotrophs and heterotrophs.

Autotrophs

Autotrophs, which make their own food, synthesize organic matter from inorganic substances. Autotrophs, which are indispensable elements of the ecosystem, produce the chemical energy necessary for all living things. In this way, the energy necessary for the continuation of the vitality of living things is provided (Kışlalıoğlu & Berkes, 2014). According to the energy source they use, they are examined in two groups as photosynthetic and chemosynthetic autotrophs.

Photosynthetic Autotrophs: They contain chlorophyll and synthesize organic matter from inorganic substances such as $C0_2$ and H_2O with light energy. Plants and cyanobacteria can be given as examples.

Chemosynthetic Autotrophs: They do not have chlorophyll and they synthesize organic matter from inorganic substances such as $C0_2$ and H_2O with the help of chemical energy. Archaebacteria can be given as example.

Heterotrophs

They do not produce their food and feed on autotrophs or other creatures that feed on it (Erten, 2019). While heterotrophs are divided into three as holozoic, saprophytic and parasitic; holozoics are grouped as herbivores, carnivores and omnivores according to the type of food they consume.

Holozoic

They feed on solid foods. Holozoic is classified as herbivore, carnivore and omnivore.

Herbivores are creatures that feed directly on autotrophs (Zooplankton, rabbit, cow).

Carnivores feed on by eating other heterotrops (hyena, lion)

Omnivores are creatures that feed on both autotrophs and heterotrops (bear, mouse, human)

Saprophytic

Saprophytes undertake the task of making various chemical substances in plant, animal dead and residues in soil or water usable for living things (Erten, 2019). Saprophytes generally consist of bacteria and microscopic fungi (Kışlalıoğlu & Berkes, 2014). Saprophytes are small-scale grinders that do very large-scale works that enable material cycles to take place.

Parasitic

Parasitics obtain some or all of their food from another living thing and harm that living thing. The organism in which the parasite lives is called the host. If the parasite is inside the host, it is an internal parasite, if it lives outside, it is an external parasite (Dinç & Aslan, 2009).

Abiotic

Biotic factors are affected by the amount of light in the environment, water supply, temperature change and soil composition, and these factors form abiotic components. Abiotic factors determine what kind of organisms can live in a particular environment (Suri, 2018). The abiotic factor, which is one of the main dimensions of the environment, is light, temperature, water and soil, can be examined as shown in Figure 4.

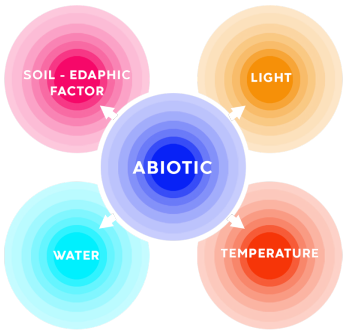


Figure 4. Abiotic Factors

Light

Light is the energy source of plants (Roeber et al., 2020) and the main environmental factor affecting their growth (Skalak et al., 2021). It significantly influences the way autotrophs adapt to changes (Janda et al., 2020). Changes in the quality and amount of light can affect the components in plants (Roeber et al., 2020). Considering that plants

play a leading role in producing chemical energy in the ecosystem with photosynthesis, it is seen that light is the primary energy source in the ecosystem. Light provides energy to components and stages in the biosphere (Norton et al., 2017). When we customize it for humans, it is known that light has behavioral, cognitive, psychological and physiological effects (Münch et al., 2017) and plays key roles in vitamin D synthesis.

Since light is necessary for photosynthesis, its intensity, quality, duration, wavelength and period are important factors. 5% of the light reaching the earth, which provides the continuation of the ecological balance and life, consists of UV (UVA, UVB and UVC) rays (Bayramgürler, 2005). This type of light, which is harmful to humans, can cause cancer, aging and burns (Çayırlı et al., 2013). It is known that some insect species develop a chitin layer to protect them from these rays.

Temperature

Temperature, which is associated with sunlight from abiotic factors, has a strong effect on the environment. Regional temperature differences are seen on earth due to the sunlight coming from different angles. These different temperatures directly affect the habitat distribution of living things. Plants and animals live in the range of 0-50 ^{0}C, and there are differentiating optimum values for each species. Temperature, which is so effective on biotic factors, is at the center of one of the important environmental problems. The increase in temperature, which is the cause of global warming and climate change, affects all components of the environment. It is predicted that the temperature on earth will increase by 0.2 ^{0}C every ten years, and it may increase up to 4 ^{0}C in 2100 (The Intergovernmental Panel on Climate Change [IPCC], 2007), and there is even concern that this 4 ^{0}C threshold will be exceeded.

Water

Water is the main natural resource (Akın & Akın, 2007; Poonam et al., 2013). With its content, water plays an important role in the biochemical activities of living things (Akın & Akın, 2007). As it is known that it creates a suitable ground for biological activities and that life will cease when there is no water, a life without water is unthinkable. One of the proofs of this is that the importance of water has been known even from ancient times, civilizations have been established near the waters (Erten-Bilgiç & Abdelhamid-Hosny, 2019). From oceans to deserts, all living things live on water. Every living thing contains water in different proportions. 70% of the human body, about 75% of succulents and 95% of a jellyfish is water. With its solvent feature, water is also an important part of the substance cycles (Abreu, 2005).

Water resources are classified as fresh and salt water resources. Our planet contains ¾ of water, 97-97.5% of this water is salt water source, while only 2.5-3% is fresh water

source (Cassardo & Jones, 2011). Today, there is a dramatic decrease in fresh water resources due to the rapid increase in population and related reasons, and the decrease in surface waters increases the need for groundwater (Poonam et al., 2013). In addition, agricultural activities consume 5 times more water than economic activities (Walczak, 2021) and it is predicted that this fresh water problem will increase with increasing food production activities. In addition, it causes problems such as detergents that harm nature, industrial residues, pesticides chemically polluting groundwater.

Soil-Edaphic Factor

Soil is a complex structure consisting of solid part (organic components and minerals), soil water and air (Turgut et al., 2010). While about half of the soil consists of solid part, air and water share the other half (Malkoç, 2018). Soil-related factors, in other words, edaphic factors refer to the effects of soil on biotic factors. It is such a sensitive structure that it can be said that it is impossible to revert when the soil loses its properties. It is known that a quarter of the world consists of land and 12% of its surface is agricultural land (Verma et al., 2005). Compared to plants, soil contains twice as much carbon as plants (European Environment Agency, 2019) and can hold much more water than its own mass. The soil consists of different layers, and the Soil Organic matter (SOM) part contains biotic factor corpses, which are of great importance for productivity (Stevenson, 1994). Many variable effects such as the living things living on the properties of the soil, the organic substances that occur with the activities of the living things, and the temperature (Kışlalıoğlu & Berkes, 2014). Soil works as a ground, a recycling stage, where organic-inorganic matter transformation takes place.

Interaction

The concept of interaction, which is one of the main components of the environment, consists of ecological relations between living and non-living things. The relationships between living and non-living things are divided into three groups. The effect of the non-living things on the living things is called action, the effect of living things on the non-living things is called reaction, and the relations of living things with living things are called coaction (biological relations) (Malkoç, 2018). The image explaining this interaction is in Figure 5.

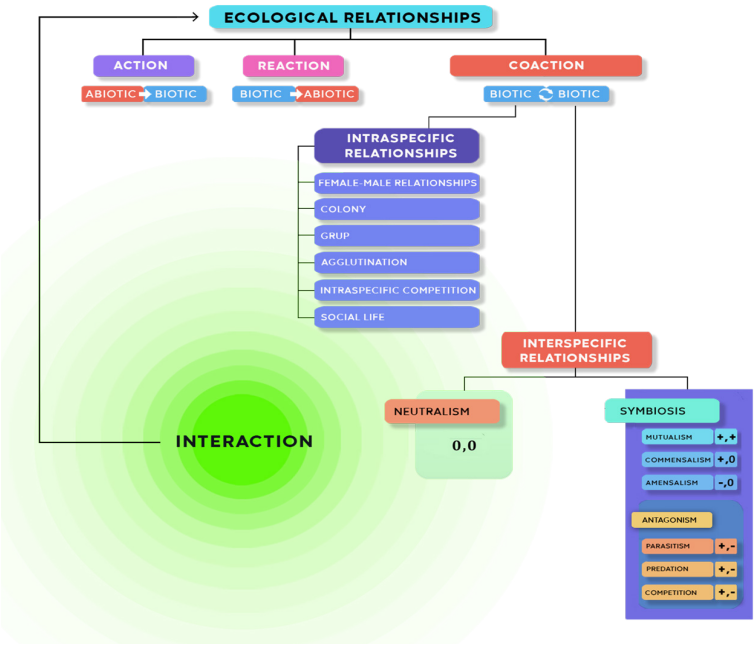


Figure 5. Interaction (Ecological Relations) Factors

Action

It is the non-living factors that make up the environment affect living things. (Dinç & Aslan, 2009; Erten, 2019). The change that occurs in a plant with temperature change, and the shedding of leaves with climate change are examples of action. Against the effects of non-living factors, biotic elements tend to adapt (Kışlalıoğlu & Berkes, 2014).

Reaction

It is the modification of non-living factors by living things and their products in order to survive (Erten, 2019). The effects of humans on the environment, the secretion of plants and the change of the organic-inorganic structure of the soil can be given as examples.

Coaction

It covers all kinds of interactions between living things (Erten, 2019). When we consider the taxonomies of living things, the relations of all categories with others and with each other means coaction, that is, biological interaction. Male and female offspring care, migration, leadership struggle are examples of coaction/biological interaction. Coaction is examined in two groups as intraspecific relationships and interspecific relationships.

Intraspecific Relationships

Six different relationships can occur between individuals belonging to the same species (Malkoç, 2018):

Male-Female Relationships: It is the union of males and females for reproduction and care of offspring.

Colonies: A community that comes together by asexual reproduction.

Groups: Individuals of the same species coming together for a specific time and purpose. It's like flying together to migrate.

Clustering: Clustering that occurs as a result of the inadequacy of the facilities in the habitat of the species for the number of individuals in the environment can create a negative situation for individuals.

Intraspecific Competition: It is the struggle between individuals of the same species (Gilad, 2008).

Social Life: It is the division of labor by organized species members (Erten, 2019).

Interspecific Relationships

The following relationships can occur between at least two different species:

Neutralism: It is the type of relationship in which order is seen most concretely in the relationship between species and it is a coincidental situation. It is the situation in which two species do not affect each other and there is no relationship between them (Srinivas et al., 2014).

Mutualism: It is the unity of interspecies coexistence and mutual benefit (Erten, 2019). e.g.: Lichens, which are formed by the partnership of fungi and algae and are a fresh air indicator.

Commensalism: It is the coexistence between species, where one of the species benefits and the other does not benefit or harm (Srinivas et al., 2014). For example: Vultures eating lion's prey residues.

Parasitism: It is the situation in which a species harms that species by benefiting from another species and cannot continue its non-species life with interspecies cohabitation (Price, 2002).

Predation: It is the use of one species as a food source by interspecies cohabitation (Price, 2002).

Amensalism: A condition in which secretion of one species suppresses the growth and development of another species. It does this by nature. e.g.: It is the suppression of the growth of other plants around it with the secretion (juglone) of the walnut tree.

Competition: Competition between species for food, shelter and space (Dhondt, 2012).

Symbiosis: It is the state of mutual long-term coexistence in interspecies relations. Mutual benefit can be provided, as well as harming (Roossinck, 2008).

Antagonism: It is the situation in which another species is damaged by effects such as protection, obtaining food or chemical secretions in interspecies relations (Price, 2002).

Balance

When viewed with the environment or its restricted state, the balance for the ecosystem means balancing the interactions of biotic and abiotic factors and maintaining the system's order without being disturbed. The continuation of the photosynthesis reaction, the blooming of flowers, the fruiting of the trees, the breathing of people, the nourishment of living things, the complete and uninterrupted fulfillment of every imaginable life-related event, such as rain, is ensured by an ecological balance. In order to achieve this balance, a transformation takes place in which the biotic and abiotic factors in the environment are involved. After the inorganic substances are taken from the abiotic environment and transferred between the biotic factors, they are returned to the abiotic environment (Kışlalı & Berkes, 2014) and this transformation is called the biogeochemical cycle. Substance cycles, which are the movement of substances between biotic and abiotic factors, provide the balance between the elements of the environment. Thanks to cycles, we give back what we borrowed for others to use, and this continues systematically. This cycle is the expression of the balance of elements with its most basic definition (Exley, 2003). Cycles are a movement that ensures the continuation of life.

The term biogeochemical consists of the concepts of biology, geology and chemical (O'Neill, 1998). Water, Carbon, Oxygen, Nitrogen, Sulfur and Phosphorus are found in organic molecules in various forms and circulate between living and non-living things with the biogeochemistry cycle.

Water Cycle Water/Hydrological Cycle

The water cycle, which is one of the most basic cycles, is also called the hydraulic cycle. The amount of water on our planet is constant, it remains in balance with the completion of the circulation of water on and below the earth. Understanding the water cycle is also important in understanding the other processes of the earth (Gleick et al., 2013). The water cycle is the condensation of water that goes to the atmosphere through evaporation and perspiration under the influence of the sun and its return to the earth as precipitation. This continues as a systematic process, forming the water cycle.

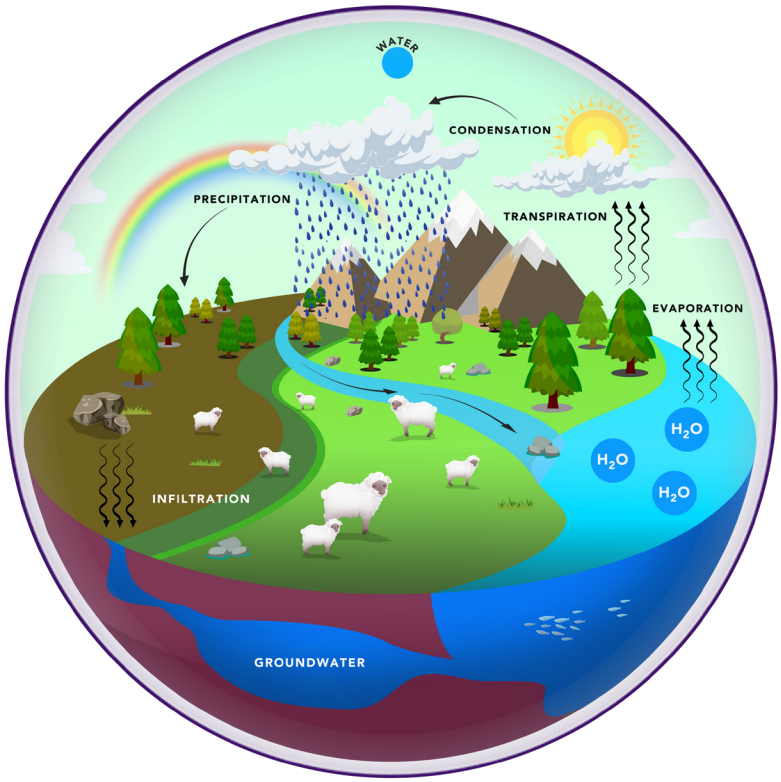


Figure 6. Water/Hydrological Cycle

The water cycle consists of five stages: condensation, precipitation, infiltration, runoff, and evapotranspiration (Gupta, 2016).

Condensation: It is the process in which water turns into water droplets in vapor form. This is when the clouds appear.

Precipitation: It is the return of water to the earth as downfall. It can take different forms such as rain, hail, snow.

Infiltration: It is the process of water infiltrating from the soil and going to underground water resources.

Runoff: It refers to the flow of water that is not absorbed by the soil and does not infiltrate into groundwater.

Evapotranspiration: It is a combination of transpiration in plants and vaporization from the earth.

Oxygen Cycle

The oxygen cycle is an important part of the functioning of the earth (Kasting & Canfield, 2012). It is the first element according to the density in the earth's crust and the second element according to the density in the atmosphere (Huang et al., 2021). Ozone form

of oxygen (O_3) takes place in the stratosphere layer and filters UV rays (Gupta, 2016). The oxygen cycle consists of the stages of oxygen production and consumption. Green plants, algae and water play a role in the production of oxygen.

Figure 7. Oxygen Cycle

While green plants and algae take CO_2 and produce O_2 with the photosynthesis reaction, O_2 comes out with the decomposition of water with sunlight. Fossil fuel use and respiration play a role in oxygen consumption, and O_2 is taken and CO_2 is produced. This continues in a cycle. As can be seen, the photosynthesis reaction and respiration play a role in the oxygen cycle.

Carbon Cycle

There is an important connection between the carbon cycle and the oxygen cycle in terms of its effects on the realization of biotic activities (Schimel, 1995). The carbon cycle is important for three reasons (Houghton, 2003):

1. Carbon is the basis of life and constitutes an important part of living things.

2. Carbon is converted into chemical energy by plants and this energy feeds the energy flow in the ecosystem.

3. The use of fossil fuels increases carbon dioxide (CO_2) and methane (CH_4), which are the forms of greenhouse gases released into the atmosphere, and this causes warming. In

this respect, warming is linked to the carbon cycle.

Carbon carries out its cycle by moving between fossil resources, atmosphere, ocean and terrestrial ecosystem (Schimel, 1995). This cycle takes place in two processes.

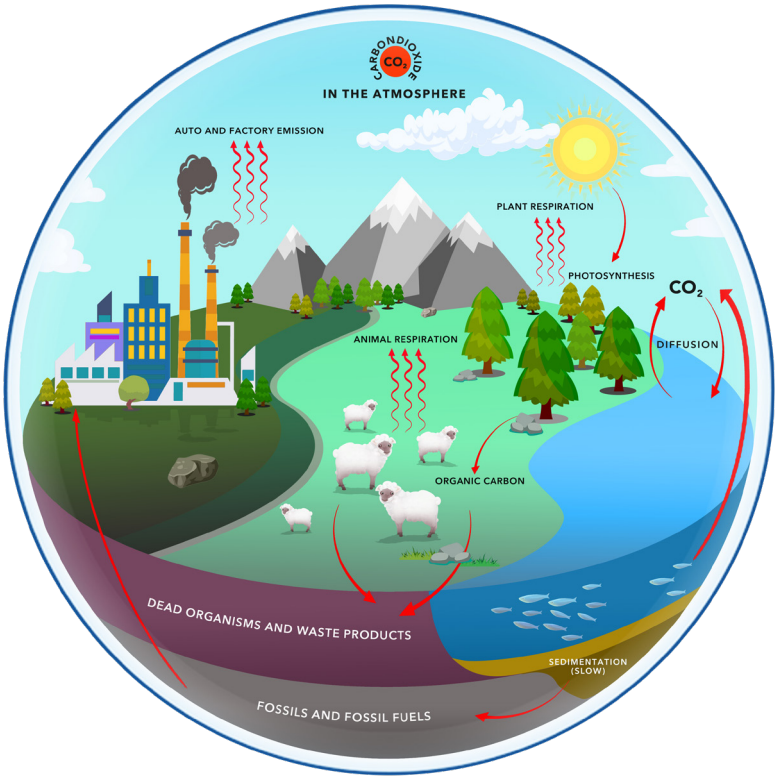


Figure 8. Carbon Cycle

1. In the first carbon cycle process between biotic factors, autotrophs convert CO_2 into carbon-containing organic compounds through photosynthesis, and these compounds are broken down by cellular respiration by heterotrophs fed with autotrophs. At the end of this process, CO_2 is released. Plant and animal dead and residues are transformed with decomposers, resulting in the formation of organic compounds and CO_2 release.

2. The second longitudinal process of the carbon cycle takes place in three different ways. Over millions of years, carbon accumulates with fossilization and CO_2 is released with their use. CO_2 in the lower layers of the earth is released by volcanic eruptions. Carbon dioxide dissolves in the oceans, and as a result of the reactions, it first combines with carbonate and then with calcium, turns into calcium carbonate and takes part in the shell formation of sea creatures. With the death of these creatures, it accumulates at the bottom and is stored with the formation of limestone over time.

Nitrogen Cycle

Nitrogen, which is a very small amount in living things when compared to other elements in the structure of living things, is of vital importance. Nitrogen (found in the form of

N_2 in the atmosphere), which is the most abundant element in the atmosphere with a rate of 78%, is required for protein synthesis in the molecule that stores genetic information, and is taken as nitrogenous compounds from foods that cannot be used directly by most organisms. Plants cannot use nitrogen in the atmosphere directly and they need nitrogen-fixing bacteria (Smil, 1997). Nitrogen turns into many forms during the cycle.

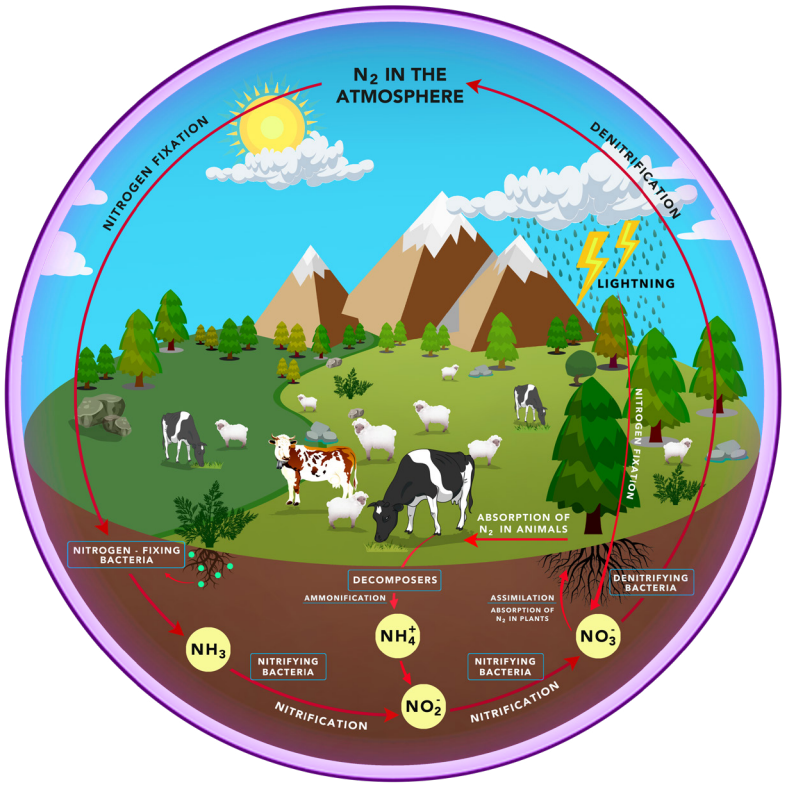


Figure 9. Nitrogen Cycle

N_2 in the atmosphere can react with O_2 in events such as thunderbolt and lightning and can pass into the soil as ammonia (NH_3), nitrate (NO_3^-), ammonium (NH_4^+), and this is called abiotic nitrogen fixation. The conversion of N_2 in the atmosphere to NH_3 by some bacteria is called biotic nitrogen fixation.

Rhizobium bacteria living in the roots of legumes convert the N_2 in the atmosphere to ammonia (NH_3) $\rightarrow$ nitrite (NO_2^-) $\rightarrow$ nitrate (NO_3^-). This phenomenon is called nitrification. The plant, which uses nitrate in amino acid and protein synthesis, incorporates nitrogen into its body. Nitrogen continues its movement between living things through the food chain.

The conversion of NO_3^- to N_2 and release to the atmosphere by denitrifying bacteria, which is the opposite of nitrification, is called denitrification.

The nitrogen, which returns to the soil with the residues and dead of plants and animals, turns into NH_3 by the saprophytes and the cycle continues.

Sulfur Cycle

Although sulfur is of great importance in life, it is the building block of amino acids such as cysteine and taurine (Brosnan & Brosnan, 2006). Sulfur is found in nature in different forms and during the sulfur cycle, there is a transition between the hydrosphere, lithosphere, atmosphere and biotic.

In its cycle on land, sulfur in the atmosphere in the form of sulfur dioxide (SO_2) turns into weak sulfuric acid (H_2SO_4) with rain (Kocataş, 2008). It can fall directly from the atmosphere with the name of sulfur spray, or it can mix with the soil from rocks containing sulfur. These sulfates (SO_4^{2-}) taken from the soil by plants reach living things through the food chain and are decomposed as a result of the death of the plants and released as hydrogen sulfide (H_2S).

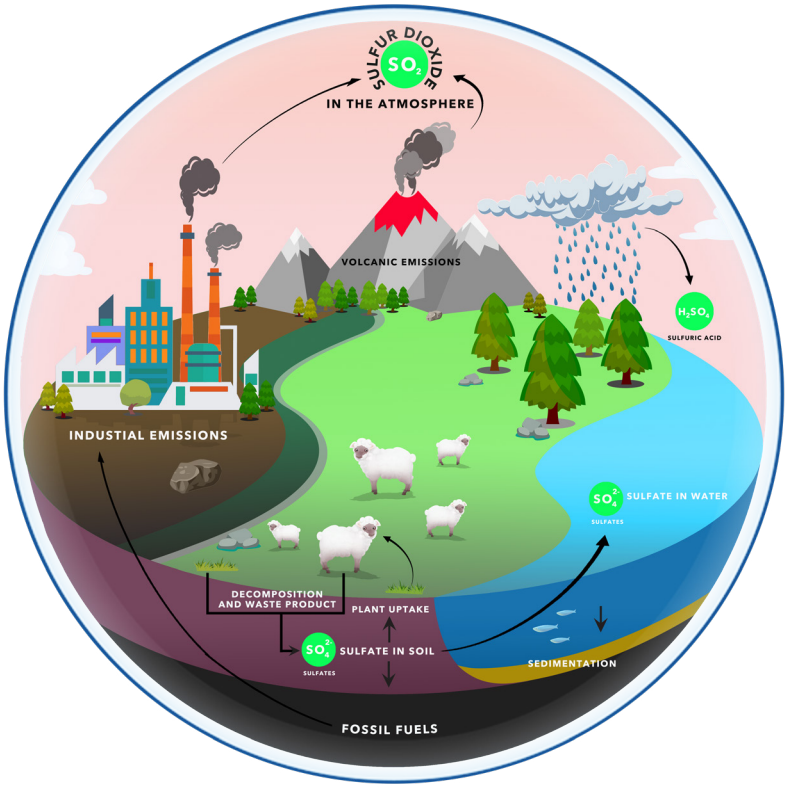


Figure 10. Sulfur Cycle

In the oceans, sulfur entering the environment from land, fallout and geothermal crevices is found in marine ecosystems in the form of SO_4^{2-}. Sulfur dioxide (SO_2), which increases with the use of fossil fuels, turns into weak sulfuric acid (H_2SO_4) and harms this ecosystem (Fisher, 2017).

Phosphorus Cycle

The phosphorus cycle is a cycle that moves from land to sea and from sea to land (Nebel & Wright, 1996). Phosphorus also differs due to its absence in the atmosphere. It is present as orthophosphate ions (HPO_4^{2-}) in the form of phosphoric acid salt during the cycle

(Beiras, 2018). Phosphorus has a tendency to form compounds that do not dissolve easily in water (Gupta, 2016). Phosphorus in phosphate rocks dissolves and is taken by plants as inorganic form orthophosphate (N_2PO_4) and converted to organic form. Phosphorus, which moves between the food chain and living things, is converted into inorganic form by decomposing wastes and dead (Kocataş, 2008). Phosphorus transforms into different forms in the hydrosphere and undergoes the stages of decomposition, precipitation and rock formation.

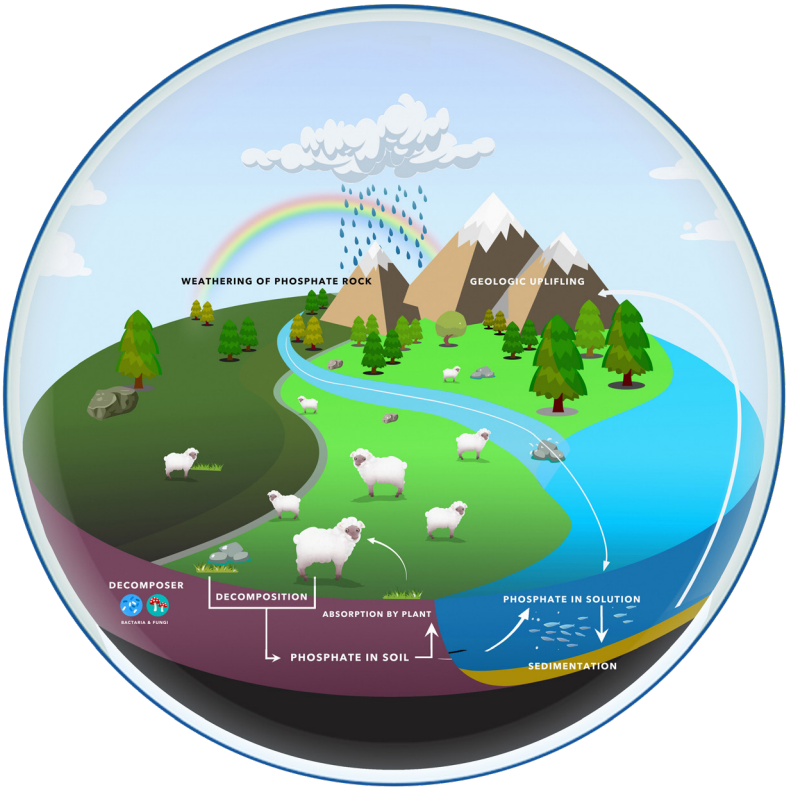


Figure 11. Phosphorus Cycle

Energy Flow: Food Chain, Food Web, and Food Pyramid

The ecosystem consists of organized producers, consumers and decomposers and abiotic factors affecting this organization. Abiotic factors include the flow of energy and the transformation of substances. Energy circulates between species and provides the energy flow in the ecosystem, which is associated with biodiversity. All the energy in the ecosystem comes from the sun. The first law of thermodynamics (conservation of energy in the ecosystem) and the second law (energy is lost as energy is transformed and lost as heat energy) form the basis of energy flow.

Energy transfers of living things take place in the form of feeding steps and each feeding step is called the trophic level. Living things settle in trophic levels in the ecosystem according to their energy production and consumption status (Cebrian, 2015). One of the important concepts in energy flow is biomass. It is all the unfossilized biological contents

of living and recently lived organisms (Öztürk, 2013). During the energy flow, the energy transferred by biomass is lost at each step or level. While about 80-90% of it is given to the environment as heat, 10% of it can be transferred to the next step. Bioaccumulation is the accumulation process when the chemical uptake of the organism is greater than its excretion from the organism (Popek, 2018). Accordingly, the concentration of the energy flow in the food chain and the accumulation in the upper steps is called biomagnification. Bioaccumulation and biomagnification create negativities for ecosystem health.

In the first trophic level of the energy flow in the ecosystem, green plants, that is, producers, produce chemical energy by photosynthesis by using sunlight. While some of this energy is used in metabolic activities, some of it is lost with heat. This energy, which is transferred to the second trophic level with the living things that feed on plants, is transferred to the third trophic level by being used in metabolic activities and undergoing heat losses at this level. The same processes take place at this level as well.

At each trophic level, very little of the energy taken is converted into biomass. In this energy flow, 10% of the energy used in the metabolic activities of the living thing, excluding the energy lost as heat, is transferred to the living thing at the upper trophic level. This is called the 10-percent rule.

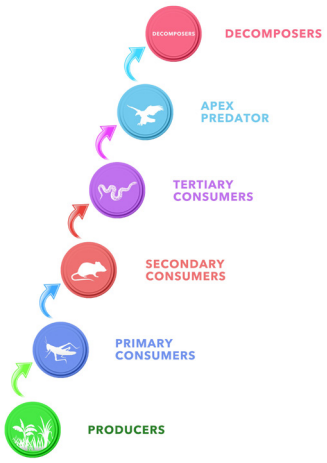


Figure 12. Food Chain

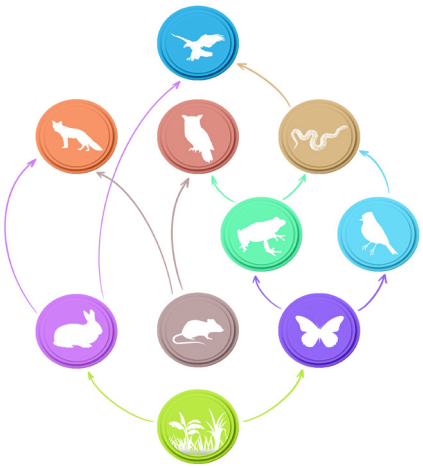


Figure 13. Food Web

Energy flow, which is the interdependence of species with energy and matter flow, can be shown in three different ways. The energy flow that continues in a straight line, which is formed by the use of another living thing as a nutrient, refers to the food chain. Since it does not consider other species in the environment (Fontefrancesco & Sidsaph, 2019), it offers limited energy flow information. The energy flow representation, which is a more complex structure consisting of food chains and presents the flow of nutrients between living things more realistically, is called the food web (Fontefrancesco & Sidsaph, 2019).

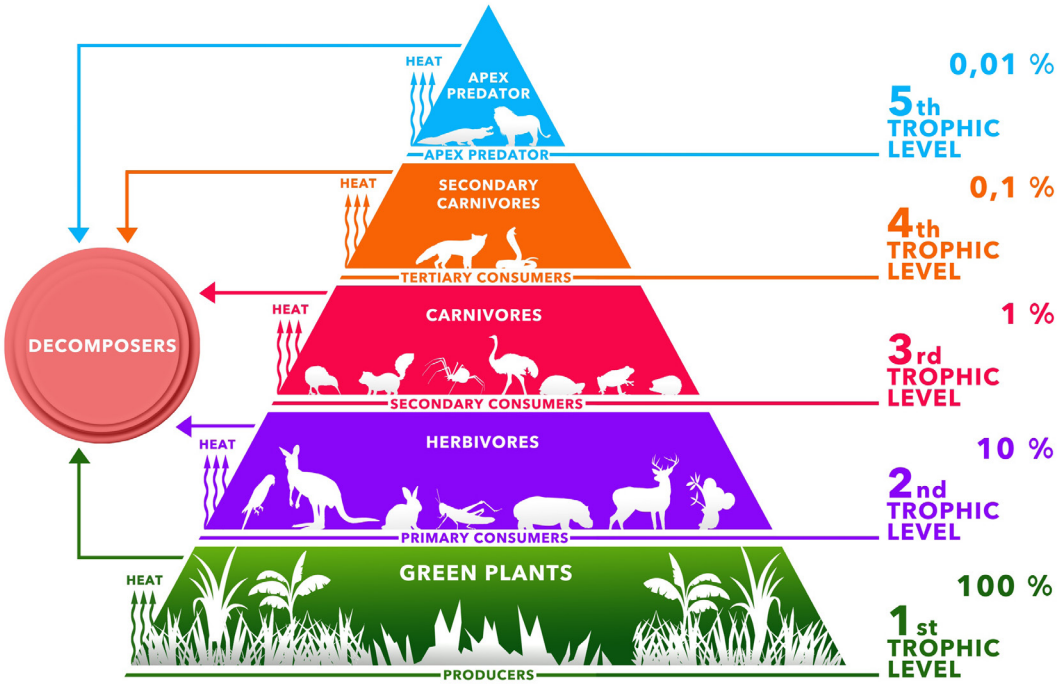


Figure 14. Food Pyramid

The system that the energy flow creates vertically with trophic levels is called the food pyramid.

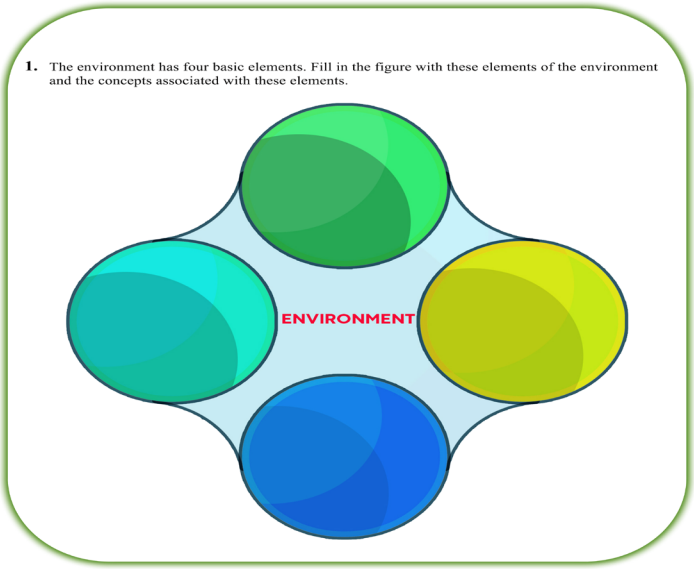
Conclusion

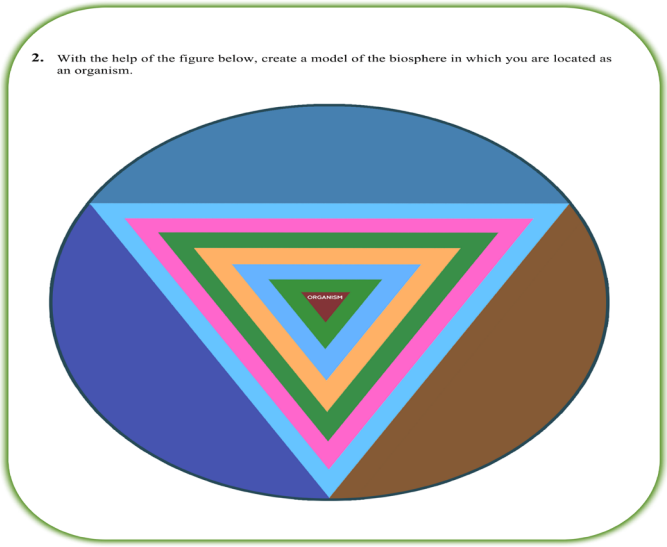
Environmental education is an indispensable education and its basic pillar is to know ecological knowledge. Individuals who know the basic information about the environment have feelings for the environment and take actions for the environment. Environmental knowledge is a prerequisite for concrete steps to be taken towards the environment and for the formation of environmental awareness. For example, there is a big difference from an environmental awareness perspective between an employee who is responsible for collecting garbage, separating waste suitable for recycling due to his job, and a student using waste recycling bins, considering the environmental benefits and knowing the effects on the environment, although the behaviors are the same. Environmental consciousness wants the actions and feelings towards the environment to be "conscious" and environmental information provides the knowledge required for this awareness.

Within the scope of environmental education, it is thought that basic ecological information at the point of developing environmental awareness will be a reference point in the journey of the individual to perform environmental-friendly behaviors. The borderless environment is fed by its own nature and is full of complex and comprehensive information and research. With new questions, directions, and advances in science, this

body of knowledge is open to development.

Activities





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