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BIOLOGY

4

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PREFACE

Biology is a rapidly developing branch of science. The major advances being made continuously affect our life on earth. Some of these important advances are included here.

The results of a recent survey on the attitudes towards existing literature available to high school students showed that many were unhappy with the material used in teaching and learning. Those questioned identified a lack of the following: accompanying supplementary material to main text books, current information on new developments, clear figures and diagrams.

This book aims to improve the level of understanding of modern biology by inclusion of the following: main texts, figures and illustrations, extensive questions, articles and experiments. It is the intention and hope of the authors that the contents of this book will help to bridge the current gap in the field of biology at this level.

This book has been carefully reviewed and the language is considered suitable for students for whom English is a second language.

To the students

Being curious students, you may have wondered why you resemble your parents or why you need to breathe. In this book, I try to summarize some major subjects of biology. These are the most promising and perhaps the most complicated subjects of modern biology.

Group work will greatly enhance your learning abilities as well as give you an opportunity to share your knowledge and experience with your friends. I hope that, being assiduous students, you will work hard throughout this academic year and do your best to satisfy your scientific curiosity and, of course, to pass all of your exams successfully.

The author

CONTENTS

Classification of living organisms

Classification

Several million types of living organisims are known to exist today. Furthermore, new species discovered each year increase this number. As millions of organisms may belong to a single species, it is not possible to investigate and recognize the billions of individual organisms. To acquire sufficient information about organisms, classifying into smaller groups is necessary.

Biologists have used observation methods since ancient times. Although, many classifications are made by observation, some new techniques are used as well. The Science of classifying organisms is known as taxonomy.

History of Classification

The Greek philospher Aristotle (350 BC) listed only a few hundred plants and animals. Aristotle and his pupils grouped plants as grasses, bushes, or trees, and animals as aquatic or terrestrial. Another philosopher classified animals as useful, harmful or useless.

Classification by appearance and similarities in function is called **empiric (artificial) classification**. This classification is based on observations.

Initially, organisms were classified as plants (motionless organisms) or animals.
With the discovery of microorganisms in the 16th century, classification problems became more complex.

Organisms like bacteria, blue-green algae and euglena became problematic for botanists and zoologists.

Use of analogous organs in classification was replaced with use of homologous organs.

Analogous Organs

These are organs generally similar in shape and function. For instance, wings in butterflies or birds provide flight, whereas legs in flies and cats function in walking.But these organs are embryologically different. Therefore we say that butterflies and birds aren't related.

Homologous Organs

Some similarities may be seen in structures seemingly unrelated in appearence. For instance, a human's arm seems quite different from a bat's wing.But these are seen to be similar both anatomically and embryologically. Organs sharing the same origin and similar embryological stages are called homologous organs. Functions of homologous organs may be the same or different.

Homologous organs are the basis of modern classification.Before modern classification was developed in the 18th century, several methods had been used. John Ray (1626-1705) tried to unify classification systems and was the first to use the term "**species**". The founder of modern systematics was Carolus Linnaeus. He applied his binominal nomenclature method to plants (in 1753) and to animals (1758) in his book **Systema Naturae**.

System of Classification

Phylogenetic systematics used today depends on **Linnaeus systematics** and **homology**. Homology is used in determining the level of relatedness; e.g. bats and humans are in the group Mammalia.

The basis of modern systematics is the grouping of organisms according to similarities. In the classification of organisms, the following critera are used: origins, relatedness, developmental stages.

In the binomial system created by **Linnaeus**, species is the basic unit of nomenclature. A species is a group of organisms from the same population sharing the same embryological, morphological, and physiological features, and are capable of giving birth to fertile offspring when mated under natural conditions.There are two points in Linnaeus' hypothesis:

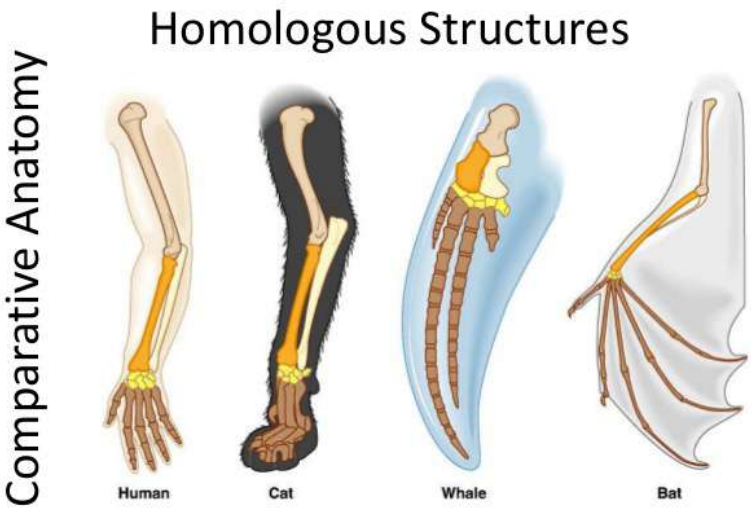
- There is an ideal type for each species. This ideal type represents the standard features of every single individual of the species.

The number of species and their types is constant and unchangeable.

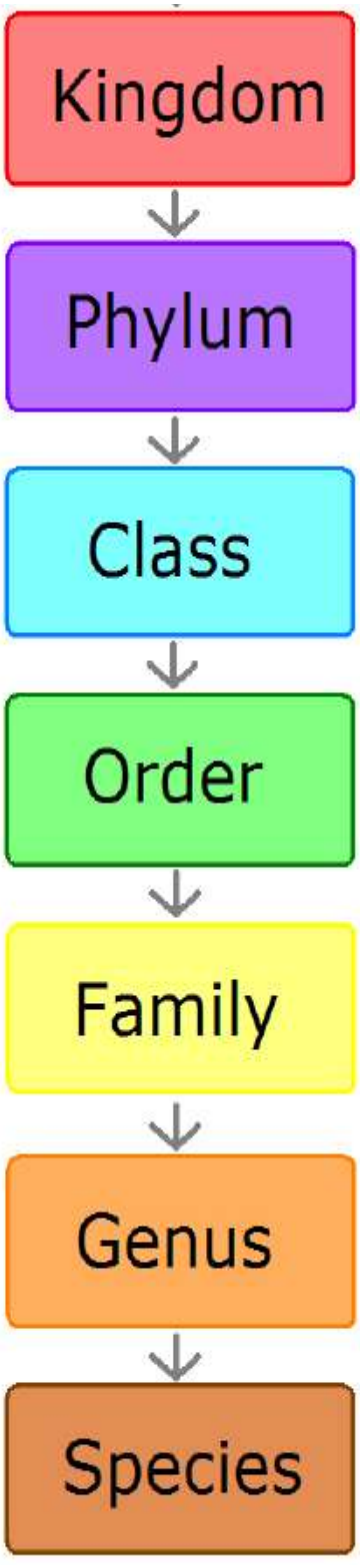
According to Linnaeus systematics, a species is named with two names. First is the genus name with the first letter capitalized. Second is the specific epithet (species name) and the first letter is not capitalized. Both are written in italics and in Latin. The reason for this is to have a single name in the scientific world, thus simplifying the study of species. For example, *Canis familiaris* is the name for dogs, whereas *Canis lupus* is the wolf. The first name (Canis) shows that these two species are in the same genus.

A group of species similar in some characteristics forms a genus, similar genera form a family, similar families form an order, similar orders form a class and similar classes form a phylum. Similar phyla form a kingdom.

In this system, species level has the largest number of common features and the least number of individuals compared to the higher levels. As you go up, common features decrease while the number of individuals increases. So the fewest common characteristics and the highest number of individuals are found in the kingdoms.



Homologous organs in different organisms



SELF CHECK

CLASSIFICATION

A. Key Terms

Homologous organ
Species
Family
Analogous organ
Kingdom
Genus
Class
Order

B. Review Questions

1. Explain the classification of Aristotle.
2. Explain analogous organ with an example.
3. What are the two points in Linnaeus hypothesis?
4. Explain homologous organ with an example.
5. Explain how Linnaeus named organisms with an example.

C. Fill in the blanks

1.Initally organisms are classified as ..... and .....
2. According to ..... a species is named with two names.
3. The basis of modern systematics is the grouping of organisms according to .....

D. True or False

1. Aristotle was the first scientist to name organisms with binomial nomenclature.
2. Plants are photosynthetic, multicellular organisms.
3. Similar genera form family .
4. Animals are non-motile eukaryotic organisms.

Kingdom	Organization	Type of Nutrition	Representative Organisms
Protista	Complex single cell, some multicellular	Absorb, photo-synthesize, or ingest food	 paramecium  euglenoid  slime mold  dino-flagellate
Fungi	Some unicellular, most multicellular filamentous forms with specialized complex cells	Absorb food	 black bread mold  yeast  mushroom  bracket fungus
Plantae	Multi-cellular form with specialized complex cells	Photo-synthesize food	 moss  fern  pine tree  nonwoody flowering plant
Animalia	Multi-cellular form with specialized complex cells	Ingest food	 coral  earthworm  blue jay  squirrel

ECOLOGY

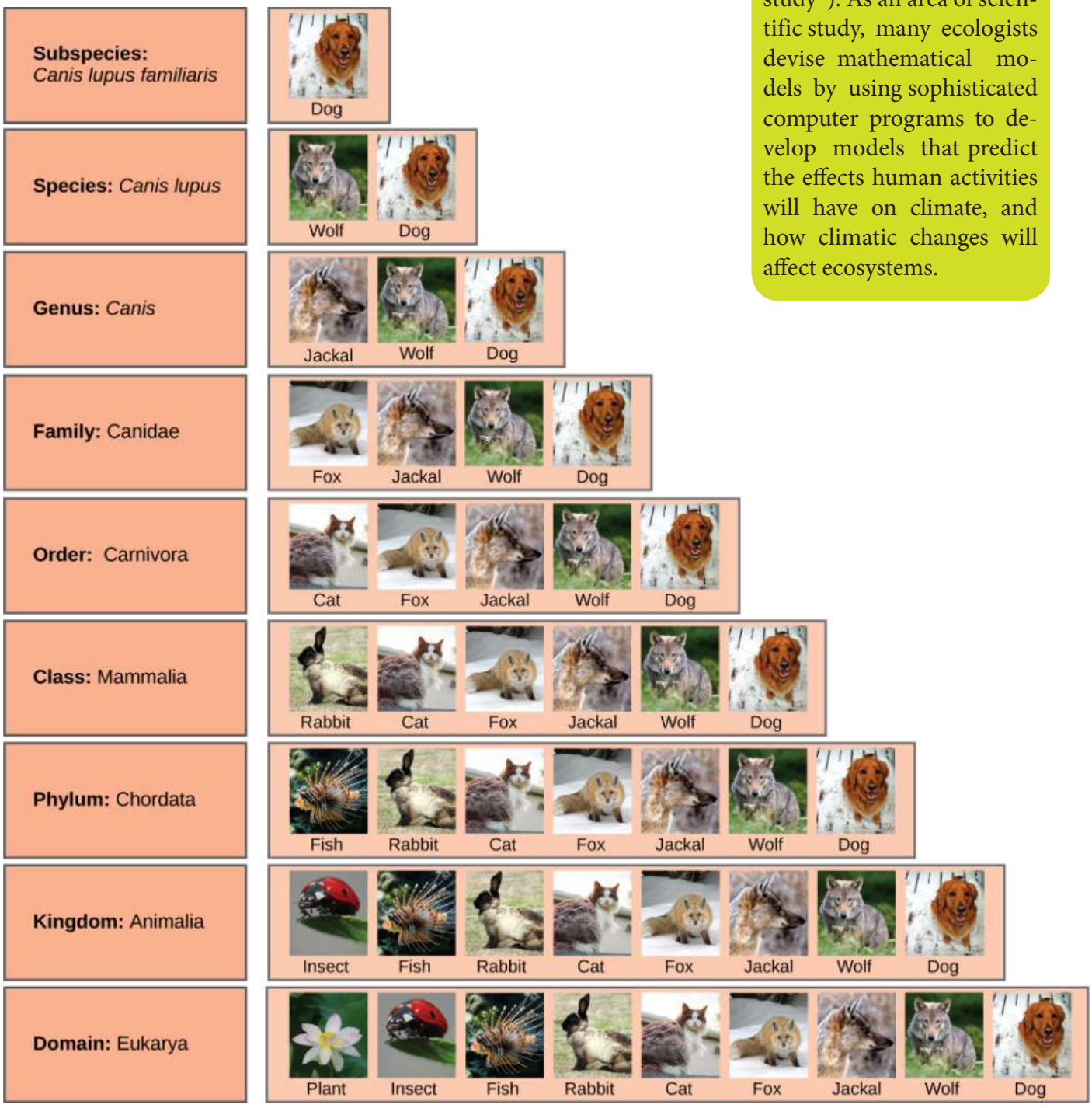
The Scope of Ecology

Ecology is a branch of science that studies the interactions of living things with each other and with the environment. Today there are over a billion organisms on earth. The complex relations of organisms with each other and with the environment is discussed and explained by ecology.

Today environmental problems have increased due to development in technology and industry, and because of the **unwitting actions of people**. For example, the overuse of chemical substances contaminates the water and causes slow-progressing diseases in humans; the inefficient use of soil depletes water sources and makes the soil arid. Such environmental problems increase the importance of ecology. For this reason ecology is taught as a science in schools, and private institutions keep people informed so that they will be more consciously aware of the environment.

For a thorough understanding of ecology, the relationships between organisms and the environment must be surveyed. Accordingly, the levels of organization are as follows: **protoplasm - cells - tissues - organs - organ systems - organisms - population - community - ecosystem - biosphere**. Only the levels between organisms and biosphere are included in ecology.

Ecology is the scientific study of the interactions between organisms and their environments ecology (from the Greek oikos, "home," and logos, "to study"). As an area of scientific study, many ecologists devise mathematical models by using sophisticated computer programs to develop models that predict the effects human activities will have on climate, and how climatic changes will affect ecosystems.



Terms used in Ecology

1-Ecosystem: A community together with the abiotic environment forms an ecosystem. Environment is the place where an organism lives. The environment is made up of abiotic and biotic factors. e.g., air, light, water, humans, other organisms and all non living things form the environment.

Organismal (Individual) Ecology: A branch of ecology that studies the relationship of an individual or individuals of a species to the environment.

Population ecology: The next level of organization in ecology is the population, a group of individuals of the same species living in a particular geographic area.

2-Population: The word "population" initially was used only for humans, but later was used for other organisms as well. Population is a group of individuals of the same species living in the same area. Population is the smallest unit of ecology. A population exists as long as it lives together with other populations and maintains its relations. In other words, one population is not self-sufficient.

3-Community: A group of populations living together in the same area. With abiotic factors included, communities are self-sufficient.

4-Biosphere:All of the places where organisms can live, from the bottom of the ocean to an altitude of 10,000 m.

5-Habitat: The natural environment or place where an organism, population, or species lives. It is shortly address of the organism. For example habitat of paramecium is fresh water and habitat of certain kind of ants is trees in the forest.

6-Biome: The geographical area of the environment that an organism needs to live. Biome can be thought of as the place where the community lives.

7-Biomass: The dry weight of organic matter comprising a group of organisms
in a particular habitat.

Flora: The plant or bacterial populations living in a particular environment.

Fauna: The animal populations living in a particular environment.

For a thorough understanding of ecology, the relationships between organisms and the environment must be surveyed. Accordingly, the levels of organization are as follows: protoplasm - cells - tissues - organs - organ systems - organisms -population - community -ecosystem - biosphere - Earth -planets - solar system - galaxies -cosmos. Only the levels between organisms and biosphere are included in ecology.

Interaction is a key idea in ecology. No organism is completely self-sufficient. Organisms depend upon other organisms and upon the environment for survival. For example autotrophs produce food and oxygen and heterotrophs produce carbon dioxide, which is needed for autotrophs to produce food.

Ecosystem componants

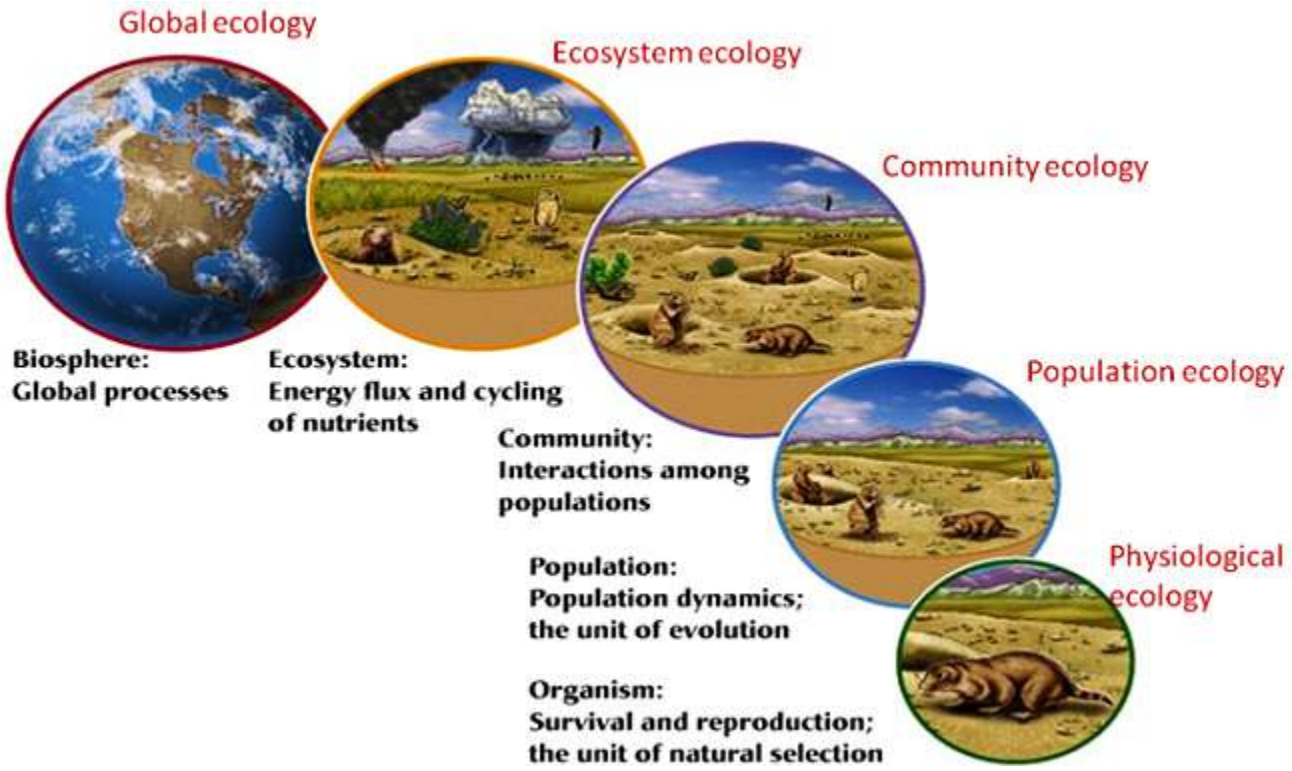
Environment is the all living and non living factors that surround an organism. The environment includes abiotic components (nonliving chemical and physical factors and physical factors) such as temperature, light, water, and nutrients and biotic components (living) such as plants, animals, fungi-all the other organisms.

Ecology is the study of the interactions between organisms and their environment. An ecosystem (environment) is all the living and nonliving factors that surround an organism. The ecosystem includes the **biotic** (living) community, together with the associated **abiotic** (nonliving) components. The abiotic components of an ecosystem include soil, water, light, inorganic nutrients, and weather. The biotic components include producers, autotrophic organisms which can produce their own food (and indirectly for other organisms as well).

A- Biotic componants

In terrestrial ecosystems, the dominant **producers** are green plants, while in fresh water and saltwater ecosystems, the dominant producers are algae (a kind of protist). Consumers are **heterotrophic** organisms that can not produce their own food. Four types of consumer can be identified according to their food source.

1-Herbivores (also called primary consumers), such as sheep, eat plants directly.
2-Carnivores (secondary or tertiary consumers), such as lions, feed on other animals.
3- Omnivores, such as humans, feed on both plants and animals.
4- Decomposers are organisms of decay. They break down detritus (nonliving organic matter) to inorganic matter which can be used again by producers. In this way materials are constantly recycled in an ecosystem. Interaction is a key idea in ecology. No organism is completely self-sufficient. Organisms depend upon other organisms and upon the environment for survival.



Branches of Ecology

B- A biotic Components:

1- Minerals:

can be solid that form the soil, contains all elements & chemical compounds which are necessary for life maintenance, organic and non organic materials are main components of soil.

2- water:

forms the biggest part in the ecosystem, such as : rivers, lakes and oceans. Water is the habitat for many solvent minerals and chemicals.
Water basically is the most important life source, due to its percentage in living cell (more than 90% in some cells kinds).

3- Gases:

take an important role in ecosystem, represented by a mixture of different gasses that forms biosphere.
Mainly this mixture is formed by Nitrogen, Oxygen, CO_2, water vapor and other gasses.
Although all of these gasses are important but, oxygen is the most important base that forms any ecosystem.

4- Solar energy:

clearly affect the ecosystem; this effect appears in different forms due to alternation of earth position around the sun and four seasons sequence.
That affects the density of living organisms numbers from one habitat to another.

If you must drink bottled water, recycle the bottle.

Sun is a clean source of energy

Underinflated tires decrease your fuel economy and lead to increased pollution.

SELF CHECK

ECOLOGY

A. Key Terms

Ecology
Biosphere
Biome
Community
Population
Ecosystem
Flora
Fauna

B. Review Questions

1.What is the difference between population and community?

2. What is the importanse of gasses in ecosystem?

3. What are the biotic components of an ecosystem?

C. Fill in the blanks

1.....is a key idea in ecology.

2.In fresh water and saltwater ecosystems, the dominant producers are .....

3. ..... is the plant populations living in a particular environment.

4. Lions are ..... and feed on .....

D. True or False

1. Herbivores eat plants directly
2. Decomposers are organisms of decay.
3. Soil contains organic materials only.
4. Herbivores are tertiary consumers.

E. Multiple Choises

1. .....group of individuals of same species.

A) Biosphere
B) Flora
C) population
D) Habitat

2. Which one of the following biggest than others?

A) Population
B) Community
C) Ecosystem
D) biosphere

3. Which of the followings is the most important in ecosystem?

A) Magnesium
B) Oxygen
C)Water vapour
D) Algae.

Food chains and elements cycles in nature

The Interactions of Life

One of the properties that distinguishes living things from non living things is their nutrition. Organisms feed and acquire materials necessary for energy production, regulation and assembly. Organisms are classified according to their feeding styles to:-

1- Autotrophic organisms

Autotrophs produce their own food from inorganic substances. Autotrophs are either photosynthetic or chemosynthetic according to the energy used.

Photosynthetic autotrophs: These organisms produce organic molecules from inorganic molecules using sunlight energy (photosynthesis). Green plants, algae, and blue-green bacteria are photosynthetic autotrophs. Some bacteria use hydrogen sulfide (H_2S) or hydrogen (H) instead of water. The bacteria using these don't release O_2.

Chemosynthetic autotrophs: Some bacteria oxidize inorganic substances and release energy. From this energy ATP is synthesized. ATP is used in the production of organic substances from inorganic ones. Since chemicals are used in place of light, this food synthesis is called chemosynthesis. Examples of chemosynthetic bacteria are nitrite and nitrate bacteria.

Carnivorous plants are meat eaters or morecorrectly insect eaters hence their true title. Insectivorous plants (Carnivorous sounds far more interesting). These plants lives in areas where there is a lack of nutrients in the soil or very poor conditions where roots do not survive well. The plants have adapted their leaves into insect catchers that can hold down an insect and digest the internal juices. Insect eaters are therefore highly advances plants quite different from other plant types.

Figure: Some plants living in nitrogen-deficient soils obtain nitrogen by ingesting insects. These plants are called insectivorous plants. Some examples are dionea, drosera and nepentes that attract insects with their color and aroma. The trapped insects are digested with enzymes secreted by the plant and then metabolized.

Auto-heterotrophic organisms

Some unicellulars (e.g. *Euglena*) carry chloroplast and practice photosynthesis. These organisms carry out photosynthesis in the presence of light (autotrophs), while at night they obtain food from their surroundings (heterotrophs). **Insectivorous** plants have chloroplasts like green plants and carry out photosynthesis. At the same time, since these plants live in nitrogen-deficient soil, they obtain nitrogen by eating insects. They secrete enzymes to digest insect proteins. The amino acids released are absorbed into the cells and used in metabolism. Examples include **dionea**, **drosera** and **nepentes** plants.

Heterotrophic organisms

Animals, fungi, some bacteria and protists can't synthesise their own food and get it from other organisms or decaying matter. Heterotrophs have different types of nutrition according to their habitat and food type used.

Holozoic nutrition (Heterotrophic)

This is the form of nutrition used by most animals and involves the ingestion of complex food, which is broken down into simpler molecules before being absorbed.

Carnivores (meat eaters): They eat only meat. Examples are **lion, tiger, wolf** and etc.

Herbivores (plant eaters): They eat only plant. Examples are **sheep, gazelle, cows** and etc.

Omnivores (plant and meat eaters): They eat both plant and meat. Examples, **monkeys, birds** and etc.

Food relationships

The digestive systems of these organisms vary according to the type of food. For example, herbivores have well-developed molar teeth, 4-chambered stomachs, and long intestines, because the digestion of grass is difficult. Carnivores have well-developed incisor and canine teeth, single-lobed stomachs, and shorter intestines.
Omnivores have the properties of both moderately.

All organisms need energy to live and complete their life cycle. The main source of energy is the radiant energy from the sun but it is unusable by all organisms.

Biotic (plants, animals, and decomposers) and abiotic factors (soil, light, water and nonliving matter) interact continuously in the balance of nature.

Symbiotic Nutrition (living together)

Some organisms live in close relationship. There are types of this relationship.

1-Commensalism

If one organism benefits and the other is neither harmed nor helped, the relationship is called **commensalism**. The helping organism is called **commensal**. For instance, small fish (Echeneis) attach to sharks and live with them. These small fish feed on the residue of the shark's prey. Here, while the small fish benefit, the shark (commensal) is not affected.

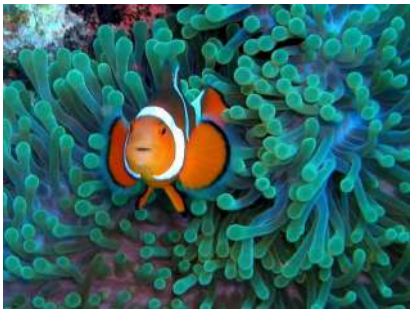


Figure: Commensalism in the sea. Clownfishes often form symbiotic association with sea anemones, gaining protection by remaining among their tentacles and gleaning scraps from their food.

2-Mutualism (Mutual Benefit)

In this type of relationship both organisms benefit. **Lichens** are a typical example. Lichens are composed of **fungi** and **green algae**. Fungi protect the algae and provide them with water and CO_2. Green algae supply the fungi with food and O_2. Another example is the relationship between the rhizobium bacteria (*Rhizobium leguminosarum*) and legume plants. These bacteria live in the root nodules of legume plants. Saprophytic rhizobium bacteria live in the soil and when they encounter the roots of legume plants, they enter the root hairs and pass to the cortex cells, where they reproduce using the food and enzymes of the plant.

Figure: Rhizobium bacteria living in root nodules of legume plants are a good example of mutualism. The bacteria supply the plant with nitrogen, and the plant supplies the bacteria with the products of photosynthesis.

Host cells activated by the bacteria multiply quickly and form pocket-like bacteria containing nodules. Here the plant gets the advantage of atmospheric nitrogen, which is fixed by the bacteria. The plant provides the bacteria with shelter and the products of photosynthesis.

Figure: Flea and tick, external parasites, are very dangerous to humans. These organisms don't have a well-developed digestive system and suck blood for nutrition.

Figure: Broom-rapes, a full parasitic plant, does not carry out photosynthesis but obtains nutrients through haustoria from the host plant.

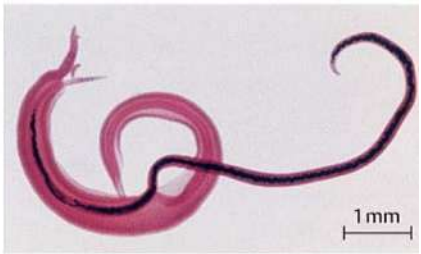


figure.flat worm as example for internal parasites.

3-Parasitism

Parasitism is the symbiotic relationship in which one member (parasite) benefits and the other (host) is adversely affected.

Parasites have well-developed sense and grasping organs and reproduce quickly. On the contrary, their enzyme and digestive systems are not well-developed. Parasites live in or on the host. They suck liquid nutrients from the host.

Parasitic animals may be internal or external. Both groups contain different organisms. Internal parasites don't have digestive systems and live in places where digested food is available. External parasites can partially digest food. Examples of external parasites are **lice, fleas** and **bedbugs**. Examples of internal parasites are ***plasmodium*, tapeworm, roundworms** and **flukes**.

Parasitic plants: Some plant species live on other plants and obtain organic or inorganic substances from them. Such plants are of two types: **half-parasitic** and **full-parasitic.**

Full-Parasitic plants: The organs of these plants have certain peculiarities. Leaves are small, with little or no chlorophyll, weakened xylems and, in some cases, roots disappear.

The absence of photosynthesis is compensated for by the development of sucking organs called **haustorium**.

Parasitic plants anchor their haustoria to the vascular tissue of the host plant and absorb and use the food produced by the host. In the same way they obtain the water necessary for transpiration.

Parasitic plants cause enormous harm to cultivated plant. Examples include **Broom-rapes** and **Cuscutaceae**.

Half-Parasitic plants: These plants anchor their haustoria into the xylem of the host plant, absorbing water and minerals which they use to produce organic substances.

They have chlorophyll and also carry out photosynthesis. Mistletoe, a half parasite, lives on trees such as apple and pear.

Pathogens: Many bacteria and fungi live parasitically on higher plants and animals and cause disease. In other words such parasites are at the same time pathogens.

Parasites that can't survive unless they are on a host organism are called **obligatory parasites.** The bacteria that causes diphteria is such an organism, unable to survive outside the human body.

The bacteria that cause cholera and tetanus can live in soil or water in a dormant condition. When they find suitable conditions they become parasitic and pathogenic. Viruses are also obligatory parasites.

4-Saprophytic nutrition (decomposers)

Saprophytic nutrition is a type of heterotrophy. Some bacteria and fungi feed on and digest organic substances in decaying animal and plant remains. These organisms, also called decomposers, have a well-developed digestive system.

They practice extracellular digestion and convert organic substances into inorganic ones. In this way they clean the environment and contribute to the nitrogen cycle.

Bacteria and fungi that get food from the nitrogenous organic compounds of dead plants and animals cause decomposition and putrefaction, and enable matter to cycle in nature.

Proteus vulgaris one of the saprophytic bacteria that causes putrefaction.

Figure:Some bacteria and fungi, living as saprophytes, decompose dead plants and animals, making their nutrients available and participating in the cycling of matter.

For a good understanding of the problems these parasitic plants can cause, it is necessary to give some background information about the biology of parasitic plants in general and, more specific, about the various stages of the life cycle and the interaction with the host plant during these stages. Interactions between organisms in nature occur frequently. These interactions can be symbiotic. This term includes both mutualistic symbiosis (all the organisms involved benefit from the association) and parasitic symbiosis (only one of the organisms involved benefits to the detriment of the other organism of the interaction). Associations involving higher plants can be found on two levels. The majority comprises the interaction between higher plants and mycorrhizas or nitrogen-fixing bacteria. These associations are mutualistic symbiotic in nature. On the contrary, interactions between higher plants are usually parasitic, involving a non-parasitic host and a hemi- or holoparasitic plant.

It has been estimated that about 1% of all flowering plants, roughly 3000 species, is parasitic. They form a close connection with the vascular system of the host through a so-called haustorium and are at least partially dependent on the host for their supply of water, nutrients and organic solutes. For a good understanding it is necessary to define specific terminology. Parasitic angiosperms may be classified as either root parasites (60%) or stem parasites (40%), depending on whether the haustorium is below or above soil surface.

They also may be divided into groups with regard to the presence (hemi-parasites) or absence (holo-parasites) of chlorophyll. Approximately 20% of all parasites is holo-parasitic, the remainder being hemi-parasitic. All chlorophyll-lacking species are obligate parasites, meaning they cannot establish and develop independently. Other parasitic plants are facultative parasites; they can establish and grow independently but in field situations always meet a wide variety of hosts and behave heterotrophic.

Food chain

A food chain consists of producers, consumers and decomposers. All organisms need energy to live and complete their life cycle. The main source of energy is the radiant energy from the sun but it is unusable by all organisms.

All organisms need energy to live and complete their life cycle. The main source of energy is the radiant energy from the sun but it is unusable by all organisms. So that, it has to be converted into a usable form by photosynthetic reactions, and then transferred from one organism to another in the form of organic compounds. The series of steps through which energy is transferred from the sun to organisms (producers, consumers, decomposers) in an ecosystem called is food chain.

So that, it has to be converted into a usable form by photosynthetic reactions, and then transferred from one organism to another in the form of organic compounds. The series of steps through which energy is transferred from the sun to organisms (producers, consumers, decomposers) in an ecosystem called **food cahin**. In a living region, there are producers, consumers and decomposers. These are like links of a chain.

The absence of a link breaks the association.

1-Producers

The bacteria, protists and plants that can convert light energy into chemical energy are called **producers**. These organisms form the first link of the food chain. For this reason, on land, the food chain gener ally starts with flowering plants, in aquatic places it starts with **microscopic algae.**

2-Consumers;

a-Primary consumers

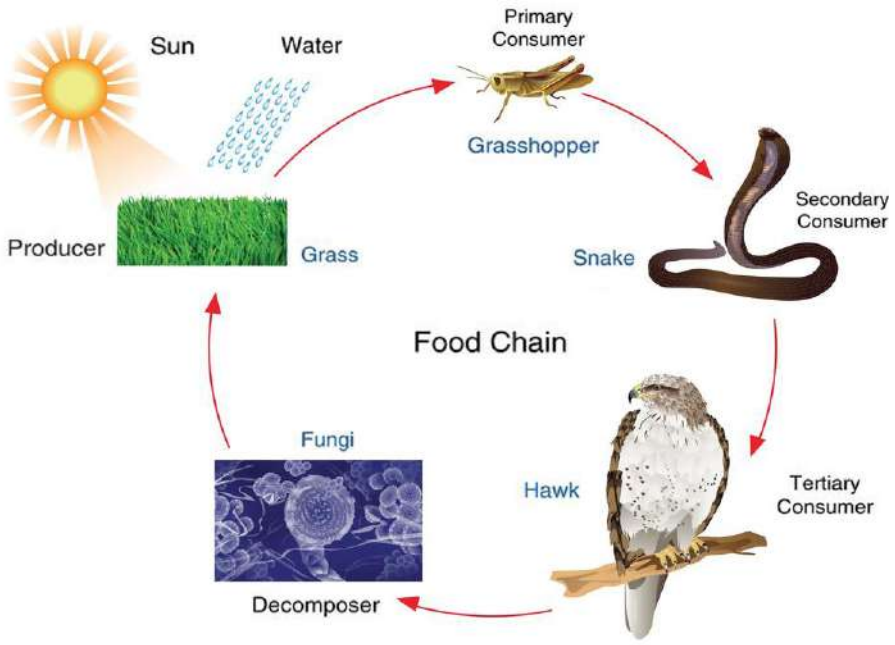
These are the animals that feed on plants, the herbivores. Examples are insects, gnawing mammals and ruminants. Mollusks and crustaceans that feed on phytoplankton in marine and freshwater are also herbivores.

b-Secondary and tertiary consumers

Secondary consumers are organisms that feed on herbivores, tertiary consumers are organisms that feed on secondary consumers. Animals of both groups catch their prey and have features for killing and tearing it before eating.

3-Decomposers

Decomposers are mainly bacteria and fungi. These organisms have a very important role in ecosystems. For example, in forests tons of leaves are shed by trees every year. If decomposers didn't decay this layer of leaves every year it would accumulate, cover the trees and kill them. These organisms decompose dead animals. Nutrition starts with plants and passes to different animals. Most of the animals in a food chain feed on more than one type of food.



Food webs

Food relations in a community or an ecosystem are not formed from a regular chain. Sometimes they contain complex interconnections of many food chains called a **food web**. Food webs may have short and long chains. Carnivores have a variety of food sources which causes the chain to have a complex structure and form a web. For example, falcons and eagles eat different bird species, snakes and small mammals.

The consumers located at the higher levels of food chains are not always carnivores, but sometimes parasites or organisms feeding on organic wastes. The most important feature of parasitic food chains is that the organisms at the higher levels are smaller than the organisms at the lower levels. In other words, it goes from bigger organisms to smaller organisms, like dog to flea.

Each ecosystem has a trophic structure of feeding relationships.

Each level in food web is called a trophic level. The first trophic level is formed by producers, the second trophic level by primary consumers (herbivores), the third trophic level by secondary consumers (carnivores).

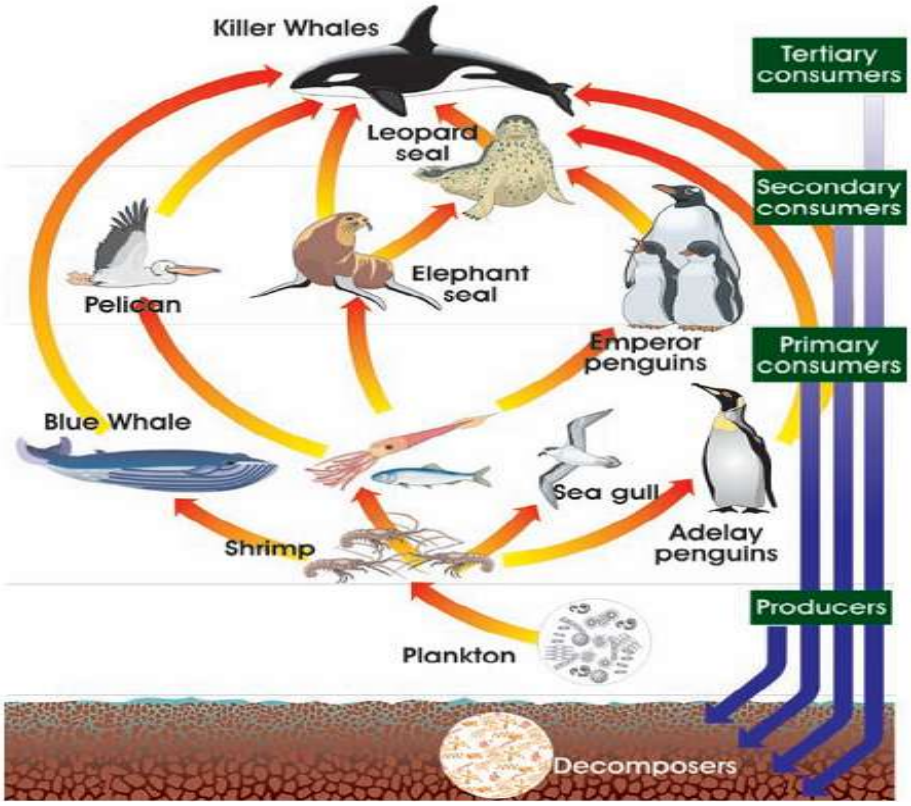
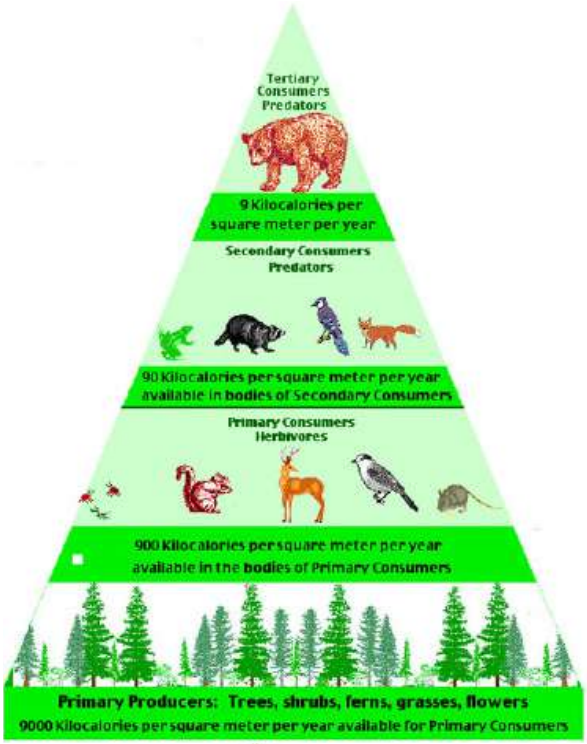


Figure: The food web in an aquatic ecosystem. A food web, not as regular as a food chain, starts with phytoplankton and continues with various animals, sometimes interconnected with different chains, and ends in decomposers.

Ecological Pyramids

The values of some ecological factors can be shown in a pyramid for a concretely explanation. Examples are energy pyramids and biomass pyramids. Ecological pyramids are prepared on the basis of biomass, which includes the number of individuals of the community and ecosystem, and energy. Biomass of terrestrial animals is 1% of the biomass of terrestrial plants. More than 90% of this animal mass is invertebrates.

Biomass decreases from producers to consumers. The organisms in the chain convert only 10% of the energy in food into biomass. Biomass decreases up to the end of the chain or pyramid.



Pyramids of biomass

Biomass means "**living weight**". Biomass is a quantitative estimate of the total mass or amount of living material in a particular ecosystem. For example, the total weight of the roots, stems and spikes of wheat in a one hectare wheat field is called **biomass**. Organisms may be either plant biomass or animal biomass.

Pyramid of numbers

It shows the total number of organism at each trophic level in a given ecosystem. Let's explain this with an example. Plant-Grasshopper-Frog-Trout-Human. When you look at the food chain above carefully you will see that a human is at the end.

According to this food chain, if we conclude that a human needs 300 trout per year as a food source, the trout must consume 90,000 frogs, the frogs 27,000,000 grasshoppers, and the grasshoppers 1000 tons of plants yearly. Using these values, let's form a food pyramid. If the food chain above is shortened eliminating the trout, then 90,000 frogs would feed 30 people yearly. If frogs and grasshoppers were eliminated too, then 1000 tons of plants would feed 2000 people yearly.

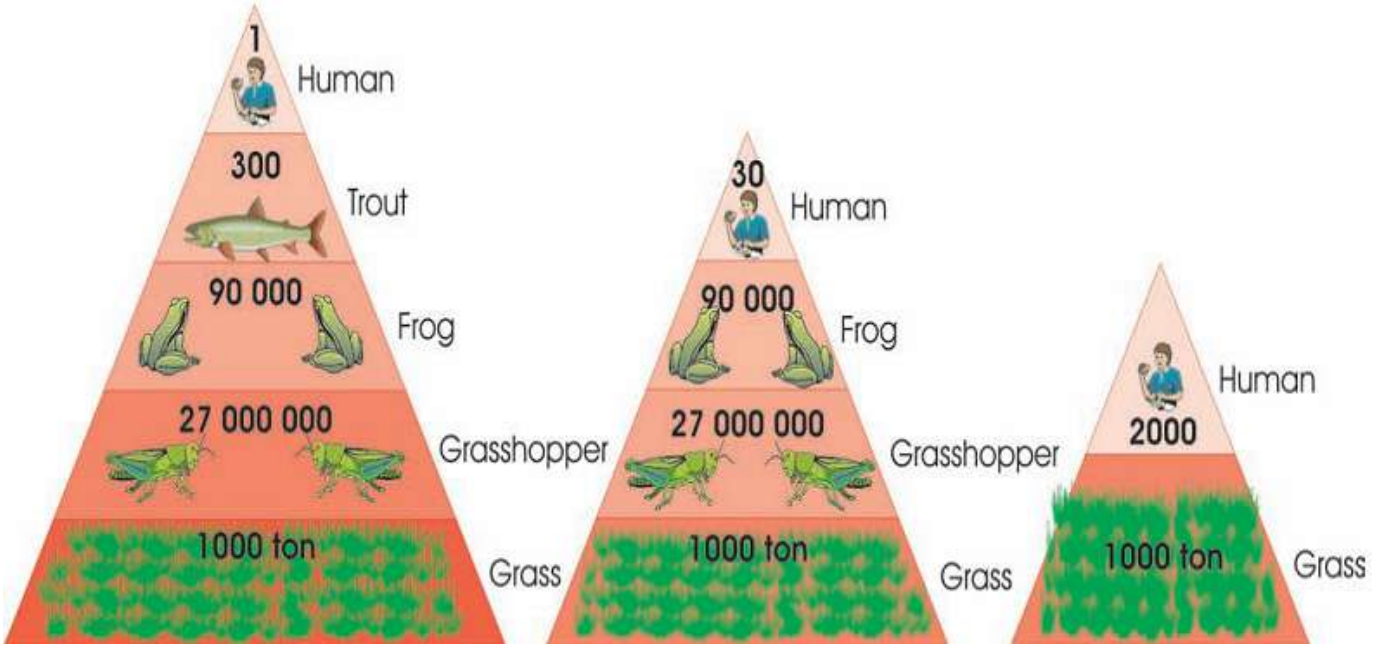


Figure: As seen in the figure, the number of individuals is highest at the bottom of the pyramid and lowest at the top.

The shorter the food chain the less energy lost. As can be understood from this data, the lowest layer of the pyramid has the greatest number of individuals. Photosynthetic organisms use only 1% of light energy in photosynthesis. Grasshoppers convert only 10% of the ingested food into biomass. Most of it is excreted undigested or used for energy. Likewise, other organisms and humans convert 10% of the ingested food into biomass. This feature is true of all layers of all food chains. As we mentioned before, as the number of individuals in the food pyramid decreases, food and energy flow decrease accordingly. Some poisonous substances like DDT, cyanide and other chemicals cannot be excreted from the body, and their concentration increases at every level of the pyramid.

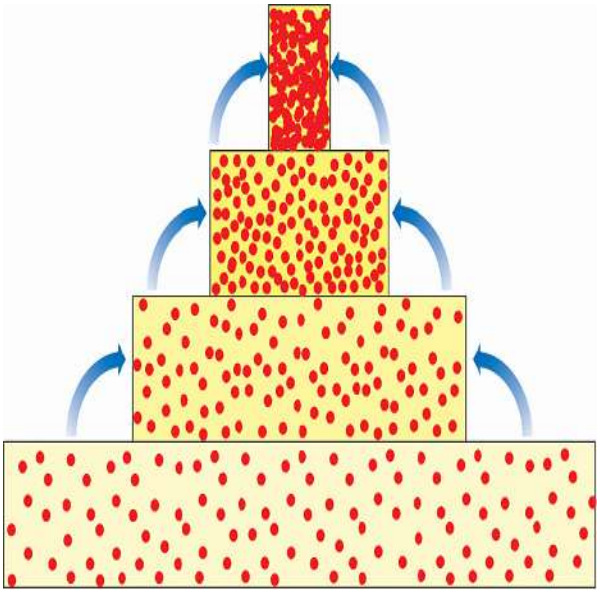


Figure: At every step in the food pyramid, the accumulation of chemicals increases. The organisms at the top of the pyramid are the most vulnerable to poisonous chemicals, like DDT.

There is an inverse relationship between body size (biomass) and numbers of organisms. In other words, in a food chain, the number of large organisms is small, and the number of small organisms is large.

Pyramid of energy:

It indicates the energy content in the biomass of each trophic level. An energy pyramid is the best way to explain the flow of nutrients in an ecosystem. These pyramids demonstrate how energy is lost between layers. The total amount of energy is the greatest in the lowest layer. As you go up, energy decreases. Energy pyramids are shown as triangles because energy is lost at every level. Energy pyramids illustrate how much energy is transported to the ultimate consumers in ecosystems.

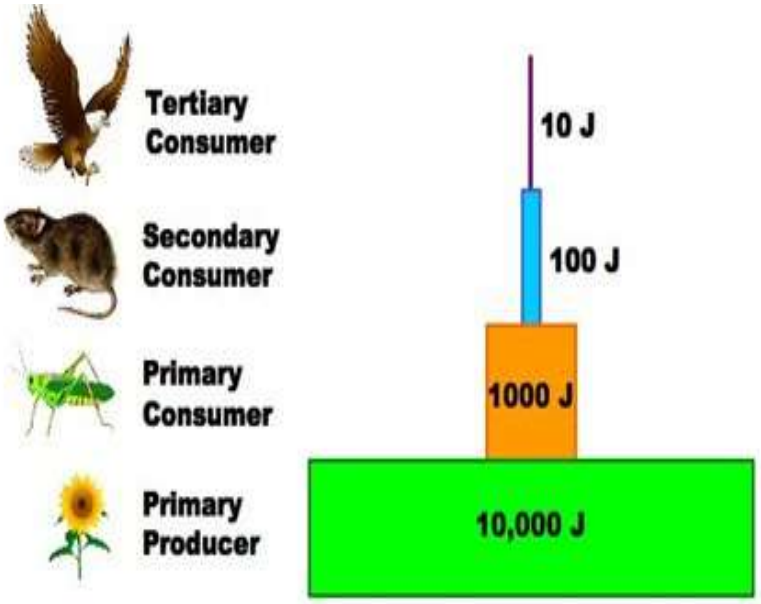


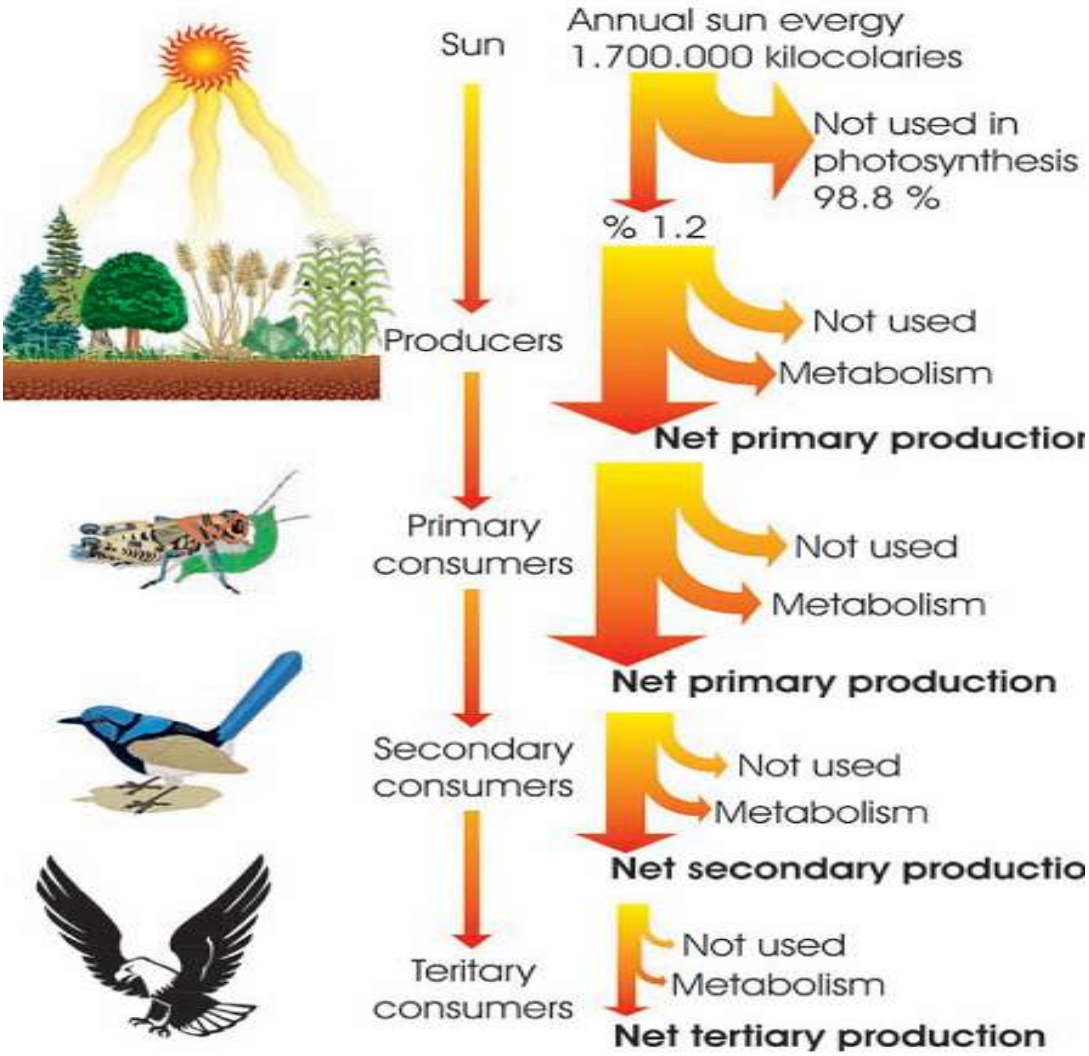
Figure: Food chain and energy flow. Only 10% of the energy is captured at each step from producers to consumers. Therefore, the amount of energy at the end of the chain is the lowest.

Energy flow

Energy flow in ecosystem.The main source of energy for all organisms is solar energy.In photosynthesis, solar energy is converted to chemical energy that can be used by plants.Some of this energy is used in the metabolism of the organism and the rest is dissipated into the environment as heat. The level of energy is the highest in plants, producers, and the lowes tin tertiary consumers.

The main energy source that powers natural systems is the sun. While plants utilize solar energy directly through photosynthesis, animals make use of it indirectly. Energy is present in various forms in nature, such as mechanical, chemical, electric, nuclear, heat and light energy. Living things need all of these except nuclear energy. Energy must be converted from one form to another for the continuity of life. For instance, a person walks because the chemical energy of food is converted to mechanical energy. After energy is used to perform body functions, the remaining energy is heat energy.

As can be seen in figure, the organic substances produced by green plants are called **primary products**. Herbivores that feed on the primary products form organic substances called **secondary products**. Carnivores that feed on secondary products form organic substances called **tertiary products.** Generally 90% of the energy is lost from one layer to the next, in accordance with the second law of thermodynamics. Only 10% of the energy is transferred to the next layer. This energy is called **usable energy**, and biologists refer to the "**10% law**". Consequently, energy flow is the greatest at the beginning of the food chain, and smallest at the end. The remaining energy is lost as heat.



READ ME!

Energy from the sun

Our sun is an ordinary star, average in size and brightness, compared to the millions of others in the universe. But when energy from the sun travels through 93 million miles of space in only eight minutes to reach us here on Earth, extraordinary things can and do happen. How does the sun make energy? The sun is a huge ballshaped cloud of hot gases held together by gravity. It is made up mostly of hydrogen and helium. Inside the sun, hydrogen atoms moving very quickly collide with one another. Sometimes they combine to make helium atoms in a nuclear process
called fusion.

During fusion, a tiny amount of mass is lost. One helium atom weighs just a little bit less than two hydrogen atoms. That little bit of mass is transformed into an enormous amount of energy, mainly infrared and visible light, which radiates in all directions through space. The sun has been emitting energy constantly for about five billion years. Astronomers estimate it will continue for another five billion. Only a small fraction of solar radiation (one part in two billion) reaches the earth. Even so, the sun is the source of almost all the energy on earth, including our food and our fuel.

Every day, Earth is bombarded by about 1022 joules (j) of solar radiation (1j = 0.239 calories). This is the energy equivalent of 100 million atomic bombs the size of the one dropped on Hiroshima. The amount of solar radiation reaching the globe ultimately limits the photosynthetic output of ecosystems, although photosynthetic productivity is also limited by water, temperature, and nutrient availability.

Much of the solar radiation that reaches the biosphere lands on bare ground and bodies of water that either absorb or reflect the incoming energy. Only a small fraction actually strikes algae, photosynthetic bacteria, and plant leaves, and only some of this is of wavelengths suitable for photosynthesis.

Of the visible light that does reach photosynthetic organisms, only about 1% to 2% is converted to chemical energy by photosynthesis, and this efficiency varies with the type of organism, light level, and .other factors. Although the fraction of the total incoming solar radiation that is ultimately trapped by photosynthesis is very small, primary producers on Earth collectively manufacture about 170-200 billion tons of organic material per year-an impressive quantity.

Elements Cycles

Elements cycles

Elements cycles are the cycling of matter from the environment to living things and back to the environment. They are also called nutrient cycles that involve both biotic and abiotic components of the ecosystem.

The earth is essentially a closed system (a system from which matter can not escape). The materials are used by organisms can not be lost and it can change its location so materials are re-used and are often re-cycled in the ecosystem. Four eiements cycles ar e impor tant for living things.

- Water cycle
- Carbon cycle
- Nitrogen cycle
- Phosphorus cycle

Carbon, Nitrogen and Water have gaseous forms and they involve atmosphere so they cycle over large distances. Phosphorus is an element that is completely nongaseous form and as a result Phosphorus cycle does not involve the atmosphere, just a local cycling.

1- Water cycle

The water or hydrologic cycle, which continually renews the supply of water that is so essential to life. Water cycle involves an exchange of water between the land, the atmosphere, and living things.

It is assumed that there is nearly 1.4 billion km^3 of water in the world. Though distributed throughout the natural world, most of this water (97%) is in the oceans. Of the Earth's total precipitation (rainfall), 465,000 km^3 falls in the sea and 100,000 km^3 falls on land.

There is a strong relationship between the location, duration, and amount of precipitation, and living things. Organisms cannot always use the available water directly, as many factors limit this use. For example, the salinity of seawater and the frozen state of polar water restrict their use by terrestrial organisms. Consequently, living organisms use only 2.6% of the total water mass. At present, rapid population increase and high technology increase the need for water.

The water cycle operates on two physical principles, namely evaporation and condensation. Water absorbs energy and evaporates, and stays in the atmosphere as vapor. As the water vapor rises it collides with cold air currents. The cooled vapor drops back to the earth as rain and snow. Some water falls into the sea, and the cycle begins again.

Underground and surface water collects in lakes and seas. From there, as the water warms, it evaporates and enters the air as vapor, and then precipitates again.

The cycling of water occurs regularly under the influence of sun energy and gravity. The water cycle is a continuous process by which water moves from the earth's surface (lithosphere and hydrosphere) to the atmosphere and back. It is also called the hydrologic cycle. Atmospheric movements and marine currents are important components of the water cycle. The processes of evaporation, condensation and precipitation make up the water cycle.

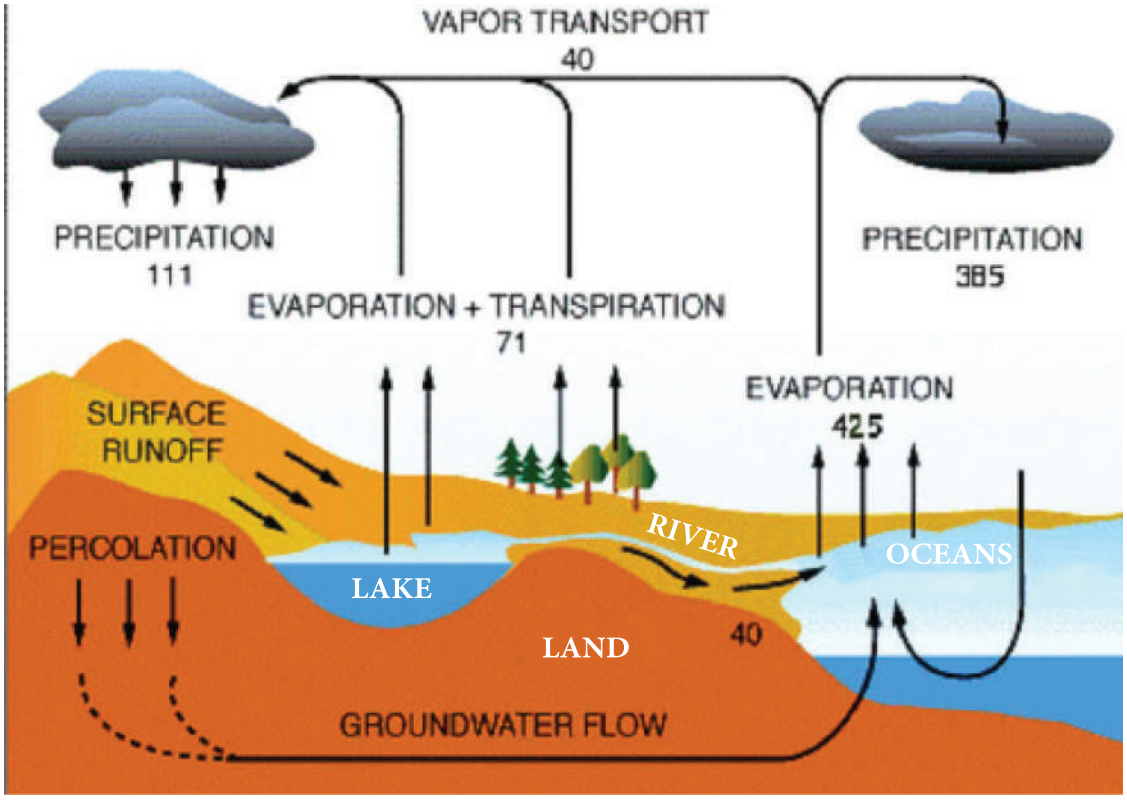


Figure. The Global Water Cycle - Pathways and Fluxes. (Values in 103 km^3/yr).

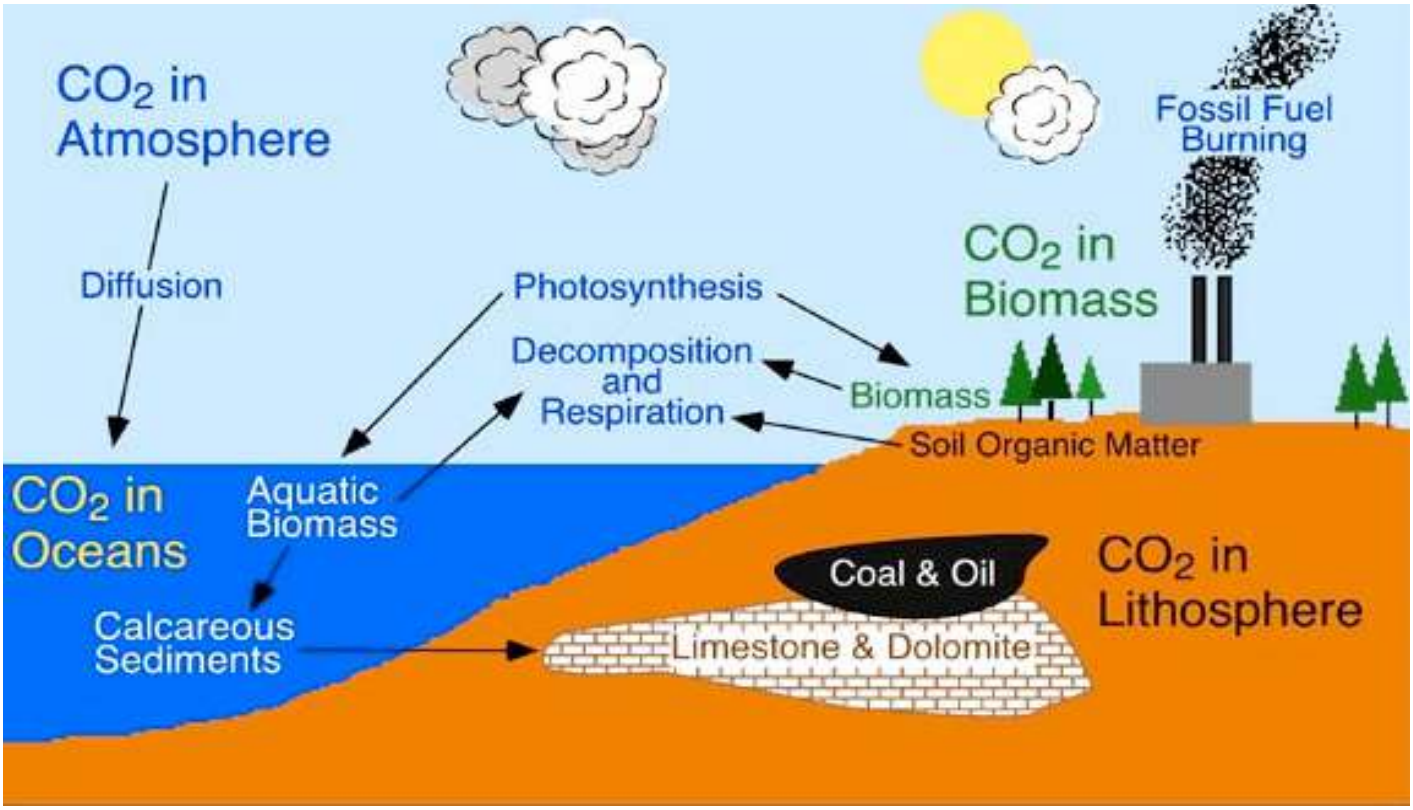
2- Carbon cycle

The main source of carbon for organisms is CO_2. Carbon dioxide is found in the lithosphere, hydrosphere, atmosphere and biosphere. Carbon is in the atmosphere as CO_2, in the hydrosphere as bicarbonate ion (HCO_3), in the lithosphere as coal, petroleum, limestone and natural gas, and in the biosphere as the basic raw material of organic substances.

The product of organismal respiration and other sources like forest fires, CO_2 is used in photosynthesis. In respiration, the reverse of this process, organic molecules and O_2 are produced. In other words water and CO_2 are produced from the burning of organic molecules with O_2. Therefore the carbon and oxygen cycles are closely related in nature. The amount of CO_2 in the atmosphere varies from day to night and with the seasons. At night, when photosynthesis stops and all organisms are respiring, the CO_2 level in the atmosphere rises. Likewise, in the seasons when photosynthesis is fast, the CO_2level in the atmosphere falls.Much research has demonstrated that, because atmospheric CO_2 reduces the reflection of sunlight entering the atmosphere, an increase of CO_2 in the atmosphere results in climatic change, the greenhouse effect.

Carbon dioxide concentrations in aquatic environments are quite different from those on land. Carbon dioxide easily dissolves in water and forms carbonic acid (H_2CO_3), which ionizes to H+ and HCO_3. These ions determine the pH of water.

Saprophytic bacteria and fungi also play a role in returning carbon to the atmosphere. These organisms are essential in the decomposition of dead organisms into inorganic substances. Despite everything, decomposition does not occur completely. Carbon in plant and animal structures is locked into underground reserves through carbonization and petroleum formation. When these formations are extracted and burned as gasoline, natural gas, and coal, CO_2 is released into the environment and used again in photosynthesis.



3- Nitrogen cycle

The nitrogen molecule (N_2), like carbon and oxygen, is an important molecule for organisms. Nitrogen is also a component of molecules like amino acids, nucleic acids, hormones and vitamins. The major sources of nitrogen are the atmosphere and living organisms. The most abundant gas in the atmosphere (78%) is N_2. This atmospheric nitrogen can be used directly by some microorganisms. Plants can use nitrogen in the form of nitrate (NO_3) and ammonium (NH_4) salts. Animals obtain nitrogen from the proteins of the organisms they eat. The cycle of nitrogen between organisms and the atmosphere is a very long and complex process. Actually there are 5-major steps in nitrogen cycle.

Oxygen is essential for the survival of living things. Oxygen is necessary for respiration and the oxidation of organic substances, and is used in the burning (oxidation) of coal, wood and gas. The atmosphere is 21% oxygen, and 5 % is dissolved in the hydrosphere. The oxygen in nature is produced as a result of photosynthesis. Oxygen also makes up the ozone layer, ozone (O_3) being released as a result of the photolysis of water.

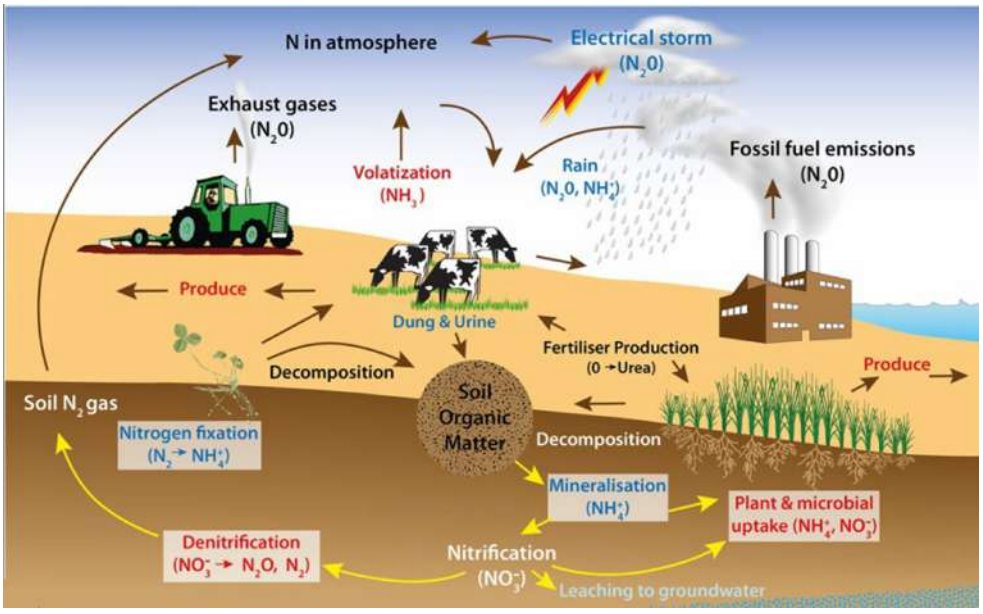
1-Nitrogen fixation: Nitrogen fixing bacteria including cyanobacteria converts atmospheric nitrogen gas (N_2) into ammonia (NH_3) and ammonium (NH_4^+)

2-Nitrification: Ammonia is converted into nitrate (NO_3^-) by bacteria in the soil
known as nitrifying bacteria. Nitrate is the main form of nitrogen absorbed by plants.

3-Assimilation: Plants use nitrate when they produce protein, nucleic acid and other nitrogen containing compounds, then animals eat plants and nitrogen can pass to animals.

4-Ammonification: When plants and animals die, the nitrogen compounds in their body are broken down by ammonifying bacteria. And one of the products of this process is ammonia (NH_4^+).

5-Denitrification: Nitrogen is returned to the atmosphere by denitrifying bacteria, which converts nitrate (NO_3^-) to nitrogen gas (N_2).

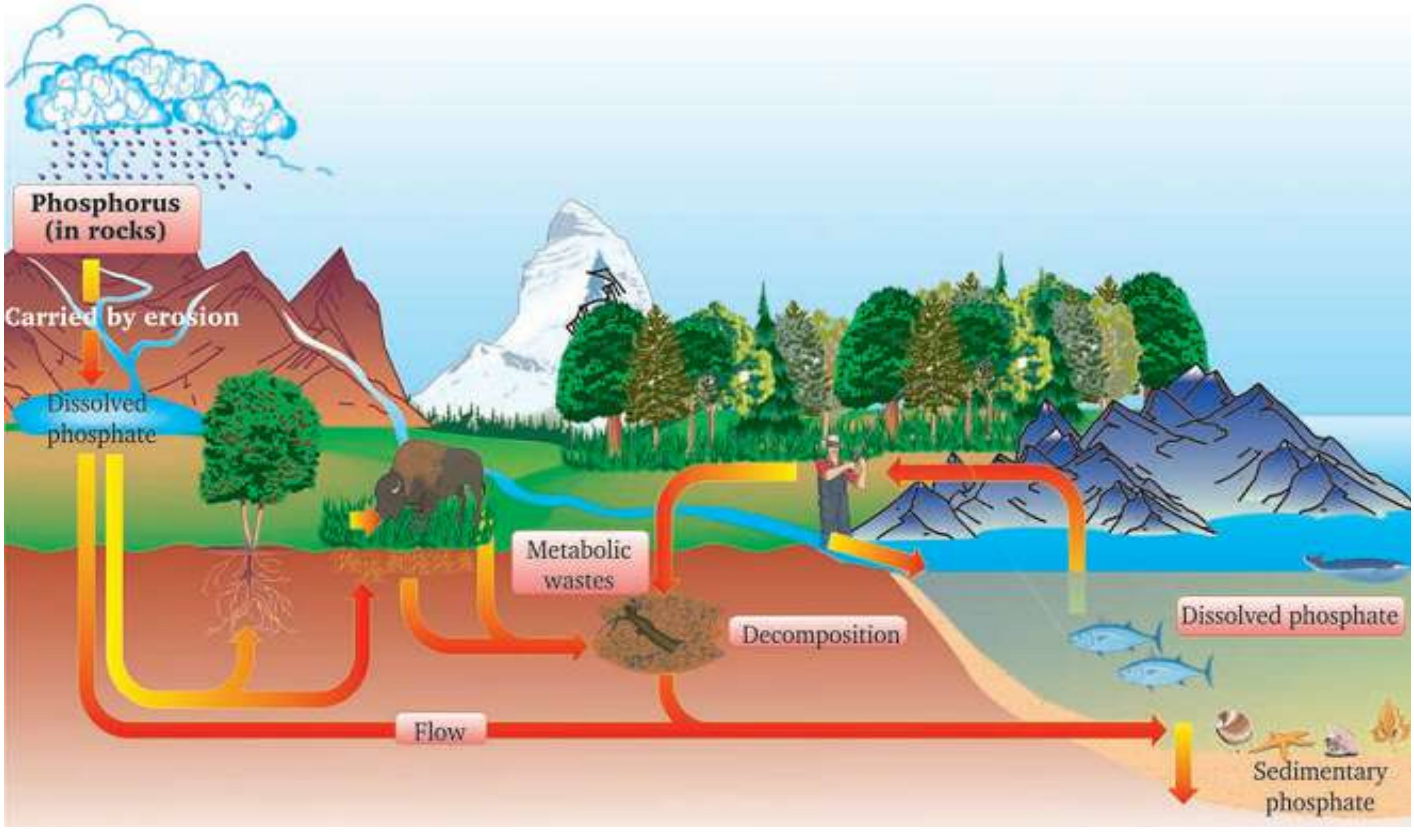


4-Phosphorus Cycle

Phosphorus is another element that is very important for life. Phosphorus is required for the synthesis of nucleic acids, phospholipids and ATP molecules. Moreover it is a component in the structure of the cell membrane, skeleton and skin. The phosphorus cycle is quite different from the nitrogen cycle in that phosphorus does not exist in a gaseous state and therefore does not enter the atmosphere. Phosphorus cycles from land to ocean sediments and back to the land. As water runs over rocks containing phosphorus, it gradually erodes the surface and carriers off inorganic phosphate (PO_4^{-3}) molecules.

The erosion of phosphorus from rocks releases phosphate into the soil where it is absorbed by plant roots. Once inside the plant cells it is converted to organic phosphates. Animals obtain most of their required phosphorus from the food they eat and the water they drink. The remains of dead plants and animals are decomposed to inorganic substances that can be reused by plants. Phosphorus is significant in the efficiency of aquatic and terrestrial habitats.Consequently it is a factor that determines the efficiency of ecosystems.

Certain observations made in oceans show that there is a relationship between fish size, plankton and phosphorus concentration in the water. Phosphate is also mined for agricultural use as phosphate fertilizers. This affects the cycle rate because it speeds up the flow of phosphate from land to sea. Phosphate fertilizers don't remain long in the soil and are carried from the land by streams and rivers to the sea. Erosion caused by human activities, household wastes, and phosphate containing detergents all increase the flow of phosphates to the seas.



SELF CHECK
FOOD CHAINS AND ELEMENTS CYCLES IN NATURE

A. Key Terms

Autotrophs	Chemosynthesis
Heterotrophs	Commensalism
Mutualism	Parasitism
Pathogens	Decomposers

B. Review Questions

1. Explain the energy pyramid.
2. What is the importance of decomposers?
3. Explain mutualism with an example.
4. Explain energy transferring from one level to another in energy pyramid.

C. Fill in the blanks

1. Saprophytic nutrition is a type of .....
2. A food chain consists of ....., and.....
3. ..... are decompose dead organisms.

D. True or False

1. The main energy source that powers natural systems is the sun.
2. The consumers located at the higher levels of food chains are always carnivores.
3. Viruses are also obligatory parasites.
4. Herbivores have five chambered stomach.

1. When you eat a banana, you are a _____.

A.primary producer
B. tertiary consumer
C.secondary consumer
D.primary consumer

2. Which of the following are photosynthetic organisms?

A. Consumers
B. Hetrotrophs
C. Autotrophs
D. Chemotrophs

3. Which of the following organism are the main decmposers in an ecosystem?

A.bacteria and animals
B. plants and animals
C.prokaryotes and animals
D.fungi and bacteria

4. Which of the following is a primary producer?

A. Apple tree
B. Lion
C. Poison frog
D. Eagle

5.Which of the following is an example of mutualism?

A. Prey and predator
B. Host and parasite
C. Lichen
D. Cat and mouse

SELF CHECK
FOOD CHAINS AND ELEMENTS CYCLES IN NATURE

E. Define the followings.

1- Nitrification
2- Codensation
3- Denitrification
4- Precipitation

F. Answer the followings:

1. Draw the water cycle by a simple diagram.
2. What is the role of saprophytic bacteria and fungi in carbon cycle?
3 What is the main source of carbon for organisms?

G. True or False

1. Carbondioxide is used in photosynthesis.
2. Nitrogen cycle is involved in recycling of biotic factors only in nature.
3. All animals obtain phosphorus from air.
4. Animals obtain nitrogen from the proteins of organisms they eat.

Biomes and Ecosystem

Community

Community is the most important social unit of ecology. A community consists of all of the different species that live and interact together within an area. A community may only consist of animal and plant populations or it may have other groups of organisms. A community may contain other communities as well. For example, a forest community has different species of organisms. The microorganisms inside the body of an organism constitute a community as well.

Communities may also be called life associations or a group of species. The type and size of the community depend on the organisms in the community and the effects of environmental factors such as temperature, rainfall, moisture and food.

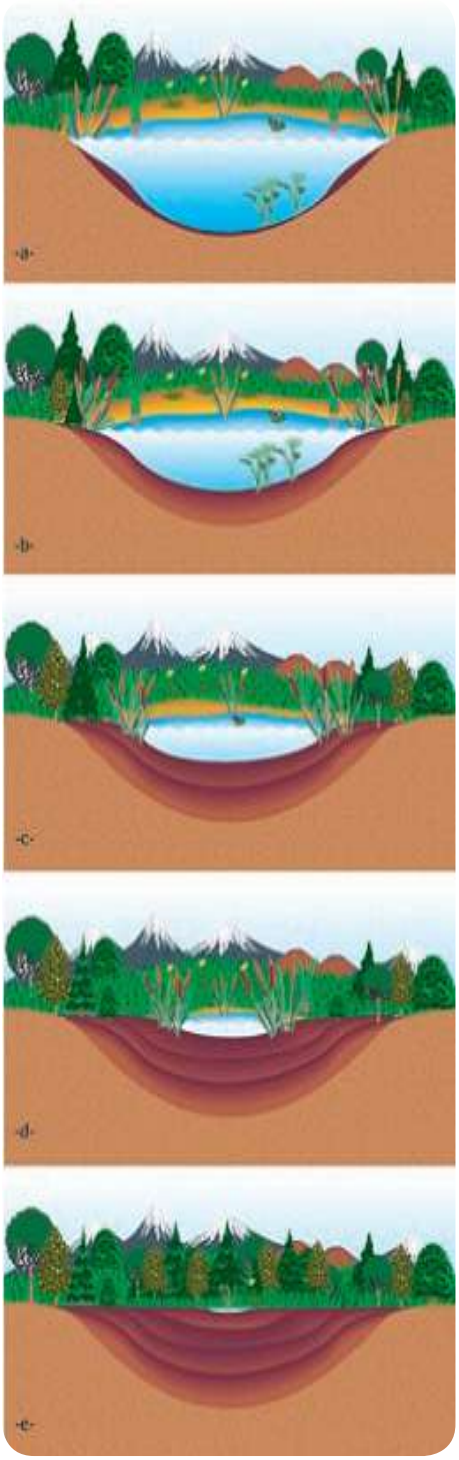
Populations under the effect of these factors live in harmony. For this reason, from the equator to the poles, from the prairies to the hills and mountains there are different-sized communities.

Communities make up the living portion of the ecosystem. Therefore, the study of ecosystems begins with communities. An **ecotone** is a zone where two ecosystems overlap. The type and width of this region are very variable. In big communities it may extend for kilometers, in small communities it may be just a few meters. Because ecotones contain individuals of both species, they have a higher variation of species than the neighboring communities. Lakeshores, stream banks, ocean beaches, the entrances of caves, and forest meadows are examples of some of ecotones.

A biome is a large, relatively distinct ecosystem characterized by a similar climate, soil, plants, and animals, regardless of where it occurs.

Generally, from an energy-flow perspective, big communities are self-sufficient but small communities are dependent on other communities. Ecological task distribution among the species in a community increases the dynamism of the community. These species generally are dominant species and mostly are composed of plants. In aquatic communities the determination of the dominant species is difficult.

Succession



Succession is community change over time. In other words, the process of community development over time, which involves species in one stage being replaced by different species is called **succession**. In succession every species prepares the habitat for another species. Because changes are observed clearly in vegetation, it is perceived as a process of plants. Ecologists recognize two types of succession.

1- Primary succession

Which occurs in areas where no community existed before. For instance, primary succession would take place on new volcanic islands, deltas, dunes, bare rocks, and in lakes,.

In natural areas the order of formation in primary succession is: lichens–mosses–grasses–shrubs–trees.

a- Lichen Phase

Places like sandy, bare rock and clay, where there is no other life, are first inhabited by lichens. Lichens secrete acids that help to break the rock apart, which is how soil starts to form. Lichens also add valuable organic matter to the young soil. Lichens, though they are very resistant to extreme physical conditions, can't compete with other organisms and, once other organisms start growing, their number decreases.

b- Moss Phase

The moss phase starts after the lichen phase. The most important activity of these organisms is to add moisture to the soil, after which some invertebrates move in, followed by insectivore mammals. In other words, fauna forms parallel to flora. With the development of mosses and the addition of dead organisms, soil formation speeds up and humus quality increases. In this way mosses prepare the medium for another organism.

c- Grass Phase

Annual grasses begin to grow in competition with the mosses. In time the number of insects increases both in quantity and variety. Reptiles, frogs, birds and mammals settle and increase in number.

d- Shrub Phase

The conditions created by the grasses make way for the growth and development of shrubs. These are generally small plants like berries and drupes. Another important step in this phase is the transportation and deposition of tree seeds by birds.

e- Tree Phase

Trees start to grow during the shrub phase. Over time, the trees grow and form a forest canopy. Shrubs may continue to grow under the canopy, but most diminish over time. In the open areas, mosses are still present. Ferns multiply in wetlands. Barring extraordinary occurrences, permanent communities of fauna and flora form. This is called **climax**. The climax community continues until there is some change in climate or environment, at which point it disappears. Substantial changes in the climax community, as a result of volcanic eruptions or floods are followed by secondary succession.

2- Secondary succession

Which occurs in disturbed habitats where some soil and, perhaps, some organisms still remain after the disturbance. Secondary succession occurs after fires, floods, drought, and some human practices (slash and burn clearing of forests, construction projects). It also occurs on abandoned farmlands, in overgrazed areas, and in forests cleared for lumber.

Secondary succession occurs for the following reasons.

- Succession begins with changing environmental conditions, deteriorating living conditions, and weakening of the competitiveness of species.

- Existing species prevent the settlement of new species.

- It is observed that animal species are especially effective on some plant species. The effect of rabbits on grass and the effect of insects on grassland can be given as examples.

- Physically, freeze, fires, storms, drought, volcanic activities, earthquakes and the effects of human can destroy communities.

Ecosystem

Recall that, Ecosystem is the interacting system that contains a community and its nonliving physical environment. So, an ecosystem includes not only all of the interactions among the living organisms of a community but also all of the interactions between the organisms and their physical environment. An ecosystem ecologist for example might examine how temperature, light, precipitation and soil factors affect the organisms living in a tropical rain forest or desert. All of the communities of living things on earth are organized into biosphere. The organisms of biosphere depend on one another and on other divisions of earth physical environment. Some examples of ecosystem are mountain Everest, Black sea.

Species richness on islands depends on island size and distance from the mainland. Because of their size and isolation, islands provide great opportunities for studying some of the biogeographic factors that affect the species diversity of communities. Imagine a newly formed island some distance from the mainland. Robert MacArthur and E.O. Wilson developed a hypothesis of island biogeography to identify the determinants of species diversity on an island.

An ecosystem consists of all the organisms living in a community as well as all the abiotic factors with which they interact. The dynamics of an ecosystem involve two processes: energy flow and chemical cycling. Ecosystem ecologists view ecosystems as energy machines and matter processors. We can follow the transformation of energy by grouping the species in a community into trophic levels of feeding relationships.

What is a biome?

The biosphere can be divided into regions called biomes. A **biome** is a large region that has a distinct combination of plants and animals. Climate is a factor indetermining the type of biome that occurs. A terrestrial biome is usually identified by the types of plants that make up a climax community within it. The dominant types of plants are called the **climax vegetation**. However, a biome includes all stages of succession leading up to the climax community. In the deciduous forest biome, for example, deciduous trees are the climax vegetation. Ecologists have identified several biomes in the world. **Ecotones** are transition zones where ecosystems meet and intergrade. All aquatic and terrestrial biomes interact with one another, such that there is no isolation.

Biomes and climate

The main factor that determines the kind of biome in a certain area is **climate**. Recall that climate is determined mainly by **temperature** and **precipitation**. Average temperature decreases from the equator to the poles.

A decrease also can be seen from sea level to the mountains. Features such as mountain ranges and the nearness of large bodies of water affect precipitation. Average monthly temperature and precipitation can be plotted on a graph called a **climatogram**. Biomes can be identified by their dominant animal populations.

The same kind of biome is found at the same latitude, or distance from the equator, in different parts of the world. For example, there are grassland biomes in South America, Africa and Australia. The specific plants and animals found in these different grassland biomes are not identical, however. Populations in different biomes have similar characteristics and are sometimes related, but they are different species. Plants and animals from the same type of biome resemble each other because they are adapted to nearly identical physical and climatic conditions.

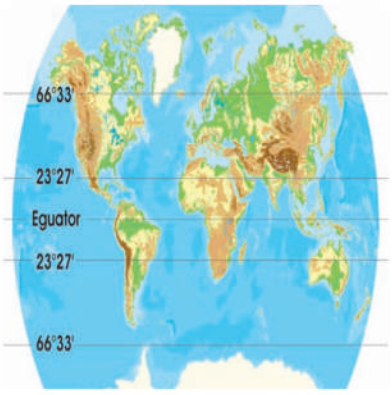


Figure: Climate changes with latitude and topography. Different latitudes are shown on the map.

Terrestrial Ecosystems (Biomes)

All the ecosystems formed by the organisms on earth are called the ecosphere. All the communities on earth are called the **biosphere**. The ecosphere includes the interactions of the **biosphere**, **atmosphere**, **hydrosphere** and **lithosphere**. The populations in the ecosphere are distributed over different areas. The distribution of populations on earth is affected mainly by climate. Climatic conditions are affected by **latitude** and **topography**. Between certain degrees of latitude, major climates are seen.
These areas and climates are listed below.

Latitude (°)	**Climate**
0-23°27'	Hot (tropical) climate
23°27' – 66°33'	Temperate climate
66°33' – 90°	Cold (polar) climate

The biosphere can be divided into regions called biomes. A biome is a large region that has a distinct combination of plants and animals. Climate is a factor in determining the type of biome that occurs. A terrestrial biome is usually identified by the types of plants that make up a climax community within it. The dominant types of plants are called the climax vegetation.

Each of these zones has a different climate. Populations of various sizes live in different climates. A large, relatively distinct terrestrial region characterized by similar climate, soil, plants and animals is called a **biome**. Biomes are not separated by specific boundaries and may overlap in some regions. Biomes are the biggest units of ecological systems. Usually biomes are named for their dominant plant species. The biomes are tundra, taiga (evergreen forest), deciduous forest, grassland, shrubs, tropical shrubs, savannas, tropical rainforests, semi-deserts and deserts

Figure: Biomes are the biggest units of ecological systems. Usually biomes are named for their dominant plant species.

BIOMES	CLIMATE	PLANT COVER	ANIMALS	SOIL
Tundra 	Polar regions with temperature below 10 C. Here mostly glaciers are present; only three months of the year pass without glaciers.	In the southern regions of the tundra there are small woods, in the northern regions there are grasses.	Fox, reindeer, snowy owls, snow goose, musk ox, and many insect species, but nearly no amphibians or reptiles.	The soil surface in these regions is frozen year-round. This prevents root growth. Plants can grow only where this layer melts.
Temperate zone grasslands 	Cold, wet winters and hot, dry summers. Rainfall is less than in the deciduous forests.	Pastures are dominant in these regions. Secondarily there are flowering and legume plants. There are few trees, mainly near water sources.	Coyote, squirrel, bison, antelope, elk, deer, wolf, puma, grasshoppers, sparrow and insects are present.	Soil is very productive and rich in minerals. Organic substances accumulate at the top of the soil and give it a dark color. This top layer is mostly neutral or basic.
Deserts 	The temperature is very high during the day and falls suddenly at night. Rainfall is very low, as is moisture.	Spreading bushes are present. Cactus and some other related plants are found as well.	Animals that need little water or store water can live in the desert. Fox, rabbit, antelope, lizards, snakes and some insect species are present.	Since production is very low, organic matter in the soil is low too. The topsoil is alkaline. The soil is rich in minerals except nitrogen.
Semi-desert and Prairie 	Prairies are generally seen in the middle of continents with low rainfall and frequent, extreme temperature differences.	Pastures generally have wheat and corn plants. Low rainfall inhibits the growth of tall trees.	Herbivores like bison, deer, and horses.	The prairie soil is deep, productive and rich. In the semidesert, soil is arid and poor.

Aquatic Ecosystems (Biomes)

In aquatic ecosystems, There are important environmental factors are **salinity, dissolved oxygen** and the **availability of light.**

The microscopic phytoplankton is photosynthetic and is the base of food webs in most aquatic communities. In the sea there is a layering of life zones according to changes in temperature with depth up to 100m below the surface, after which temperature is stable. The zone above this is called the **pelagic zone**. In every cubic meter of this zone there are millions of microscopic organisms. One of these is phytoplankton, the main source of oxygen.

Aquatic biomes are placed in two categories and based on salt concentration.

Freshwater ecosystems

Fresh-water ecosystems include **rivers** and **streams** (flowing water ecosystems), **lakes** and **ponds** (standing water ecosystems), **marshes** and **swamps** (freshwater wetlands). Each type of freshwater ecosystem is distinguished by its own specific environmental conditions and characteristic organisms.

River and Stream Ecosystem

The kinds of organisms found in flowing-water ecosystems vary greatly from one stream to another, depending primarily on the strength of currents. Cold, clean rivers have trout, streams have carp. Because the water in a river flows, it is difficult to classify the fishes. There is great ecological variation between its source (where it begins) and its mouth (where it empties into another body of water). Rivers with cold-water plants are scarce but there are some species of algae and flatworms, frogs and insect larvae.

Lakes and Ponds

Lakes and ponds are standing bodies of water that form in depressions in the earth's crust. They are grouped ecologically into two zones: limnetic (pelagic) and benthic. The limnetic zone includes the column of water that fills the depression and covers the benthic zone. The organisms found here include phytoplankton,blue-green algae, zooplankton, fishes, frogs and some insect species. The benthic zone starts at the shoreline and extends to the bottom of the lake. The plants and animals that live in the benthic zone are called benthos. Benthos includes water plants, bottom-dwelling organisms like oysters and mussels, worms, and crayfish. The parts of the benthic zones near to the shores (littoral zone) have a wide variety of vegetation. In this zone there are plants that rise above the water (reed, cane); plants with leaves that float on the water (lily); and plants that live submerged in the water (elodea).

Estuaries form where rivers and streams empty into oceans, mixing freshwater with saltwater. The water in estuaries varies considerably in terms of salinity, temperature and nutrient load. Many species are adapted to estuarine conditions. Tides especially increase the oxygen and nutrients, and organic substances increase the biological diversity. Estuaries are fish nurseries. Many species reproduce there.

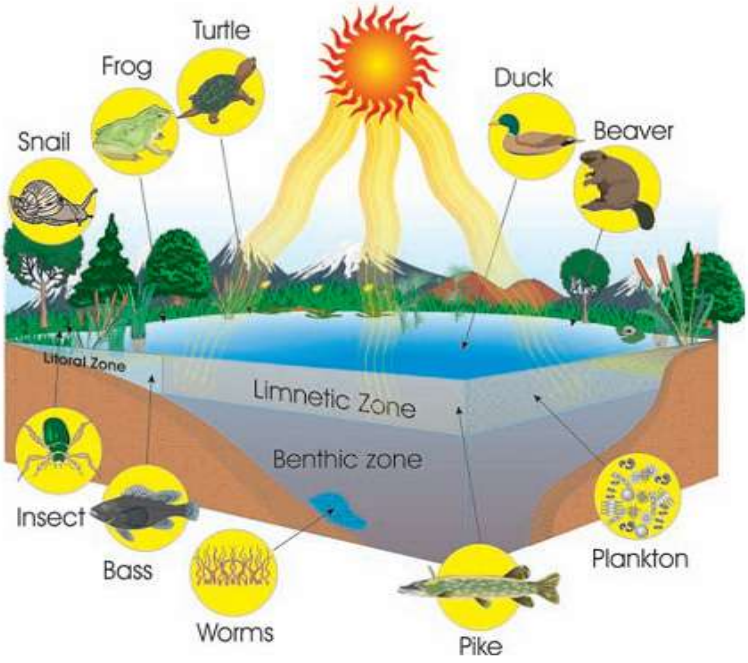


Figure: Layering in lakes and ecologic groupings of organisms living in the lakes. Lakes have benthic and limnetic (pelagic) zones according to the ecologic features.

There are lots of species of animals as well. In addi-tion, in the sediment on the lake floor there are many protozoa, rotifer and nematode species. Many species of fish live and reproduce here.

Lake pollution disrupts the balance of nature. Especially in recent years detergent remaining in wastewater has polluted lakes and harmed the ecological balance. The detergent enriches the water with food substances like nitrogen and phosphorus. This process is called **eutrophication**. Aquatic plants multiply rapidly and form a large amount of biomass. The oxygen in the water becomes insufficient to decompose the dead matter. This decreases the water quality. Organisms can't meet their oxygen needs and begin to die, and the lake become useless. This is a kind of water pollution. Another factor that damages the ecological balance of lakes is **acid rain**. This increases the acidity of the lakes in these regions.

Saltwater (Marine) Ecosystem

Based on ecological features, marine waters are divided into two main zones: **benthic** (ocean floor) and **pelagic** (ocean water). The benthic zone extends from the shoreline through the ocean floor; pelagiczone contains the water column above the benthic zone. Organisms that live in the pelagic zone don't have any interaction with the ocean floor.

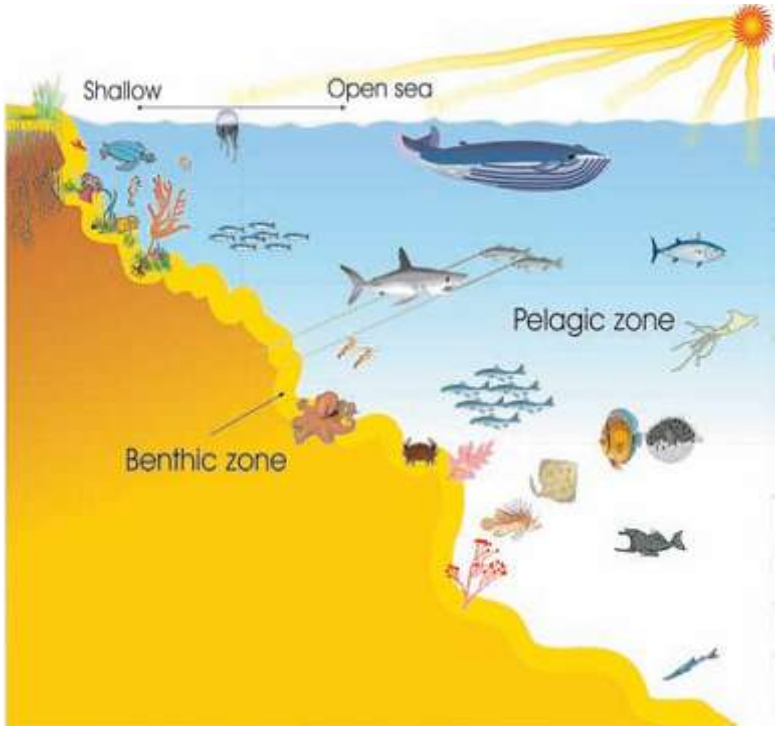


Figure: Marine ecosystem. Seas are ecologically divided into two zones: benthic and pelagic.

Free-living organisms like phytoplankton, zooplankton, cartilaginous and bony fishes, some reptiles, mammals (seals and whales), squid and octopus, shrimp and crab species are some organisms that form the marine ecosystem.

There are some organisms that live in the deep ocean where there is no light. These organisms are adapted to such conditions with unique body shapes and feeding styles.

Marine ecosystems are rich in biological diversity. Types of organisms and population size depend on the **amount of light**, **water temperature, pressure, salinity, currents and tides,** as well as the **concentration of dissolved minerals and gases** and the **amount of food** in the water.

Climate of Baghdad

- Baghdad, Iraq is at 33°13'N, 44°13'E, 34 m (112 ft).
- Baghdad has a subtropical desert / low-latitude arid climate (Köppen-Geiger classification: BWh) that is hot year round.
- According to the Holdridge life zones system of bioclimatic classification Baghdad is situated in or near the subtropical desert biome.
- The average temperature is 22.8 degrees Celsius (73 degrees Fahrenheit). See the temperatures page for a monthly breakdown and the fixed scale graph.
- Average monthly temperatures vary by 24.5 °C (44.1°F). This indicates that the continentality type is continental, subtype subcontinental.
- Total annual Precipitation averages 156 mm (6.1 inches) which is equivalent to 156 Litres/m² (3.83 Gallons/ft²).
- On average there are 3244 hours of sunshine per year. Visit the sunshine and daylight section to check monthly details including how high in the sky the sun reaches each month.
- If you were to burrow down through the Earth from Baghdad you would come out nearest to the climate station at Adamstown, Pitcairn Islands where you would find a Tropical wet climate.

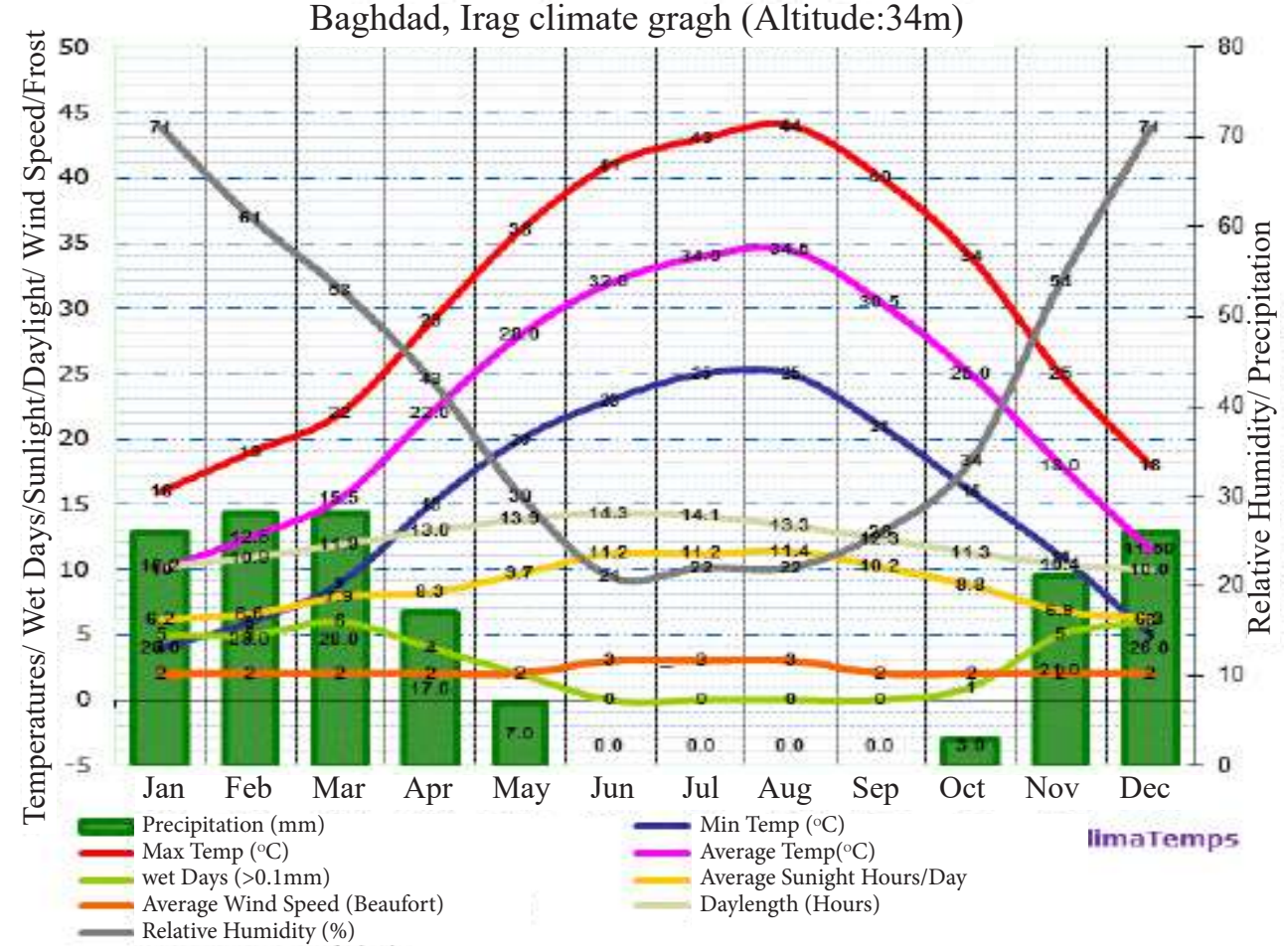


Diagram: The climate table use scolour to represent the data so you can get a good idea about the climate at a glance. The colour also helps when comparing two or more locations.

SELF CHECK

Biomes and Ecosystem

A. Key Terms

Succession
Pelagic zone
Climax vegetation
Ecotone
Benthos
Lichen phase
Eutrophication

B. Review Questions

1.Explain the two types of succession.

2.Write the order of phases forming primary succession.

3.What are the resons of formation for secondary succession?

4. Comapare between the decidious and tropical forest?

5.Explain the marine ecosystem.

C. Fill in the blanks

1. ..... make up the living portion of the ecosystem.
2. The temperature is very high during the day and falls suddenly at night in .....
3. Marine waters are divided into two main zones; ..... and ..... .
4. The microscobic ..... is photosynthetic.
5. The main factor that determines the kind of biome in a certain area is ..... .
6. The dominant type of plants are called ..... .

D. True or False

1. Acid rain increases the acidity of the lakes.
2. The distribution of populations on earth is affected mainly by climate.
3. Average temperature decreases from the poles to the equator.

E. Multiple Choises

1. Which of these is a starting point for primary succession?

A.on new volcanic island
B. abandoned farmland
C.an abandoned city
D.a fired forest
E. all of the above

2. All the organisms in a particular area make up a_____.

A. niche
B. food chain
C. population
D. community

3. In an ecosystem, the roles of phytoplankton are _____.

A.decomposers
B. producers
C.primary consumers
D.secondary consumers

4. Praries are seen in:
A. Deserts
B. Tundra
C. Tiaga
D. Semi deserts

5. Which of the following describes the region where fresh water and salt water mix?

A. Photic zone
B. Estuary
C. Intertidal zone
D. Aphotic zone

ENVIRONMENTAL FACTORS

Factors Affecting the Distribution of Living Things

Environment is the all living and non living factors that surround an organism.The environment includes abiotic components (non living chemical and physical factors and physical factors) such as temperature, light, water, and nutrients and biotic components (living) such as plants, animals, fungi-all the other organisms.

Abiotic factors of the biosphere

Abiotic factors are important determinants of the distribution of organisms in the biosphere.

Climatic Factors:

Light,
Temperature,
Water

Soil Factors:

Structure of soil Minerals and salts pH of soil.

Climatic Factors

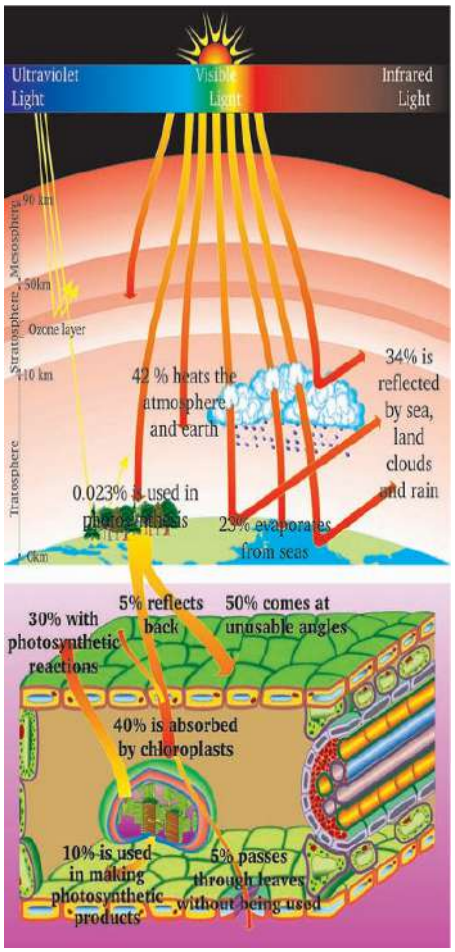


Figure: The source of energy in ecosystems is sunlight. Only a small amount of sunlight can penetrate the atmosphere and reach the earth. Some of this light is absorbed by plants. In the figure above, across-section of a leaf and the storing of light enery in organic molecules in chloroplasts are demonstrated.

The variety of living things on earth is affected and determined by sunlight, temperature, pressure, moisture, and air movements, which are called **climatic factors**. When the weather of an area is mentioned, it means all the above factors at that time or in that year.

The science of climate is **meteorology**. The climate of an area refers to the annual average of light, temperature, rainfall, and air movements in the area over many years.

A related science is **climatology**. Weather is studied by meteorologists, who determine the average values of atmospheric characteristics for an area. These values determine the living area of an organism. For example, areas with heavy rainfall and temperate climate are suitable for a jungle ecosystem and the dependent jungle animal populations. At the same time, climatic conditions are the main factors that determine the distribution of living things and habitat formation.The factors that cause the formation and change of climate are temperature, light and water.

Light

As explained before, the energy source for all organisms in nature is light. The natural source of light is the sun. From an ecological point of view, the intensity and duration of light is important. The amount of light energy at a certain time and place is related to the angle of incidence of light rays.

As the angle of incidence increases, the incoming light rays are spread over a greater surface and the amount of light per surface unit is proportionally less. The reproduction, migration, and pigmentation of various organisms are all affected by light, as is respiration, especially of those organisms, living in wet environments, resulting in decreased oxygen consumption. Light is essential for photosynthesis.

Figure: Forests have four regions, namely canopy, understory, shrubs and grasses. The factor that determines the formation of these regions is light.

Light intensity and photosynthetic rate are directly proportional. In both shade and sun, light intensity increases the rate of photosynthesis. If the food produced at the maximum level of photosynthesis is higher than the amount consumed in low light, the plant will store the excess. The stored food is eaten by animals.

In tropical forests, long day plants form the canopy. (e.g., acacia, willow).These are broad-leaved, large-celled and large-stomated plants. Below the canopy are understory plants. The plants of this layer include banana, dog-rose, and ivy. Beneath there are herbaceous plants such as ferns, horsetail and some grasses. Shade density increases with forest density. The development of the canopy and forest regeneration are proportional to the shade tolerance of the young trees. If the plants are resistant to shade, then forest regeneration will be easy; if they are not, regeneration will be difficult and the forest may undergo a new formation as dominant species are replaced.

Environmental temperature is an important factor in the distrbution of organisms because of its effect on biological processes and the inability of most organisms to regulate body temperature precisely.

Temperature

Sunlight transports energy from the sun to the earth. The light that passes through the ozone layer energizes molecules in the atmosphere and, consequently, supplies heat energy (temperature) to the living and nonliving things on earth. This process is very important for living things because all life on earth needs heat to survive. The source of this heat is sunlight.

All organisms must live within a certain range of temperatures. In general, warm-blooded animals are active in a wide range of temperatures. Cold looded animals are active in narrow range of temperatures. Animals generally cannot su vive in temperatures that exceed 52°C. Some types of algae survive in hot springs, where temperatures may be 73°C or even higher. Some types of algae live in artic ecosystems. Extraordinary
adaptations enable some organisms to live outside this temperature range.

Effect of Temperature on Plants

The temperature of a plant is directly related to the temperature of the environment. Generally, the temperature of plant roots depends on soil temperature. The parts of the plant above ground, when they absorb sunlight, are a few degrees higher than air temperature. During transpiration the temperature of these parts is lower than the air.

The effects of low temperatures on plants is not seen everywhere and every time to the same degree. When the temperature declines slowly, plants get rid of excess water and can accommodate to the low temperature to a certain level.

In winter, especially at night, when air temperature declines substantially, the temperature of the plant stem declines as well. As a result, some shrinking or wrinkling may appear on the stem. Though at low temperatures the bark of trees decreases due to heat loss, the inner structures of the stem experience no shrinkage because they are warmer.

Effect of temperature on animals

Animals are placed into two groups according to the relationship between their body temperature and the air temperature: poikilothermal animals (without constant body temperature) and homoiothermal animals (with constant body temperature).

Invertebrates, fish, frogs and reptiles are poikilothermal animals. These animals have a body temperature close to the ambient temperature. Homoiothermal animals, though they have a constant body temperature independent of the ambient temperature, may experience slight temperature changes due to external conditions. Temperature affects the development, reproduction and metabolism of organisms. Extreme temperature changes cause death.

Temperature range and survival

Figure: Aquatic plants like water lily, a hydrophate, have features adapted to their environment. Wide leaves and the placement of stomata on the upper surface of the leaves ease the process of evaporation.

Some organisms that have a metabolism that normally functions between (0°-°50 C) can live below 0 °C or above 50° C as well. Some bacteria can survive temperatures of 90 C, some mollusks live in water at (46°-48° C), and some fishes can live in water with a temperature above 40° C. Organisms can decrease their metabolic rate to adjust their body temperature to the ambient temperature. As in the examples given above, the tolerance of species to temperature varies. For every species there is an upper and lower limit.

However there are minimum and maximum temperatures at which organisms decrease or increase their activity to survive. Organisms normally seek the optimum temperature.

Water

Water precipitates from the atmosphere in the form of rain, snow, and hail. Annual rainfall varies in different parts of the world. Latitude, large bodies of water, mountains and wind affect precipitation. Organisms can't live without water and there is no substitute.

Water vapor enters the atmosphere through evaporation, where it absorbs most of the light reflected from the earth's surface, which in turn prevents the excess warming and cooling of the earth. As humidity decreases, evaporation and transpiration rates increase. Plants need water and exchange it with the atmosphere. Plants need at least 65% humidity to maintain this balance.

Moisture is another factor that determines climate. Moisture includes both water that falls from clouds, or precipitation, and water vapor in the air, or humidity.

Effect of water on plants

Plants are placed in three groups according to their water needs or structural differences arising from the amount of water.

- Hydrophytes (grow where water is always available)
- Mesophytes (grow where water availability is intermittent)
- Xerophytes (grow where water is scarce most of the time)

Hydrophytes

Hydrophytes live in water and therefore have no problem with transpiration. Roots may be in or out of the water. Stomata are present on the upper surface of the leaves and the leaves are covered with a thin layer of cuticle. They don't have any water related problems. Examples include water lily and elodea.

Figure: These plants have zigzagged leaves with a wide surface. This feature enables greater light absorption, a high rate of photosynthesis, and faster transpiration.

Mesophytes

These plants are adapted to live in places where water supply is intermittent. Cuticles are of intermediate thickness; stomata are present on both upper and lower surfaces of the leaves.

Xerophytes

Xerophytes are adapted to arid conditions like deserts and sand dunes. They have a very extensive root system. Some xerophytes store water inside their bodies after rainfall.

Their cylindrical and spherical shapes produce a small surface area, so they lose less water through transpiration. They also have a thick cuticle, and stomata that open at night instead of during the day.

Generally, xerophytes have properties that decrease transpiration. Their leaves are thick, needle-like and small-celled. Stomata may be covered with hair-like structures or protected folds of the leaf, or they may be embedded beneath the leaf epidermis. Moreover, cells have high osmotic pressure.

Plants living in salty environments also have the properties of xerophytes, but it can't be said that these plants can live in arid places as well.

Figure: Desert and a rid region plants. The leaves of these plants are either spiny or needle like. This makes for a smaller surface area for transpiration, an adaptation for life in arid regions.

Effect of water on animals

Animals obtain water with active processes. Their means of water acquisition are:

- Ingesting water directly through the digestive system.
- Wet-skinned animals (living in soil, mud, and sand) absorb water through the skin.
- Water present in ingested foods.
- Water released from the food in metabolism.

To save water, animals have mechanisms like those of plants. For example, skin minimizes water loss. Most organisms lose water and salt from their sweat glands to maintain body temperature. The body maintains water balance by taking in enough water to compensate for the excreted water.

The animal respiratory system has an important role in conserving body water. Since fish live in water, they don't have a problem. In terrestrial organisms though, the respiratory system is inside the body (lung, trachea). A small amount of water is lost by insects and terrestrial mollusks (snails). Closing of respiratory holes in arid times minimizes water loss. Animal excretory systems also play an important role. Aquatic organisms excrete ammonia, a very toxic substance, with substantial water. Terrestrial organisms convert ammonia into less toxic urea. Reptiles and insects living in arid areas convert ammonia to uric acid and excrete it with little water. Animals' metabolic reactions provide some water. Termites eat dry wood continuously. When termites digest wood and metabolize it, water released as a result of metabolism quenches their thirst. Desert camels can survive without drinking water for 11 days by using metabolic water produced in the catabolism of fat in the hump. In the same way, hibernating animals, like bears, and migrating birds obtain water as a result of the metabolism of fats stored in the body. Antelope and some rodents can survive on guttation water.

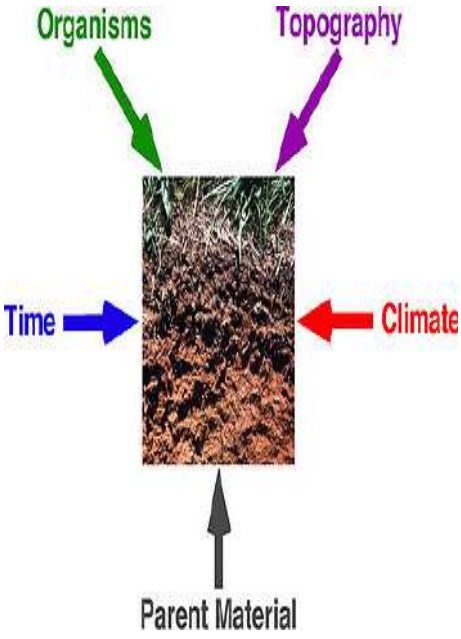
Bergman'sRule: Temperature is a factor that determines the size of animals. Homoiothermal (warm blooded) animals living in northern latitudes tend to be bigger than their relatives in the hotter regions. Bergman's rule states that populations in colder climates (higher latitudes) have larger bodies than populations in warmer climates (lower latitudes). With a larger body, the surface/volume ratio decreases. Largebodied animals have a relatively smaller surface area and preserve internal heat more efficiently. This is an important adaptation. For example, the size of penguin species increases from South America to Antarctica. The size of bears and hares increases from south to north in their ranges. But there are examples of the opposite as well. In the poikilothermal (cold-blooded) animals like frogs and reptiles the reverse is seen. These animals have smaller bodies in cold regions than in hot regions. In other words, in poikilotherms, as air temperature decreases body size decreases as well.

Allen'sRule: Allen's rule states that animals in colder climates generally have shorter extremities (beaks, wings, ears, feet) than those populations in warmer climates. In hares and foxes, organs like the ears are smaller from southern to northern regions. In hot regions, a large surface area is a means of transpiration and cooling for the animal. Allen's observations have been demonstrated experimentally. Laboratory mice grown at a temperature of 31-33.5 C have longer tails than those grown at a temperature of 15.5-20 C.

Gloger`sRule: Gloger's Rule states that populations in warmer and more humid climates have darker coloration than those in cooler or drier climates. In the northern hemisphere birds and mammals have lighter colors from the Equator north; and have darker colors from north to south in the southern hemisphere. In the formation of colors environmental and genetic factors interact.

Soil Factors

Soil is another factor with which living things are continuous interacting, directly or indirectly. Soil structure, pH, mineral and salt content affect the organism in different ways.



Soil structure

When you glance at the soil, it seems that it is non living, but actually it is full of billions of organisms. Soil is very suitable to life for bacteria, fungi, viruses, algae, and protozoans.

Microorganisms are especially abundant in soil rich in organic wastes. The dominance of a microorganism in a certain area is determined by environmental conditions. For example, in fall yeast cells are more abundant in soil that is covered with ripe fruit.

After yeast cells, Acetobacteria are second in dominance. After rain, low-lying areas become swampy, which prevents the diffusion of gases into the soil. As a result, aerobic bacteria are replaced by anaerobic bacteria. For instance, the process of nitrification carried out by aerobic bacteria like nitrosomonas and nitrobacteria is replaced by a denitrification process carried out by anaerobic bacteria.

The number and variety of soil bacteria are greater than all other soil organisms. These bacteria may be autotrophic or heterotrophic, aerobic or unaerobic.

Soil, water, air, organic and inorganic molecules are very important for plant growth. The ratios of these 4 groups in the soil are as follows:

- Minerals (Ca, Mg, P, N): 45%
- Organic molecules (plant and animal residues): 5%
- Air: 25%
- Water (soil water with dissolved salts): 25%

Minerals and Salts

Organisms contain very important and vital minerals. The most important ones are (N, P, K, Ca, S, Fe and Mg). Deficiency of these causes serious problems in living things. For example, Ca is an element used by all organisms. Calcium is a constituent of animal endo- and exoskeletons, and is necessary for muscle contraction and blood clotting. Moreover, it has a role in the adjustment of soil pH and in the density of soil water. Magnesium is present in the chlorophyll and also works as a cofactor of enzymes in DNA replication.

Some elements may be present in sufficient amounts for the survival of organisms. The measurement of the amounts of these elements is very difficult, but can be determined by the isotope method. If one of these elements is missing, pathological symptoms are seen in plants, animals and humans.

Soil is another abiotic factor of ecosystems. Soil is important to plants as a source of minerals and as a material in which to anchor their roots. Many animals also depend on soil for a place to live and for food. The physical structure, pH and mineral composition of rocks and soil. They limit the distribution of plants and animals that feed upon them.

The essential minerals and elements for living things are Fe, Mn, Zn, B, Na, Mg, Cl, and Vanadium. Every organism needs these elements in different quantities. Atpresent, certain important minerals, especially N, P and S are mixed into the soil as inorganic fertilizers to meet the requirements of plants. If excess fertilizer (minerals) is applied to the soil, plants can't absorb water because of the increased density of soil (physiological drought). Consequently, plants get yellow and die.

Soil pH and plant relations

Soil pH means its degree of acidity or alkalinity. This depends on the amounts of hydrogen (H^+) and hydroxyl (OH^-) ions. Cultivated plants mostly need soil with pH (6.7-7.0).

The main reason an increase in soil acidity is a decreased level of Ca. For this reason, highly acidic soils are treated with lime (CaO) to decrease acidity.

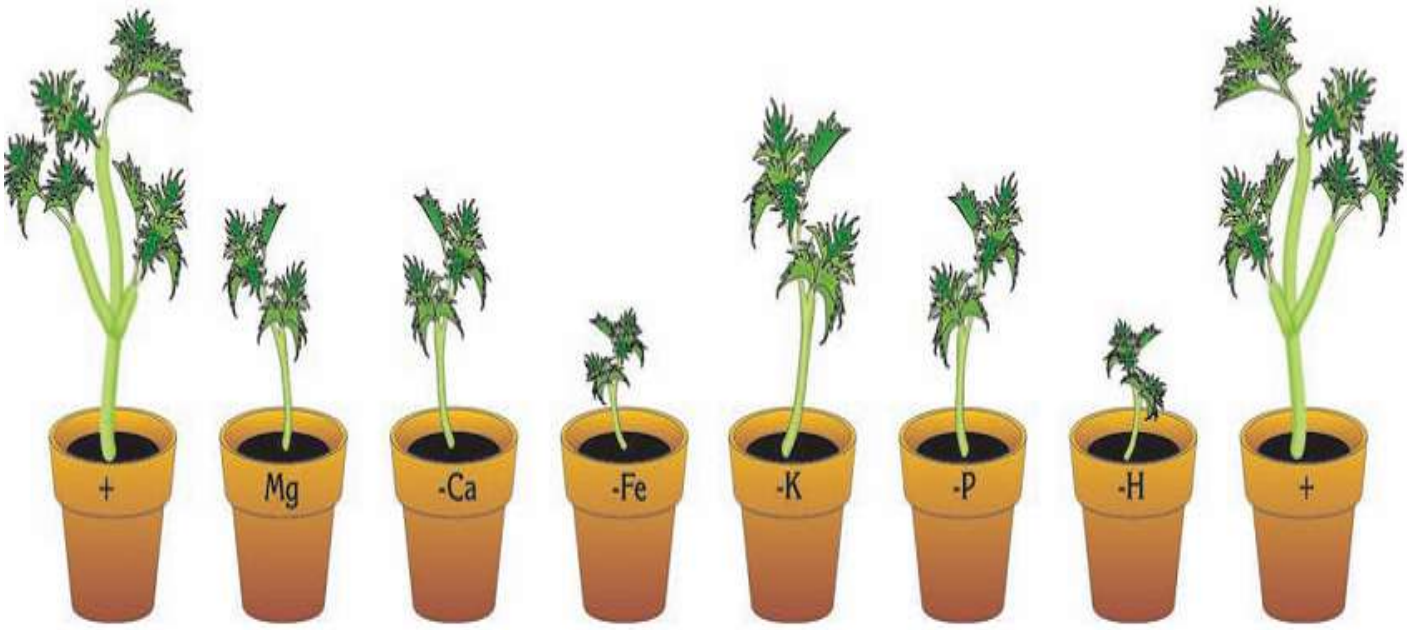


Figure: The deficiency of the essential minerals in the environment influences the metabolism of plants. As seen in the figure, the deficieny of a certain mineral affects plant growth differently

READ ME!

Heat-Temperature-Freezing

Heat and temperature describe two physical features that are closely related to each other. They are frequently confused. It is important to understand that heat and temperature are quite different.

Heat is the potential energy present in the mass of an object. It is the energy that keeps the molecules inside an object in motion. It is also called internal energy. Heat is measured in units called calories. One calorie is the energy needed to raise the temperature of 1 gram of water 1 degree Centigrade (from 14.5 to 15.5 C). Another unit of heat measurement is the joule (J), where

1 calorie= 4.184 J

Temperature is a measurement of hotness or coldness. Heat is a form of energy, whereas temperature is a measurement of the intensity of heat. Heat always flows without outside help from warm objects to cool ones. For example, a cup of hot coffee cools because heat flows from the hotter coffee to the cooler surroundings.

Temperature is measured with the Centigrade(C) or Fahrenheit (F)scale. The main source of heat is the sun. The amount of heat energy coming from the sun in the form of light depends on various factors. The amount of light reaching our planet is highest at the equator and between the tropics; it is lowest at the poles (the effect of latitude).

Accordingly the temperature is higher near the equator and lower at the poles. In the same way, at higher altitudes the weather is usually cold. The thawing of frozen soil causes the water below to rise, evaporate and mix into the air. If the temperature falls below the freezing point, a thin layer of topsoil freezes. The bottom surface of this frozen layer attracts water from the soil, forming a thin layer of ice. As the layer of ice increases, the frozen soil swells. This swelling is called frost heave. In this way, a cycle develops of swelling at night and melting during the day. This in turn causes the roots of plants to be pulled up more every day. If this cycle continues, the roots of young plants may be pulled up 8-10 cm, and the plants will die. Most of the time when the plants are pulled up, their roots are torn, causing death.

SELF CHECK

ENVIRONMENTAL FACTORS

A. Key Terms

Hydrophyte
Metorology
Homoiothermal
Mesophyte
Xerophyte
Poikilothermal

B. Review Questions

1.What is the importance of light for plants?

2.Explain water saving in animals by examples.

3.Enumarate the factors affecting on distribution of living things.

4. How do the xerophytes decrease the transpiration?

5.Explain how animals get water to survive.

C. Fill in the blanks

1. Soil pH means is degree of ..... and .....

2. ..... animals have constant body temperature while ..... animals dont have.

3. ..... is essential for photosynthesis.

D. True or False

1. Soil pH means its degree of solidity.

2. Microorganisms are especially abundant in soil rich in organic wastes.

3. Desert camels can survive without drinking water for 11 days.

4. Light is used as an energy source by aquatic plants and affects pigment production

E. Multiple Choises

1. Which one of the following is not a climatic factor?

A) Light
B) pH of soil
C) Water
D) Temperature

2. In tropical forests ..... forms the canopy?

A) Ferns
B) Long day plants
C) short day plants
D) Understory plants

3. Which one of the following group of plants grow where water always available?

A) Mesophytes
B) Xerophytes
C) Pidophytes
D) Hydrophytes

4. How much is the pecentage of air in soil for plant growth?

A) 45 %
B) 54 %
C) 25 %
D) 5 %

Animal Adaptation With Environment

Adaptation In Water Environment
1- Bony Fishes

Of the 25,000 known species of fishes, about 95% are bony fishes, formerly grouped in the class Osteichthyes. Bony fishes account for most of the vertebrates living in fresh water and in salt water. In this section, you will study some of the adaptations of this group.

Charactheristics

The bony fishes are characterized by three key features:

• **Bone** —This material is typically harder and heavier than cartilage. The skeletons of most bony fishes contain bone.

• **Lungs or swim bladder** - Only a few species of bony fishes have lungs . Most bony fishes have a swim bladder, a gas-filled sac that is used to control buoyancy. The swim bladder is thought to have evolved from the lungs of the early bony fishes.

• **Scales** —The body of a bony fish is usually covered with scales. Scales protect the fish and reduce friction when swimming.

External Anatomy

The yellow perch, like all bony fishes, has distinct head, trunk, and tail regions. On each side of the head is the operculum, a hard plate that opens at the rear and covers and protects the gills.

Fins

The fins of the yellow perch are adapted for swimming and navigating through the water. The caudal fin extends from the tail. It moves from side to side and amplifies the swimming motion of the body. Two dorsal fins, one anterior and one posterior, and a ventral anal fin help keep the fish upright and moving in a straight line. The fish uses paired pelvic fins and pectoral fins to navigate, stop, move up and down, and even back up. The pelvic fins also orient the body when the fish is at rest. The fins are supported by either rays or spines. **Rays** are bony yet flexible, while **spines** are bony and rigid.

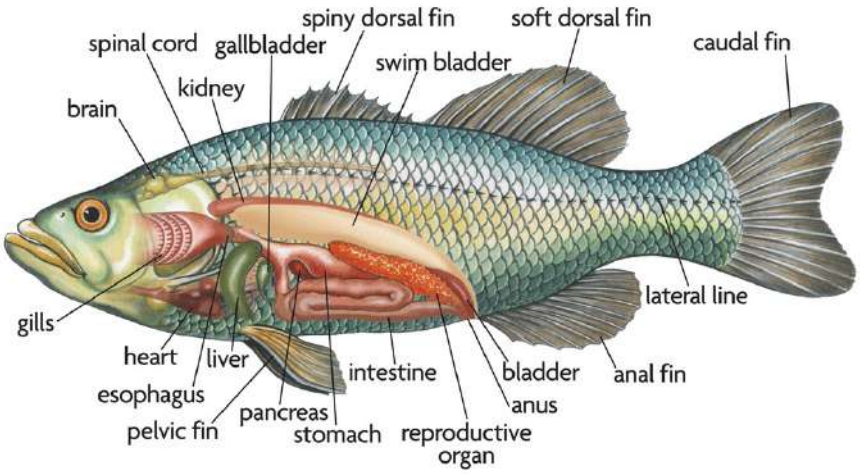


Figure: External anatomy of fish

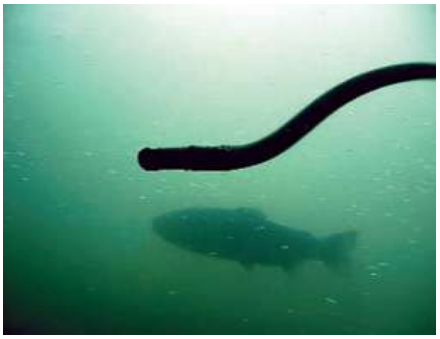


Figure: Lampreys

Skin

The skin of the yellow perch is covered with **scales**. Scales are thin, round disks of a bonelike material that grow from pockets in the skin. They all point toward the tail to minimize friction as the fish swims. Scales grow throughout the life of the fish, adjusting their growth pattern to the food supply. The scales grow quickly when food is abundant.

Internal Anatomy

The major parts of a fish's skeleton are the skull, vertebral column,
pectoral girdle, pelvic girdle, and ribs. The vertebral column is made up of many bones, called vertebrae, with cartilage pads between each. The vertebral column also partly encloses and protects the spinal cord. A fish's skull is composed of a large number of bones (far more than are in the human skull) and is capable of a wide range of movements.

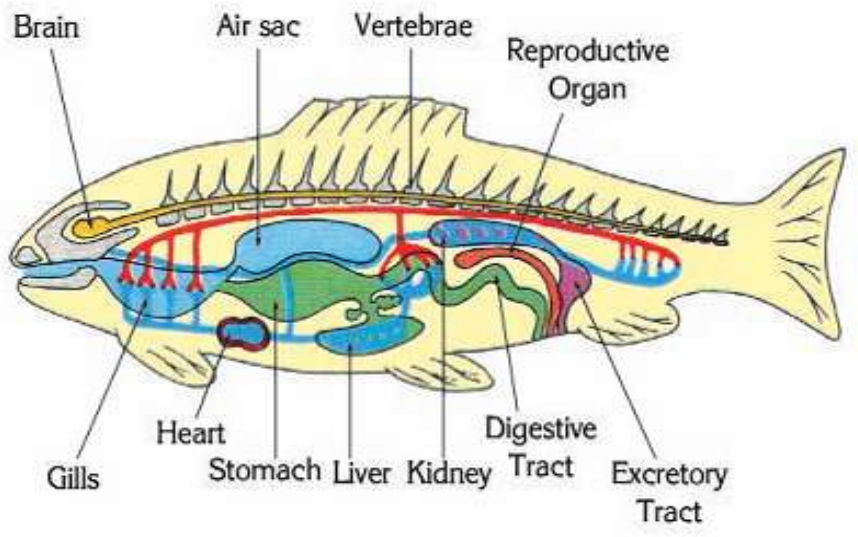


Figure: Internal anatomy of bonyfish

Digestive System

Bony fishes have diverse diets but commonly are **carnivores**. The jaws of predatory fishes are lined with many sharp teeth that point inward to keep prey from escaping. Strong muscles operate the jaws, which are hinged to allow the mouth to open wide.

Food passes from the mouth into the pharynx, or throat cavity, and then moves through the esophagus to the stomach. The stomach secretes acid and digestive enzymes that begin to break down food. From the stomach, food passes into the intestine, where digestion is completed and nutrients are absorbed.

The liver, located near the stomach, secretes bile, which helps break down fats. The gallbladder stores bile and releases it into the intestine. The pancreas, also located near the stomach, releases digestive enzymes into the intestine. The lining of the intestine is covered with fingerlike extensions called villi that increase the surface area for absorption of digested foods. Undigested material then eliminated through the anus.

Oarfish are large, greatly elongated, pelagic Lampriform fishes comprising the small family Regalecidae. Found in all temperate to tropical oceans yet rarely seen, the oarfish family contains four species in two genera.

Reproduction

Eggs are produced by ovaries in the female, and sperm are produced by the testes in the male. Eggs and sperms are released through an opening behind the anus. Fertilization in most species takes place externally. Mortality among the eggs and young fishes is often very high. Many species of fishes lay large numbers of eggs, which ensures that at least a few individuals survive to become adult fish.

Some bony female fishes carry the eggs in their body until the young are born. The reproductive, or spawning, behavior of bony fishes varies widely. Some species build crude nests from plants, sticks, and shells. Many species migrate to warm, protected shallow water to spawn.

Respiratory system

The large surface area of a fish's **gills** allows for rapid gas exchange.Gills are supported by four sets of curved bones on each side of the fish's head.In most bony fishes, water is taken into the mouth and pumped over the gills, where it flows across the gill filaments before exiting behind the operculum. Water flows across the gill filaments in a direction opposite to blood flow. This arrangement is known as **counter-current flow**. causes more oxgen to diffuse into the blood than would be possible if blood and water flowed in the same direction.

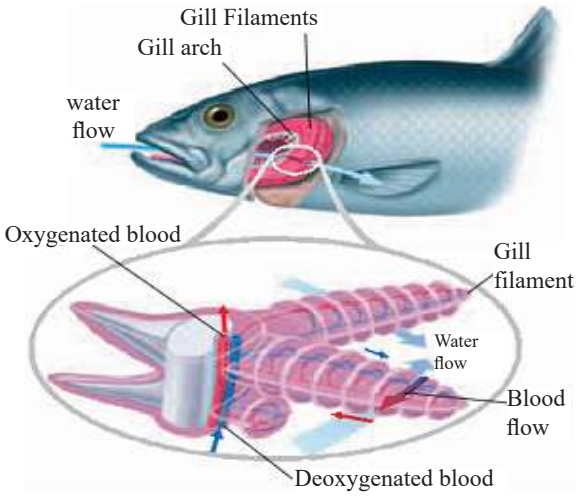


Figure: Fish respiratory system

Excretory System

A fish's kidneys filter dissolved chemical wastes from the blood. The resulting solution, called urine, contains ammonia, ions such as sodium and chloride, and water. Urine is carried from the kidneys through a system of ducts to the urinary bladder, where it is stored and later expelled. By varying the amount of water and salts in the urine, the kidneys help regulate the water and ion balance in fresh and saltwater fishes. As blood flows through the gill filaments, ammonia generated by metabolism diffuses from the blood into the water passing over the gills and is removed from the body. The gills also regulate the concentration of ions in the body.

Swim Bladder

Most bony fishes have a swim bladder. This thin-walled sac in the abdominal cavity contains a mixture of oxygen, carbon dioxide, and nitrogen obtained from the bloodstream. Fish adjust their overall density by regulating the amount of gas in the swim bladder, enabling them to move up or down in the water. In some fishes, the swim bladder is known to amplify sound by vibrating and transmitting sound to the inner ear.

Nervous System

The nervous system of a bony fish includes the brain, spinal cord, nerves, and various sensory organs. The fish brain is illustrated in figure. The most anterior part of the brain, the forebrain, contains the olfactory bulbs, which process information on smell. The forebrain also includes the cerebrum, which has areas that integrate information from other parts of the brain. Behind the forebrain lies the midbrain, which is dominated by the optic tectum. The optic tectum receives and processes information from the fish's visual, auditory, and lateral-line systems.

The most posterior division of the brain is the hindbrain, which contains the cerebellum and the medulla oblongata. The cerebellum helps coordinate muscles, movement, and balance. The medulla oblongata helps control some body functions and acts as a relay station for stimuli from sensory receptors throughout the fish's body. From the medulla oblongata, the spinal cord extends the length of the body and carries nerve impulses to and from the brain.

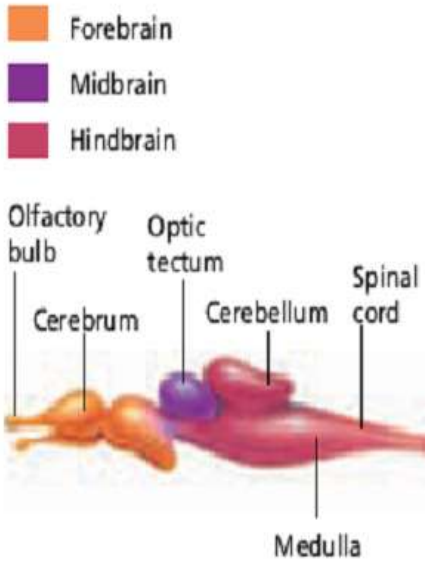


Figure: Nervous system in fishes

Adaptation In Land Environment

Birds

There are over 8,000 species of birds which vary in sizes, shape and colors. Because they can fly, distribution of birds is wider than other terrestrial vertebrates. Birds show great diversity. The bill, foot, wing and tail are highly variable and adaptable organs.

- The bird body is remarkably covered with feathers. Feathers provide insulation and prevent water loss, and function in flight.
- Their tongues are hard and they have bills without teeth.
- Their anterior extremites are wings which function in flight. A rib cage protects internal organs.
- Birds are warm-blooded:they maintain a constant body temperature as result of metabolic heat. Birds have no sweat glands and cannot cool the body by perspiring.
- Development and reproduction is similar to that of reptiles.
- Eyelids are movable. There are upper, lower and inner eyelids. The iris shrinks or enlarges to focus.

Barn owls live in trees and abandoned buildings. They feed on small rodents. Large flight feathers quiet the flapping

sound of their wings, while short head feathers help guide sound waves toward the owls' ears (lower left). The barn owl's hooked beak helps the bird tear meat (lower right).

Respiratory system

Birds need high amountsof energy to fly. Where do birds get this energy? They have very complex systems to take in oxygen and transport it to their cells. Birds have lungs and a series of **air sacs** throughout their body for breathing. These sacs cause much of the body cavity to be filled with air. Air enters the respiratory system through the nostrils and flows into the lungs and then to the air sacs. Air sacs increase the oxygen storage capacity of birds.

Birds have a four-chambered heart. The heart completely separates oxygenated and deoxygenated blood. These two kinds of blood do not mix.

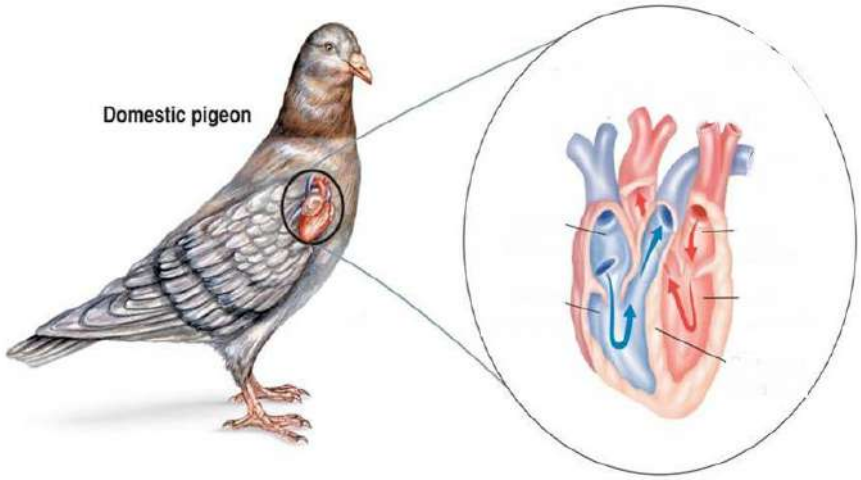


Figure: Respiratory system of bird.

Skeletal and Muscular System

The bones of birds have hollows in their structures. No other vertebrates have hollow bones. The hollow spaces are filled with air and make the boneslight. Thus, thebones of birds are both strong and light.

Figure: Bird bone

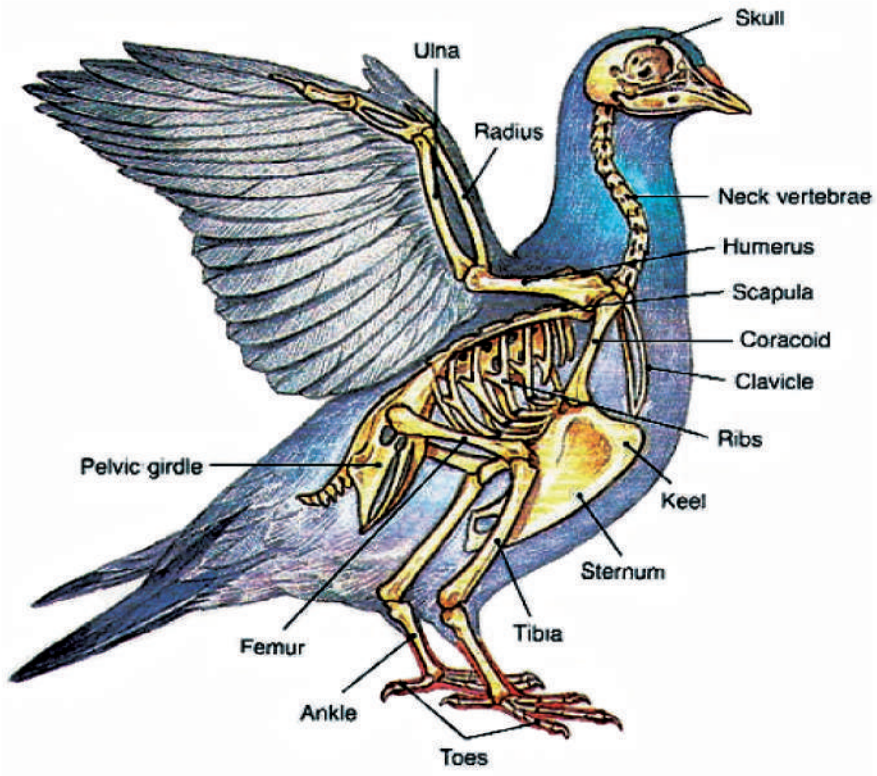


Figure: Bird skeletal system

Birds fly by flapping their wings. Flap your arms as if you were a bird. You might feel the muscles in your chest pull your arms toward your body. Birds are able to flap their wings because they have large, powerful chests and wing muscles.

Fastest Flying

Falco peregrinus can reach speeds of 200kmh/124mph in a steep dive. In level flight the record goes to the wandering albatross which was clocked maintaining 56km/h for 800 km.

Adaptations For Flight

Birds have some adaptations for flight.

1.They have wings.
2.They have light, hollow bones.
3.They have air sacs in their lungs.
4.They have large, powerful chests and wing muscles.

Feathers

Feathers are light weight and flexible. They provide a body covering that protects the skin, supportsthe bird in flight, and providesinsulation from the weather. In many species, the male and female differ in coloring, with the male generally brighter.

Feeding and Digestion

Birds need high amounts of food to satisfy their high energy needs. For example,a hummingbird may eat an amount equal to 100 percent of its body mass each day. Birds do not have teeth and can not chew their food. Instead, they take in food using their beaks.

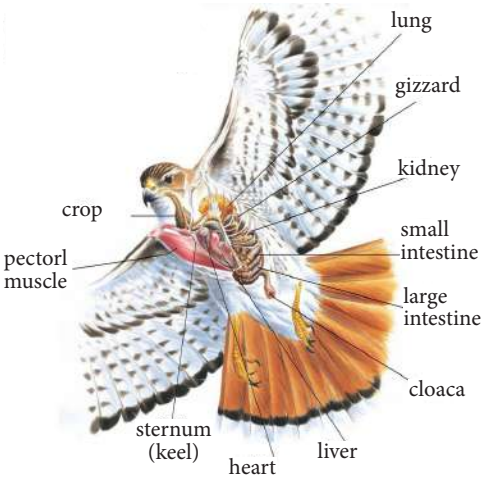


Figure: Anatomy of a bird

The beaks of birds may have different adaptations according to their feeding strategy. Woodpeckers have long, thin, tweezer-like beaks to pull insects from cracks in the bark of trees. Ducks have wide, flat beaks to strain food from water. Hawks have sharp and hooked beaks to tear the flesh of their prey. The pelican uses its long, sharp beak for catching fish.

Birds swallow their food whole and grind it down in a structure called a **gizzard**. Birds feed their offspring by vomiting through their gizzard. Food is digested very quickly. For example, a bird can eat berries and digest them, nutrientspass to the blood and undigested materials go outthe cloaca in less than half an hour.

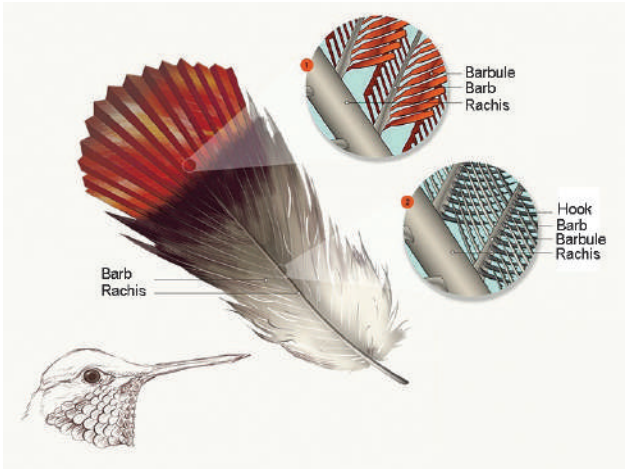
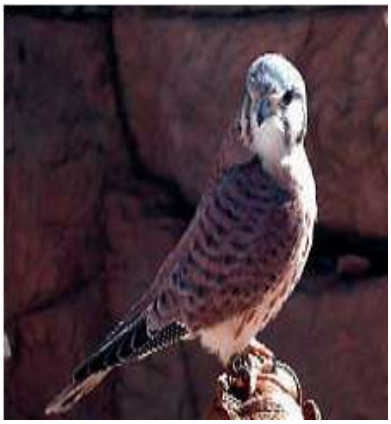


Figure: Structure of feather



Excretion

Bird kidneys are metanephric. There is no **urinary bladder**. Urine and feces are expelled through the cloaca. Because the kidney glomeruli are very small, only a small amount of fluid can pass from the blood to the kidneys. Most is reabsorbed. In this way, water loss is kept in a minimum level.

Nervous system and sense organs

A bird's nervous system includes a large, complex brain. The parts of the brain that control flight are the most well developed because flight involves taking off, landing and finding landmarks, as well as just staying in the air. A bird's brain is also adapted to behaviors like nest building and finding food.

In most birds, the senses of smell and taste are less complex, but the senses of sight and hearing are more complex. For example, owls use sounds to help find their prey in the dark. Songbirds use sounds to communicate with each other.

Reproduction

In birds, fertilization is internal and embryos develop inside shelled eggs. Birds lay eggs with a hard shell. Bird embryos need to be kept warm to develop. Therefore, adult birds incubate their eggs or warm them with their bodies.

The hard shell keeps the growing embryo from being crushed during incubation. When you look at a fertilized bird egg, the yellow part is a source of food for the growing embryo. Both the embryo and yolk are surrounded by the egg white.

The egg white contains food and water and acts as a protective cushion for the embryo. A membrane inside the egg shell controls gas exchange and excretion.

When a chick is completely formed, it cracks through the shell with a special egg tooth on its beak. This tooth falls off soon after the chick hatches.

When most birds hatch, they are covered only by down feathers and are completely helpless. Their parents keep them warm and bring them food until they are ready to leave the nest.

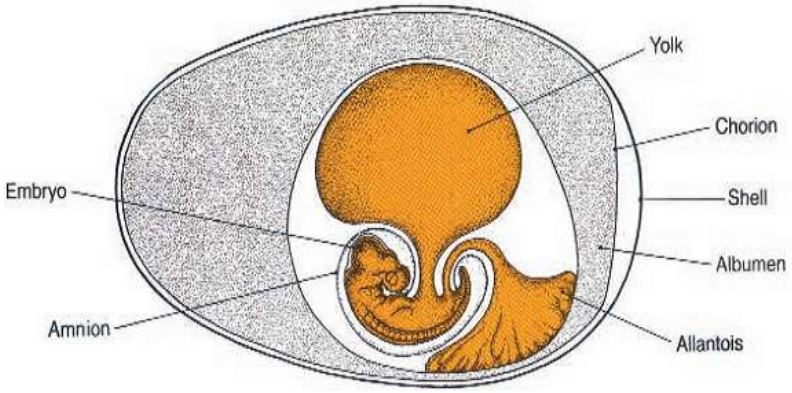


Figure: Bird egg

Migration

One of the most interesting behavior of birds is migration. Migration is the instinctive movement of animals, usually between their wintering grounds and their breeding seasons.

Most of the arcticbirds and some tropical birds migrate. However they have regular seasonal movements away from and back to the breeding area. The most famous is the arctic tern, which migrates from the northern latitudes of Eurasia and North America to Antarctica.

Long distance migration raises the intriguing question of how birds find their way. Some fly only at night, others over trackless seas. Scientists know that no single navigation system exists. Some birds seem to steer by star patterns and others by the angle of the sun. At least some birds can detect ultraviolet radiationor the magnetic field of the earth, but the actual sensory mechanism by which birds translate environmental signals into navigational aids is still a puzzle.

Classification of Birds

There are almost 9000 different species of birds. The classification of birds is disputed among experts. Decisions according to which species are related to one another are usually easy, but at higher levels relationships become more and more uncertain. One way to study these many species is to divide them into four groups:

1-Perching birds

Passerine is a common name for any of the perching birds belonging to the largest avian order, which includes more than 5700 highly diverse species and well over half of all living birds. **Passerines** are distinguished by four-toed feet, with three toes pointing forward and one large toe pointing backward. They are mostly songbirds. Robins, cardinals, blue jays, pigeons, crows, finches, wrens, swallow, nightingales, warblers, vireos, tanagers, and flycatchers are only a few of the many birds of the passerine order.

Figure: Perching bird

Passerines are highly diverse in body size, ranging from kinglets, at about 5 g,to ravens, at about 1400 gr.

2-Water birds

They live on or near water. Loons, ducks, seagulls, geese and herons belong to this group. Some water birds, like herons, have long legs for wading in shallow water. Others, like ducks, have webbed feet adapted for swimming.

3-Birds of prey

Figure: Hawk

They also known as raptors, include a night-hunting order (**owls**) and a day-hunting order that includes the hawks, eagles and falcons, as well as the carrion-feeding vultures. They are all meat eaters(although the "meat" for the smaller species is generally insects)and some feed on fish. All have powerful, sharp beaks and all but the vultures have grasping toes tipped with curved, sharp claws or talons.

Golden Eagle is distributed through most of the northern hemisphere. Females attain a length of about 1 m from the tip of the beak to the tip of the tail and have a wingspread of about 2 m. Most golden eagles' nests are placed on cliff ledges, but in some areas large trees are preferred. The diet of this species consists of mammals, ranging in size from mouse to deer.

4-Flightless birds

Penguins, ostriches and kiwi make up an unusual group of flightless birds (though they still have wings). Penguins “fly” through ocean water with their flipper-like wings. Ostriches and rheas run with their wings outstretched. This position increases their speed and helps them to maintain balance. The ostrich is the largest bird,standing nearly 2.5 m high and weighing as much as 136 kg.

Penguins have a white breast and a black head. Most penguinsare found in Antarctica. Others are native to the coasts of Australia, South Africa and South America. Penguins feed on fish, cuttlefish, crustaceans and other small sea animals.

The largest species is the emperor penguin, which may attain a height of more than 120 cm. Unlike most species, the king, emperor and little penguins have blue-gray backs. The ostrich is found only in Africa. They are the largest and the strongest of living birds, about 2.4 m in length and weighing up to 136 kg. They spread their small wings during running and have long, powerful legs that are used for defense. Theirfeet have only two toes.

Ostriches are rapid runners and can attain aspeed of about 65 km/h. Their eggs weigh about 1.4 kg. The male sits on them at night and the female incubates them during the day. Kiwislive in New Zealand and on adjacent small islands. They are about 50 cm long. The long slender bills of kiwishave nostrils near the tip, unique among living birds. Kiwis are nocturnal. Their eyes are tiny and their vision is poor. They search for their food by scent, a characteristic unusual for birds. They don’t have tails and wings.

Migratory Patterns

Migratory patterns vary by species and sometimes within the same species. Almost any possible pattern is possible and can be seen in one or more species.

Eastern Bluebird

Eastern Bluebirds (and several other species) have a flexible approach to migration. They may move only as far south as is needed for food and shelter and may move further south if local conditions become less conducive to their survival.

This migration pattern is not consistent with all Eastern Bluebird populations. In the southern part of their range the Eastern Bluebird is a permanent resident.

Northern Bobwhite

Populations are typically sedentary, year-round residents. However, in the Smoky Mountains of the southeast United States seasonal movements between low-elevation wintering and high-elevation breeding habitats have been observed

White-crowned Sparrow

Several subspecies of the White-crowned Sparrow have been studied. The northernmost breeding population migrates from Alaska and the Yukon to the southern plains of the United States and into northern Mexico. A different subspecies breeds farther south, ranging from British Columbia to northern California. These white-crowns migrate a shorter distance to the lowlands of central and southern California. Finally, a third subspecies is a permanent resident in parts of coastal California.

Before migrating, many birds enter a state of hyperphagia, where hormone levels compel them to drastically increase their body weight to store fat to use as energy while traveling. Some bird species may as much as double their body weight in the weeks leading up to migration.

Arctic Tern

The champion of long distance migration is the Arctic Tern. Arctic Terns can travel as much as 24,000 miles (round trip) each year from their breeding grounds in far northern Canada to their winter home in Antarctica. The terns follow two major pathways on their trips back and forth to the poles.

Terns that breed near Alaska and Canada migrate down the western coast of North, Central and South America. Birds from Greenland and Siberia take a route along the western coasts of Europe and Africa. Some birds in this group splinter off at the Horn of Africa and cross the Atlantic. They then fly down the east coast of South America. After spending only about two months in Antarctica they start their northward journey. The Arctic Tern can live to be at least 34 years old, in which case it may have flown more than 800,000 miles in its lifetime!

SELF CHECK

ANIMAL ADAPTATIONS

A. Key Terms

Gill
Migration
Swim bladder
Gizzard
External fertilization
Scale
Feathers
Incubation

B. Review Questions

1.What are the distinctive featuresof bony fishes?

2.Explain reproduction in bony fishes?

3.What are the distinctive features of birds?

4. What are the adaptetions of birds for flight?

5.Why birds migrate?Discuss your answer with other students

C. Fill in the blanks

1. Birds have..... and ..... in their body for breathing.
2. Urine and feces are expelled through the ..... in birds.
3.The beaks of birds have different kinds of beak according to their .....
4. stores the bile and release it into ..... in fishes.
5. In birds fertilization is ..... and it takes place in .....

D. True or False

1. A bird's nervous system includes a large, complex brain.
2. Bony fishes have diverse diets but commonly are carnivores.
3. Birds swallow their food whole.
4. Bony fishes use dissolved oxygen in water.

E. Multiple Choises

1. Which one of the following is not true for bony fishes?

A) Only a few species have lungs
B) Their body covered with scales
C) All of them have swim bladdee
D) The skeleton of most of them contain bones

2. What is the funcyion of the swim bladder in bony fishes?

A) Control bouancy
B) Help to find their way
C) Used in reproduction
D) Provide movement

3. Bird swallow their food whole and grind it down in a structure called as .....?

A) Swim bladder
B) Metanephrone
C) Gizzard
D) Stomach

4. Which one of the following is not an adaptation for flight in birds?

A) Having wings
B) Having light and hollow bones
C) Having powerfull chest and wing muscles
D) Having strong beaks

Plant Adaptation With Environment

Plant Anatomy

The plant body is organized into a root system and shootsystem.
The root system is generally the below ground portion, the shoot system consist of a vertical stem which bears leaves, flowers and fruits containing seeds.

Root

The root is a specialized structure peculiar to terrestrial plants. Roots exhibit positive geotropism. That is, they grow down into the soil. The root serves several functions. It keeps plants anchored in the soil and transports water and minerals dissolved in the water to the stems and other parts of the plant. Additionally, some roots have the ability to store materials for future use. Roots and stems are classified according to their external appearance. Roots lack leaves, nodes, internodes and chloroplasts, while stems include all of these structures. Highly branched roots have a large surface area due to branches and root hairs.

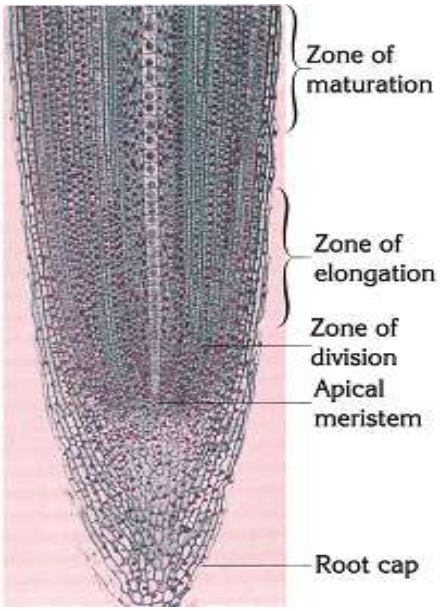
Plants have two types of roots: **taproot** and **fibrous root**.

Figure: Adventitious roots in some plants.

A tap root consists of one main root with many smaller lateral roots coming out of it. It is characteristic of dicots and gymnosperms. The tap root that develops in monocots often dies during the early growth of the plant and a new root develops from the lower part of the stem. These roots are called **adventitious roots.** They develop from an above-ground structure. Often, adventitious roots help anchor a plant, such as "prop" roots in corn. Certain dicots, such as ivy plants, also develop adventitious roots that help them cling to walls.

A fibrous root has several to many roots of the same size developing from the end of the stem with smaller lateral roots branching off these roots. Onion, crabgrass and other monocots have fibrous root.

Tap roots and fibrous roots are adapted to obtain water in different ways. Tap roots often extend down into the soil to obtain water located deep underground, whereas fibrous roots, located close to the surface of the soil, are adapted to obtain rainwater from a larger area as it drains into the soil.



1. Parts of a germinating root

A germinating root is comprised ofroot cap, zone of cell division, zone of elongation and zone of maturation.

Root cap

The root cap or calyptra is a yellow or brown structure located at the tip of the root. It protects the meristematic zone of the root where longitidunal growth occurs.

Zone of cell division

The zone of cell division is the actively dividing meristematic region. The meristematic region is involved extension of the root and in the renewal of the root cap. The cells of the growth region divide to give the root its typical appearance. Zone of elongation:In the zone of elongation, cells become longer as they become specialized.

Zone of maturation

In the zone of maturation, the cells are mature and fully differentiated. The young cells of the mature region divide to form projections from the main roots. These projections are highly branched absorptive root hairs. They are extremely vulnerable to abrasion and have a short life span as compared to normal epidermal cells. They increase the surface area of roots and absorb water and minerals. The root hairs are found exclusively in the first 6 cm of the root tip. The differentiating region of the root forms the phloem, xylem, and similar structures.

2. Internal Structure of the Root

The following structures are observed when a lateral cross section of a root is investigated under the light microscope.

Epidermis

Epidermis is the outermost layer of root which consists of single layer cells. The root hairs are composed of epidermal tissue which projects out from the main root.

Cortex

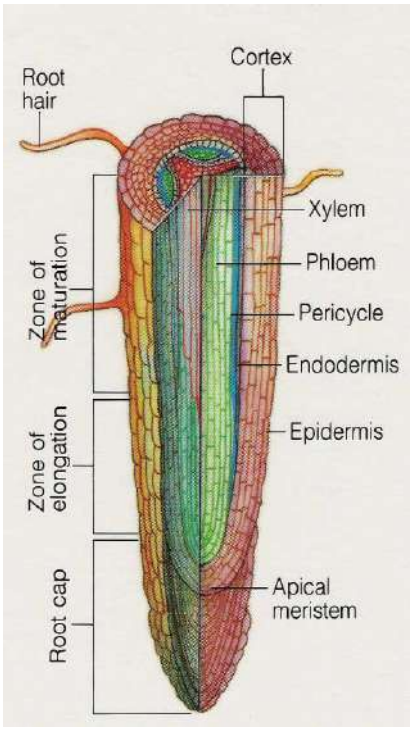
Large, thin-walled parenchyma cells make up the cortex of the root. These parenchyma cells store excess starch and transmit water and minerals to the interior structures.

Endodermis

The cortex and vascular bundles are separated by the endodermal layer, composed of closely packed single-layered cells. In young plants, the endodermis thickens to form a casparian strip which is impermeable to water thus preventing diffusion of materials across it. A few cells bordering the xylem vessels do not thicken and so form a passageway for materials. These cells, also known as gate cells, promote material exchange between the cortex and the core of the plant.

Vascular tissue

The pericycle, the first layer of cells which is directly beneath the endodermis, forms lateral roots and root cambium through its meristematic activity. The core of the plant includes xylem and phloem vessels separated by a layer of cambium.



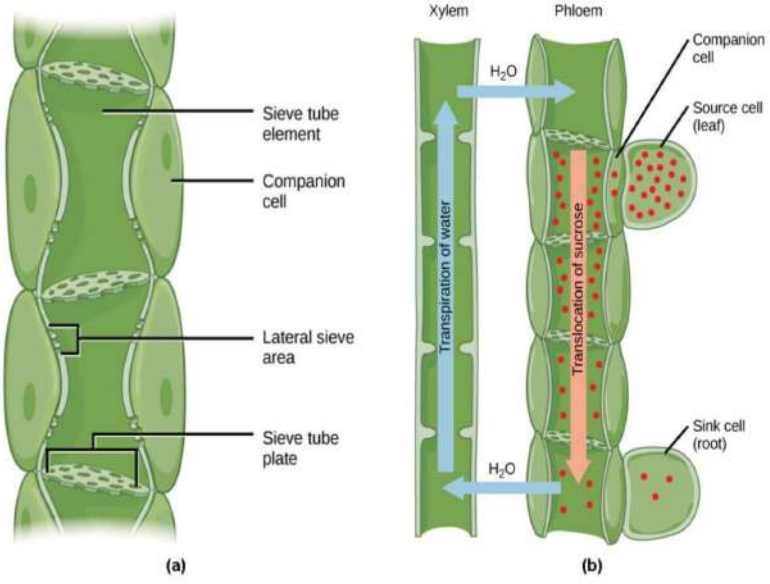


Figure: Water molecules diffuse from the outside of the root to the inside through the cortex, epidermis, pericycle and xylem vessels

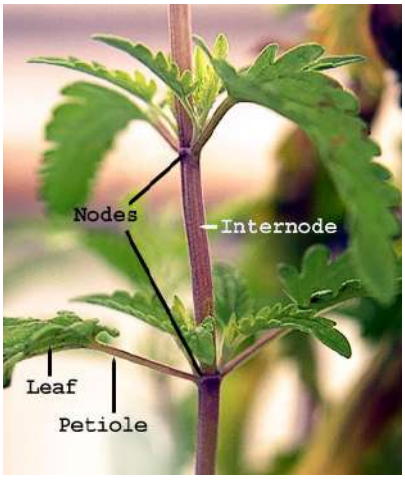


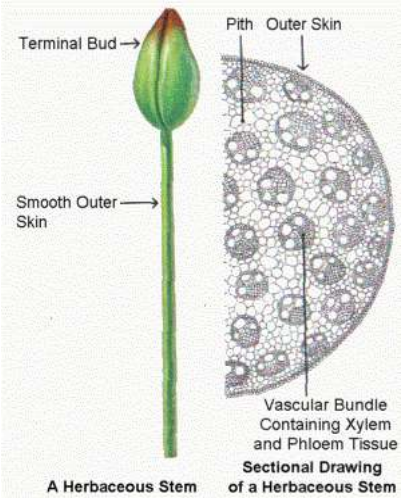
Figure: The leaves originate from nodes on the stem of the plant.

Stem

The stem is a structure that connects the root and leaves andis usually branched. Stems have vascular tissue that may be regularly or irregularly arranged. On stems, nodes are commonly found, especially lateral nodes. They are separated by internodes, tiny gaps between each node. They are peculiar to the stem and can not be observed in the roots. Stems can be classified as either herbaceous or woody.

Mature nonwoody stems are called **herbaceous stems**. They are soft and delicate and are kept erect by turgor pressure, which is a characteristic of herbs. Herbaceous stems are covered by a cuticle layer which prevents water loss. They exhibit only primary growth and contain chloroplasts. They are either annual (living for one growing season) or biennial (living for two growing seasons).

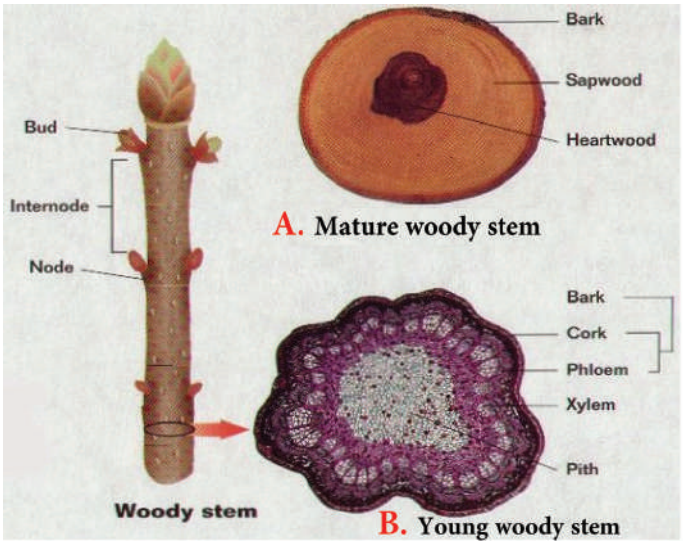
Annual stems lack a cambium layer around their vascular bundles. Because of this there is no secondary growth in these plants.



Most monocot plants are annual and don'thave a cambium layer. Their vascular bundles are scattered through the stem. Stems of monocot plants generally don't have a cortex layer.

In dicotyledons, the vascular bundles are located regularly at the core of the stem, which is surrounded by the bark. The xylem and phloem vessels are separated by a circular cambium layer. Xylem vessels are found near the core of the stem while phloem vessels are located in the outer portion of the cambium, between it and the bark.

The cambium functions as meristematic tissue, facilitating the division of cells and replenishment of xylem and phloem. In addition, it provides lateral growth. The annual rings are formed by the addition of new xylem vessels to the stem. An annual ring has both summer and winter sections. The summer ring is wider than that of the winter since growth occurs more rapidly during the summer. Furthermore, any injury to the stem is repaired by the cambium.



Some cells in the bark of woody plants gain meristematic tissue from a secondary cambium layer known as the cork cambium. Cork cambium provides protection for bundles and other tissues. Some cells of the cork cambium are specialized and rupture the epidermis to form a loosely arranged area called a **lenticel** which facilitates gas exchange in the stem, like the stomata in leaves.

Figure: (A) Cross-section of mature woody stem.
(B)- Cross-section of young woody stem.

Phloem vessels

Phloem vessels elongate from the roots to the leaves, very near to the outer section of the stem. They consist of many cytoplasmic guard cells, non-nucleated sieve plate elements, support and parenchyma cells. The sieve tube elements are closely packed cells. There are some spaces, called sieve plate tubes,which connect them to each other.The organic molecules synthesized in-the leaf of the plant by photosynthesis are carried downward and nitrogenous compounds synthesized at the roots are transmitted by means of the phloem vessels. The rate of transportation is slower than in the xylem vessels since the phloem vessels are living.

Xylem vessels

The xylem vessels stretchfrom the roots to the leaves and are located at the core of the plant. They are composed of tracheids, schlerenchyma and parenchyma cells. The cells at the outer portion of the parenchyma cells are nonliving. The xylem cells enlarge and bind to each other to form pipe-like vessels. Water and minerals absorbed by the roots are transported via the xylem vessels to the leaves. The rate of transportation is rapid since the xylem vessels are nonliving. Transportation occurs against the force of gravity.

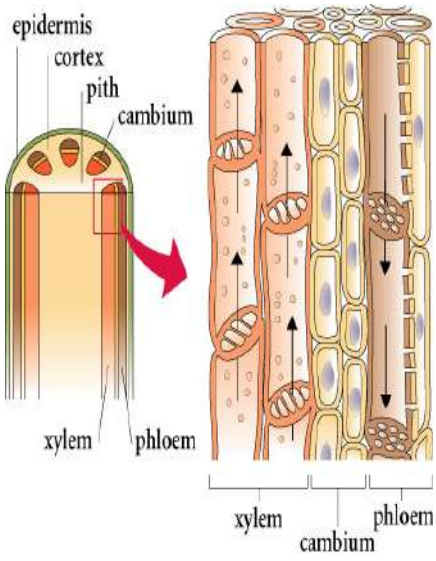


Figure: Transverse section of a dicotyledon stem.

Modified stems

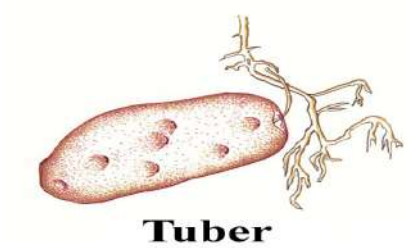
Stems may have different characteristics according to their functions. Some plants,such as the potato, have underground stems which develop into tubers and function as a storage site. Ferns and grasses also have stems beneath the surface of the soil, known as rhizomes.

Stolon

Stolons are slender stem-branches running horizontally away from the main plant, either above or below ground. Stolon shave nodes, and these nodes are capable of taking root and forming a new plant. Plants with stolons, such as **strawberrys** clone during springtime by producing stolons around the mother plant.

Rhizome

At first glance rhizomes are like underground stolons, but there's an important difference between them: Each stolon is just one of what may be several stems radiating from the plant's center. Rhizomes, in contrast, are the main stem. If a tree grew with its trunk horizontal below the ground, with its side branches emerging above ground, the buried trunk would be a rhizome. The thick, fleshy "roots" of **irises**, **cannas**, and **water lilies** are actually rhizomes. So are the whitish, thumb-thick items at the right.


Tuber

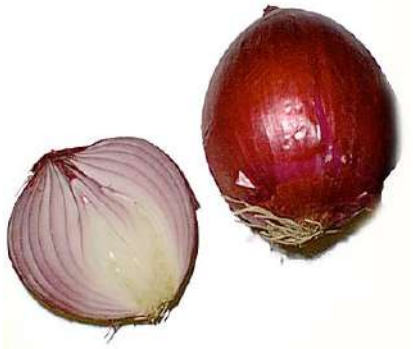
Tuber

Tubers, such as the ordinary **potato**, are often thought of as roots. However, as we've just said, roots don't have buds, and that's exactly what you see sprouting on the potato, arising from the potato's "**eyes**." Tubers are actually swollen portions of underground stems. Stems have nodes and buds arise at nodes. This type of plant stem is specialized for food storage.

Saffron

Corm

Corms are unlike stolons and rhizomes because they usually grow vertically, instead of lying horizontally. They are unlike tubers in that tubers are typumbilical cord, while corms constitute the below-ground "heart" of the plant, the part from which aboveground stems and leaves directly sprout. In the corm, notice the horizontal bands running across it. These are stem nodes such as those so conspicuous on the bamboo stem. **Gladiolus, crocus**, and **tuberous begonias** all arise from corms.

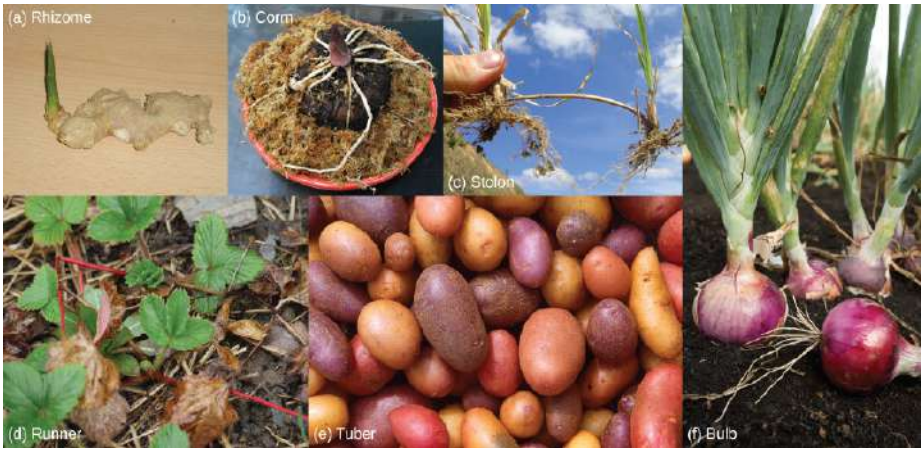


Bulb

Bulbs can be considered to be very short stems encased in thickened, fleshy bulb scales (which are modified leaves). The two basic bulb types are layered and scaly. Layered bulbs are composed of a series of fleshy scales that form concentric rings when the bulb in cut in cross-section. **Onions** and **garlic** are layered bulbs. Scaly bulbs, such as the **lily** bulb, have fleshy bulb scales, which are modified leaves, loosely clustered around the stem base. In contrast, each section or "scale" of a scaly bulb is a modified thick and fleshy leaf. The scales serve as sites of food accumulation. In the spring, when the lily stem shoots up from the center of the scale cluster, it will draw its food from the scales.

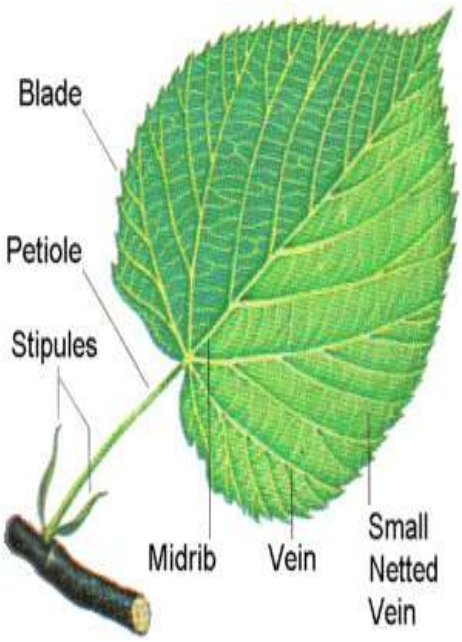
Water-storing stem

These stems are specializing in storing water for use between rains. They become very fat because of water accumulation. They act as a reservoir for the long dry periods they have to endure. The most famous such stems are those of the cacti. Other common potted plants with water-storing stems are the **spurge, purslane** and **milkweed**.



Leaf

Leaves are structures which develop from lateral buds on the stem of a plant. The leaf of a dicotyledon consists of a leaf stalk and a leaf blade. Thewide surface area of the leaf blade is important for the efficient absorption of sunlight. In some plants,leaves are ribbon-like: straight-sided with parallel veins. In contrast,some other plants have net-veined and rough-sided leaves.



The presence of a wide surface area enables a large quantity of light to be absorbed. However, it also provides a large area from which water can be lost. Plants have some adaptations to prevent water loss from leaves.

Desert plants combat water loss by reducing the surface area of their leaves to a minimum. As a result, their leaves are needle-shaped and their stomata are located on the stem which is also the site of photosynthesis. Pine trees growing in arid climates also have similar needle-shaped leaves. Each leaf is covered by a thick layer called the **cuticle** and has many hair-like structures. The stomata are buried in the lower epidermis to prevent water loss. These adaptations all help to prevent water loss in plants.

Unlike desert plants, those living in moist or wet habitats have fragmented leaves with a wide surface area and extensive veins. The leaves are covered by a thin layer of cuticle and the stomata are distributed randomly over the surface of the upper and lower epidermis. Hydrothodes, located at the edge of the leaves, facilitate water loss by guttation (the extrusion of water as drops). In humid environments, the air is too saturated with moisture for water to be lost by transpiration. These plants additionally excrete excess salts and water by means of guttation. Guttation is peculiar to humid environments since plants excrete excess water in the form of water droplets if water uptake from the roots exceeds the amount used.

All these adaptations indicate that provisions against water loss are not necessarily due to the absence of water in their surroundings.

2. The Anatomical Structure of the Leaf

The following prominent layers are observed under a light microscope when a leaf is cut in cross-section:

- Cuticle layer
- Epidermal layers
- Mesophyll layer

I. Palisade parenchyma
II. Spongy parenchyma

- Vascular bundles

a. The cuticle layer

The **cuticle layer** is a waxy material which covers the leaf surface and prevents water loss. The cuticle layer is transparent, therefore sunlight can pass through it but water loss is prevented. Its thickness is directly related to environmental conditions. It is thick in hot, arid climates and thin in moist, aquatic habitats.

b. The epidermal layers

Epidermal tissue forms the upper and lower surfaces of the leaf and comprises a single layer of epidermal cells. Epidermal cells lack chloroplasts and are consequently non-photosynthetic. The upper epidermal cells secrete waxy substances to form a layer of cuticle. The holes in the epidermis or the stomata give it a rough appearance. The stomata provide the pathways for gas exchange and water regulation in the plant.

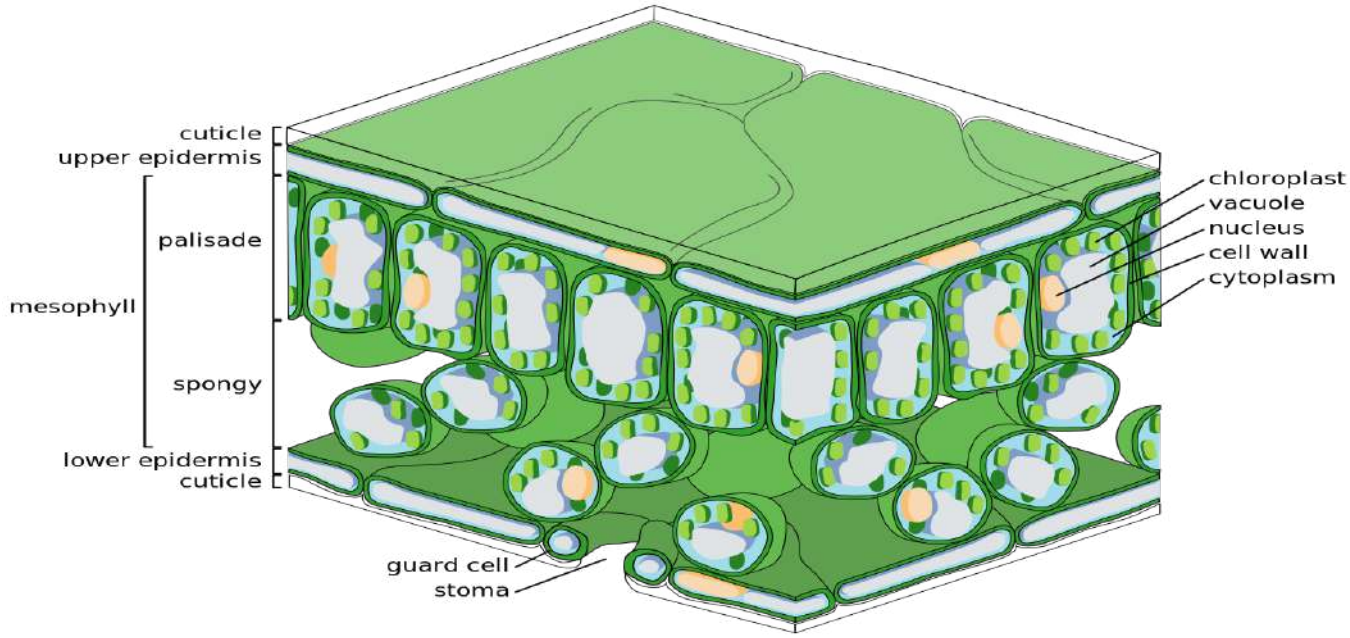


Figure: Transverse section through the leaf of a dicotyledon.

c. The mesophyll layer

The layer between the upper and lower epidermis, known as the **mesophyll layer**, comprises palisade and spongy parenchyma cells. The cells of this layer are photosynthetic.

1. The palisade parenchyma is comprised of long, cylindrical, closely packed cells, which are vertically ordered just below the upper epidermis layer. The rate of photosynthesis is very rapid due to the high amount of chloroplasts in these cells.

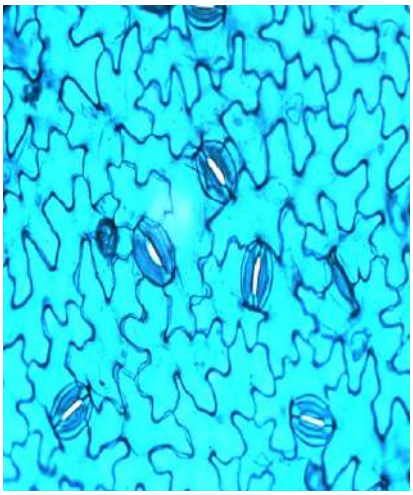
2. The spongy parenchyma is located above the lower epidermis layer and is made up of loosely packed cells with air spaces that give it a sponge-like appearance. Furthermore, these air spaces are in close proximity to the stomata enabling gases to diffuse easily in or out of the leaf. Additionally, these cells contain fewer chloroplasts when compared to palisade parenchyma.

d. The vascular bundles

The vascular bundles consist of xylem and phloem vessels which transport waterfrom root to leaf and organic materials from leaf to root.

Stomata

The cuticle layer forms an incomplete covering over the surface of the leaf. If coverage were total, transpiration and gas exchange would be prevented. Consequently, metabolic activities would be reduced to a minimum and the plant would probably not survive. Since the stomata lack a cuticle they can open and close to carry out gas exchange and transpiration. If there is sufficient water within the leaf, CO_2 molecules diffuse out through the stomatal openings.



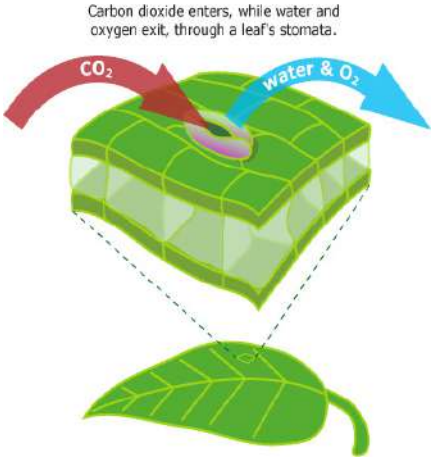
Each stoma structurally resembles a pair of bean-like cells which are specialized don't. The inner walls of guard cells are stronger than the outer walls. The difference in thickness of these walls plays an important role in opening the stoma.

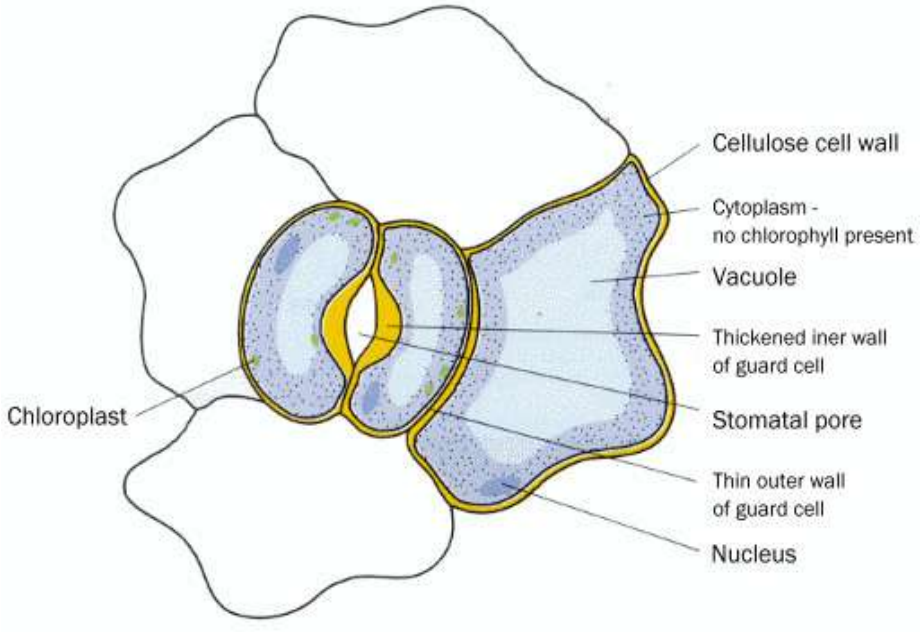
a. Stomatal Distribution in Different Types of Leaves

- Stomata are equally distributed over the upper and lower epidermis in erect leaves. Examples include the onion and the lily.

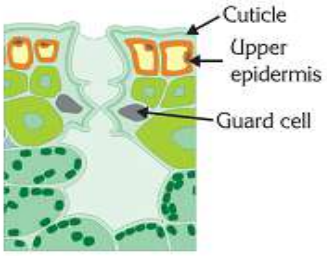
- Stomata are present in greater numbers on the lower surface in lateral leaves. This property prevents accumulation of dust and rain water on stomatal openings. Some examples include the leaves of apricots, plums.

- In the case of aquatic plants that live on the surface of the water, the stomata are located only on the upper epidermis; for example, the water lily

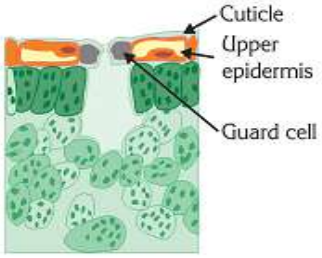




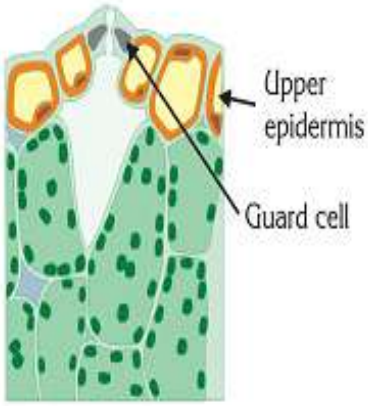
Plant Stomata Structure



Lower case stoma



Normal stoma



b. Adaptation of plant stomata to different climates

The stomata are located in different positions within the epidermal layer for adaptation to different climates. Location of stomata affects the amount of water lost by traspiration. They are classified as follows, according to their location.

Lower case stoma

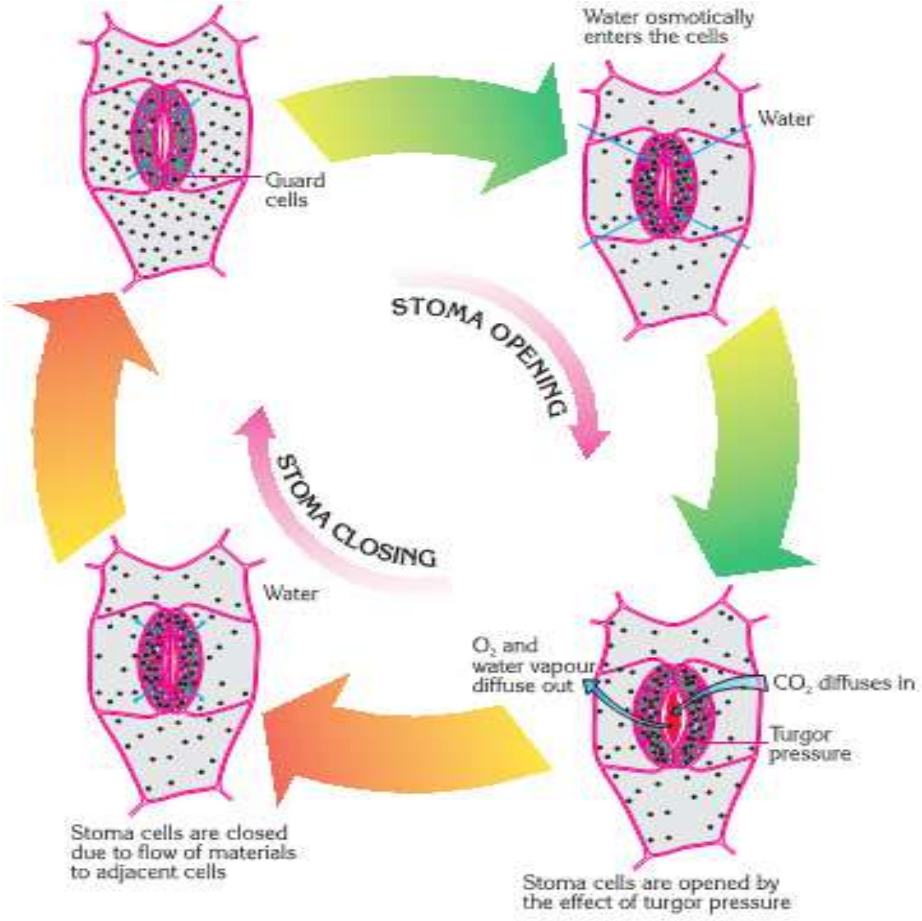
In arid climates, the stomata are found deep in the epidermal layer and are covered by an air space and stomatal hairs at the level of the epidermis. These features protect stomata from the effects of wind and temperature by reducing the level of transpiration.

Normal stoma

At normal relative humidity and temperature, stomata are at the same level as the epidermis.

Upper case stoma

In plants living in areas of high relative humidity and temperature, stomata are found in an uppermost position and are therefore considerably affected by wind and temperature. This results in a high transpiration rate.



9-5 Flower

Flowers are the reproductive shoots of flowering plants and are composed of the following parts:

- Pedicel	- Receptacle	- Perianth
- Calyx (Sepals)	- Corolla (Petals)	- Stamen (Androecium)
- Filament	- Anther	- Pistil (Gynoecium)
- Stigma	- Style	- Ovary

The flower is attached to the plant by the flower stalk, also known as a pedicel. Directly above the pedicel is a bulb-like structure known as the receptacle. All the floral parts are attached to this structure. In addition, the receptacle may be involved in the secretion of nectar, a sugary fluid that provides an energy source for insects

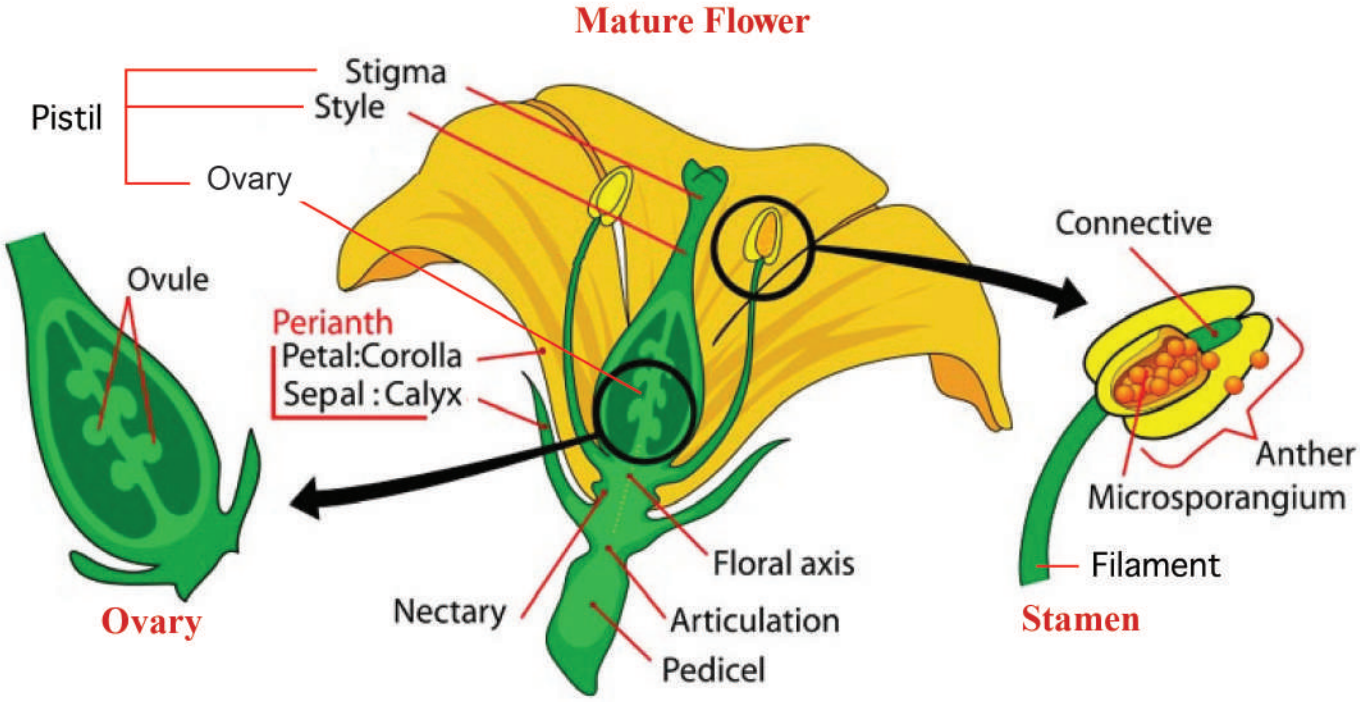


Figure: Parts of a flower

a. The Perianth

The parts comprising this structure have no function in the production of gametes. It protects the reproductive organs and in some cases attracts pollinators.

Sepals

While a flower is developing within a bud, it is fully surrounded and protected by a ring of small, greenleaf-like structures known as sepals. They are collectively called the **calyx**. Once the bud opens, the petals emerge and perform the same function.

Petals

They are leaf-like in structure and are generally brightly colored. They are collectively known as the **corolla** and protect the reproductive organs of a mature flower. The petals of plants that are insect pollinated are brightly colored and produce an attractive scent. A nectary at the base of each petal produces a sugary solution known as **nectar** and it is during nectar collection that pollination takes place.

b. Stamens

The stamens are the male reproductive organs of the flower and are composed of **filaments** and **anthers**.

Anther

Each anther is composedof four pollen sacs containing **pollen grains.** The grains are haploid and contain the meiotically produced male gametes. The sacs then burst and release spherical yellow pollen grains.

Filament

Its function is to raise the anther into the air so that its pollen can be dispersed by the wind or by an insect. It consists of a narrow stalk containing a vascular bundle.

c. Pistils

The pistil is the female reproductive organ of a flower. It is generally composed of three structures: a **stigma**, a **style** and an **ovary**.

Stigma

It is a specialized area located directly above the style and is the site of pollen reception and germination. During pollination season, the stigma may secrete sticky matter to trap pollen.

Style

It is a tube-like structure connecting the ovary and the stigma. Pollen tubes pass down through the style to the ovary.

Ovary

The ovary is a spherical structure at the base of the pistil and is formed by infolded leaves known as **carpels**. Usually at least several carpels join together to form a single ovary.

Fruits

A fruit develops from the ovary wall after fertilization. Flowering plants form fruits in order to protect the seed and to assist dispersal to colonize new areas away from the parent plant. They are classified according to their structure.

a. Simple Fruits

Simple fruits are formed from the wall of a single ovary, of a single flower. There are two types of simple fruits, fleshy fruit and dry fruit. In fleshy fruits the pericarp (tissues) are soft at maturity as their water percentage is high. Dry fruits contain less water at maturity so their pericarp is not fleshy.

b. Aggregate Fruits

Aggregate fruits are formed from an individual flower containing many separate carpels,eg. **raspberry** and **blackberry**.

c. Multiple Fruits

A multiple fruit (e.g., **pineapple**) develops from the ovaries of many flowers growing in a cluster.

d. Accessory Fruits

Accessory fruits contain tissue derived from plant parts other than the ovary; the **strawberry** is actually a number of tiny achenes (miscalled seeds) outside a central pulpy pith that is the enlarged receptacle or base of the flower. The best-known accessory fruit is the pome (e.g., apple and pear), in which the fleshy edible portion is swollen stem tissue and the true fruit is the central core.

SELF CHECK

PLANT ANATOMY

A. Key Terms

Root cap
Rhizome
Stomata
Sepal
Cotyledon
Tap root
Epidermis
Stolon
Petal
Simple fruit
Testa

B. Review Questions

1.Explain the tuber briefly?

2.Explain stomata distribution in different leaves?

3.Whatare the factors affect on transpiration?

4. Draw a flower and name the parts of it?

5.Give an example for each type of fruits?

C. Fill in the blanks

1. A fruit develops from the ..... wall after ....
2. The ..... are the male reproductive organs of the flower.
3. The rate of photosynthesis is very rapid due to the .....
4. Sepals are collectively called as ..... and petals are collectively called as .....
5. Pollen grains are formed in .....

D. True or False

1. The pistil is the female reproductive organ of a flower.
2. The stomata are located in different positions within the epidermal layer.
3. Annual stems lack a cambium layer around their vascular bundles.
4. The stomata provide the pathways for gas exchange and water regulation in the plant.

E. Multiple Choises

1. Which kind of modified stems specialized for food storage?

A) Stolon
B) Rhizome
C) Tuber
D) Corm

2. Which part of flower contain pollen grains?

A) Pistil
B) Anther
C) Receptacle
D) Ovary

3. Which one of the following is an example for multiple frits?

A) Blackberry
B) Apple
C) Pineapple
D) Egg plant

4. Herbs kept eract by .....?

A) Turgor pressure
B) Osmotic pressue
C) Xylem
D) Phloem

HUMAN AND BIOSPHERE

Environmental Problems

As mentioned previously, every organism is adapted to its living place (habitat).Humans are spread over large areas. In day-to-day life, humans are always interacting with the other living things in their environment. For the continuity of this relationship the ecological balance of the environment must be preserved, but humans frequently use and damage the environment to grow more food, make more shelter and to advance technology.

The environmental system is in balance which ensure the continuity of its living and non-living components, until the second half of 20^{th} century the situation continued in the balance between input matters and output matters, the example of input and output matters are gases, water, salts, energy and different wastes.

But great increase in population, scientific and technological revolution are some modern features of our living century that cause the increasing of natural and manufactured matters that pollute the environment which caused by human activities, the modern economic development, however, sometimes disrupts nature's delicate balance.

Pollution can be defined as the introduction of unwanted or harmful substances into the environment. Pollution caused by human activity has resulted in the extinction of various species of organisms on earth, like the dodo bird and the dusky seaside sparrow.

Oxygen is essential for the survival of living things. Oxygen is necessary for respiration and the oxidation of organic substances, and is used in the burning (oxidation) of coal, wood and gas. The atmosphere is 21% oxygen, and 5 % is dissolved in the hydrosphere. The oxygen in nature is produced as a result of photosynthesis. Oxygen also makes up the ozone layer, ozone (O_3) being released as a result of the photolysis of water.

Water pollution

Water is one of the most essential necessities of life. All organisms, including humans, need water to live. The hygiene of drinking water is important for health. Factories constructed near rivers and lakes pollute the water. The ecological balance is disturbed. Some organisms die while others carry toxic chemicals in their bodies. Most of the countries are suffering from the pollution of their seas, lakes, rivers, and the running water, which is suitable for daily use.

This problem is referred to many reasons:

- Contamination caused by living compounds that cause disease.
- Organic and inorganic compounds that are discharged by factories and house sewerage cause contamination.
- Heat contamination produced by the nuclear- reactor cooling and discharged the factory hot water into the rivers and lakes.
- Kinetic pollution is produced by the movement of boats and ships or from damps.

All the mentioned above cause diminishing (to eliminate) the oxygen rate in the water that effects the well being of all living things in water and encourage the microorganisms like in terrestrial organisms.

The hygiene of fresh water is important for health. Only half of the world's population has access to clean water. Especially in Third World countries, people have to drink water from the places where sewage is dumped. People drinking water from these sources are vulnerable to contagious diseases like cholera, diarrhea, and typhoid.

Soil pollution

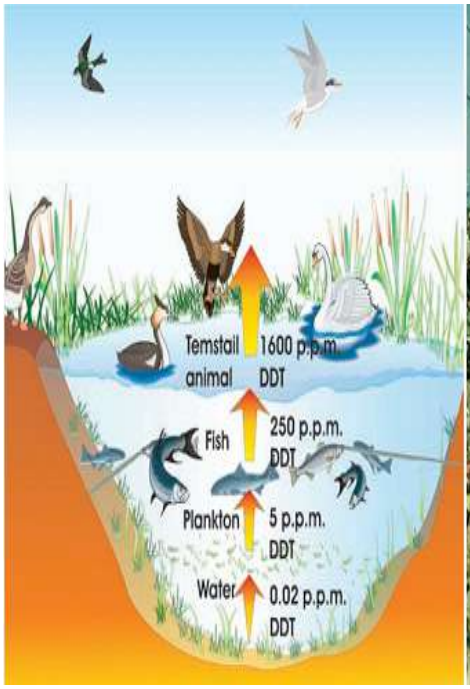
Many chemical compounds pollute soil. These pollutants are transform to the soil by **irrigation**, **rain**, and **wind**. Also pollution may occur as a result of using pesticides or from factories waste (gases, radiant, and chemical wastes plastic, metals, wood, paper, packages). They are dissolved in soil and the plants absorb them and then they enters into their tissues.

When the animals are fed with such plants, the pollutants will be moved to animal tissues as well. These can be transferred to people as a result of feeding from such plants and meet and dairy food from such animals.

Pollution of soil with agricultural chemicals

Most agricultural chemicals are water-soluble nitrates and phosphates that are applied to fields, lawns and gardens to stimulate the growth of crops, grass and flowers. The chemicals that are used as **insecticides** include arsenic, mercury and lead, which are highly toxic. Insecticides, since they remain in soil, enter the food chain and poison humans. DDT, which is not biodegradable, and other similar insecticides, accumulates in the fatty tissues of organisms. DDT causes liver cancer, nerve damage, reproductive malfunctions, and death in birds. The effect of DDT is more significant in organisms higher in the food chain.

Herbicidal chemicals, used widely to kill weeds and clear land, also have side effects. America poured 72 million tons of herbicide onto Vietnam to open paths through the jungle during the war from 1961 to 1971. The herbicides, dispersed from airplanes, contained dioxin, a general name for a family of chlorinated hydrocarbons. In the years following the war, high rates of stillbirth and premature birth were observed among the Vietnamese. Since similar effects were seen among the American soldiers, the herbicides were investigated. As a result, it was concluded that dioxin causes genetic changes–mutations. At present the use of chemicals containing dioxin is banned.



The transmission of a toxic substance from one organism to another in a lake ecosystem. These chemicals (e.g. DDT), tranmitted through the food chain but not used in metabolism, accumulate at the end of the chain. Because these chemicals are not metabolized and removed from the tissues, they accumulate in the body. Consequently, the organisms most harmed are those at the end of the food chain.

Air pollution

The tiny layer surrounding the globe is the basic source of air that all living things need and depend on it to carry out their life process. Air contains different gases that they have stable ratios, such as

Oxygen is 21%,
Nitrogen is 78 %,
Carbon dioxide is 0.03%
Nobel gases is %1 such as (Argon, Helium…etc)

Vapor water that range between 1% in cold and dry air to 4% during humid seasons in the tropical areas.

Any change in the rate of air contents with foreign particles that are contained in air cause the contamination of air.

The Earth is continuously exposed to sunlight that heats the lower layers of the atmosphere. The temperature of the upper atmosphere is lower than the temperature of the lower atmosphere. Air in the lower atmosphere warms and rises, and is replaced by cold air. Accordingly polluted air rises with air currents and spreads all over the world. In this way air pollution from industrialized countries affects other countries, too. Low quality fossil fuels and exhaust released from vehicles are the main sources of air pollution. Though such pollution is temporary, if it stays longer in the air, it may cause death.

Carbon Monoxide (CO)

Every year 350 million tons of CO is released into the environment. The major source of atmospheric CO is exhaust gases. Carbon monoxide is a toxic gas. It binds to hemoglobin strongly in the lungs and prevents the binding of oxygen. The decrease of oxygen transport to the tissues results in headache, lethargy and giddiness. If the concentration of CO exceeds 1% it is fatal.

Mercury (Hg)

Mercury vapor is released into the air from the burning of coal and gasoline, mining and the smelting of mineral ores. Increased mercury level in the air causes damage to and malfunctions of kidneys and nerves, and death.

Lead (Pb)

Lead vapor, as in the case of mercury, is released into the air by man's modern industrial activities. The main source of lead in the air is exhaust gas. Lead is added to gasoline to increase engine efficiency. Lead builds up in plants and causes the pollution of food. The symptoms of lead poisoning are giddiness, extreme fatigue and depression.

Chlorofluorocarbons (CFCs)

Chlorofluorocarbons affect the earth's ozone layer.

Acid Rain

Normal rainwater has very little acid. Acids in the air react with water vapor and form carbonic acid (H_2CO_3). The pH of normal water is around 5.4. Emissions of sulphur dioxide and oxides of nitrogen from power stations, factories, and motor vehicles cause the formation of sulphuric acid and nitric acids in rain clouds. If rain falls through polluted air it picks up more of these gases and increases its acidity. Acidic clouds may be carried away by air currents. When rain falls from acid clouds, it causes a real environmental catastrophe. For this reason every country must be sensitive to this issue and take preventive measures. Acid rain is carried from soil to rivers, streams and lakes.The effect of acid rain is greater on the lakes than the rivers and streams. It increases the acidity of the lake water and the ratio of metal salts. As a result, natural life is threatened.

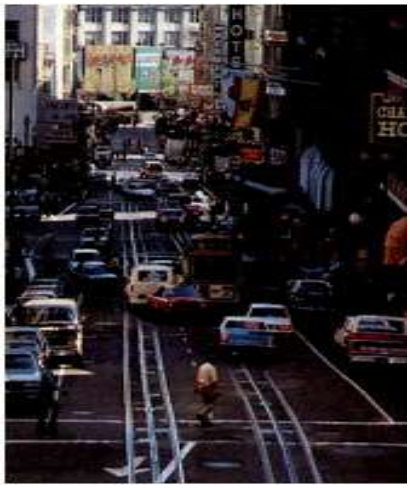
Figure: Sulfuric acid and nitric acid are produced from SO_2 and-NO_2 gases that are released into the air and mix with water vapor. When this solution falls as acid rain, it causes damage to all organisms and the environment.

Noise pollution

Sound is such a common part of everyday life that we often overlook all that it can do. It provides enjoyment, for example, through listening to music or birdsong. It allows spoken communication. It can alert or warn us, say, though a doorbell, or wailing siren. Sound is a part of life. In natural conditions, bird, wind or water sound doesn't disturb us. But the sounds that we call noise disturb humans both physiologically and psychologically. Sound level is measured in decibel (dB). The limits of noise are not certain. But sound between 35-65 dB is psychologically disturbing; between 65-90 dB is peace disturbing; and higher than 90 dB is physiologically harmful noise.

According to its source, noise falls under one of three headings: **transport (traffic) noise, industrial noise** and **social noise.** Transport noise comes mainly from trains, planes, cars, buses, trucks, and motorbikes, and each of these produces noise in a variety of different ways. All of these vehicles make noise because of the friction force between their metal parts and with the air. Social noise includes the noises made by people in parks and at sporting events, as well as radio and TV sounds. Intense noise may rupture the eardrum and cause hearing problems. People living in areas with high levels of noise may experience hypertension, a fast breathing rate, and a high pulse. In addition, noise causes stress, discomfort, anger, and behavioral problems. In noisy workplaces efficiency decreases and attention problems increase. We can control noises by:

- Protecting the human ear by ear covers.
- Using sound insulation protection.
- Eliminating the noises by oiling the machines and using the less noisy machines planning the residential areas away from airports, factories, and high ways.



Noise pollution, human - created noise harmful to health or welfare. Transportation vehicles are the worst offenders, with aircraft, railroad stock, trucks, buses, automobiles, and motorcycles all producing excessive noise. Construction equipment, e.g., jackhammers and bulldozers, also produce substantial noise pollution.

Figure: The consequences of the Chernobyll accident have been disastrous. A patient that contracted cancer as a result of the explosion is shown. There are also chronic effects of radiation in addition to its acute effects. As seen in the picture, the genetic structure and development of all organisms living and born in that region are affected. Two significant examples of this are the Hiroshima and Nagasaki cases, and the explosion at Chernobyl.

Radiation

Radiation is the process in which energy is emitted as particles or waves. The sun radiates energy continuously. Light coming to the earth is in three groups: ultraviolet light (UV), white light and infrared light. Ultraviolet light has a very small wavelength and high energy level. Therefore, it is dangerous to human health.

The ozone layer reflects most of the UV light before it reaches the atmosphere. Only 2% passes through. An increase in this amount causes certain illnesses like skin cancer. Like solar radiation, underground and underwater deposits of radioactive rock are a natural source of radiation. On the earth uranium (U-235 and U-238), thorium (Th-232), potassium (K-40), strontium (Rb-87) and other radioactive substances are found. When these molecules decay radioactively, energy is emitted. These processes are all natural and have been happening for thousands of years.

Radiation pollution exists because humans use radioactive substances. Modern life, though offering many benefits to humanity, brings many problems. The energy produced from dams and thermal plants was insufficient and people started using nuclear power, the fission of radioactive isotopes, to produce energy. After the discovery of nuclear energy, scientists looked for ways to use it. Nuclear tests were conducted in the Nevada deserts of America, the deserts of Kazakhstan and in the Pacific Ocean by France. In these tests, radiation was released into the atmosphere. Especially in areas near these places the air, water and soil is highly polluted. These radioactive substances are carried away to the other places as well.

Also these countries made ships, submarines and aircraft carriers that run on nuclear energy. They are very efficient economically, but in the event of an accident, malfunction, or technical problem they are a potential threat to the environment and humanity. Nuclear energy is also used to make bombs. Radioactive isotopes are used in medicine and biological research. The substances used in these fields must be handled and disposed of carefully.

Effects of Radiation

Radiation affects the environment both physically and biologically. Nuclear trials and explosions spread dust and smoke which block sunlight. Moreover, the air temperature under the dust layer plunges because the dust blocks the sunlight. As a result there will be serious changes in the climate. The biological effect of radiation is the damage to living things. The sensitivity of organisms varies from species to species. For example, insects are more resistant to radiation than birds and mammals. Grasses are more resistant than broad- and needle-leaved plants.

Measures Against Environmental Pollution

Some measures that can be taken to reduce the dangers described are given below.

- The waste from factories should be recyclable. In this way we can save the raw materials and also prevent the pollution of the environment.

- Fossil fuels used in heating should be high in calor ies and low in toxic substances so that air pollution is reduced.

- Chimneys of factories and houses, and exhausts of cars should have filtering devices to reduce toxic substances in the air.

- Tree planting should be encouraged so that the gas balance in the atmosphere is maintained and air pollution is reduced.

- Recyclable materials should be collected and used again

- Recyclable materials should be used as much as possible.

- And, most importantly of all, everyone should be trained to be aware of environmental problems.

Carbon dioxide concentrations in aquatic environments are quite different from those on land. Carbon dioxide easily dissolves in water and forms carbonic acid (H_2CO_3), which ionizes to H^+ and HCO_3^-. These ions determine the pH of water.

Humans and environment

Improvements in the areas of genetics, energy, and chemical synthesis will provide the needed steps for advancements in agriculture and food. Genetically engineered food (which is already on the market) will only increase as scientists and engineers come to a better understanding of genetics. More efficient energy sources may allow for easier food production locally as well as cheaper methods of harvesting and allow for cheaper irrigation and water pumping.Chemical synthesis may allow for better pesticides, fertilizers,
and even soils for growing crops.

Human, like other organisms, are participants in the food chain and part of the balance of nature. Like other heterotrophs they eat, excrete and need heat and shelter. All of these necessities are met by nature. However, the technology developed by humans for a better and more comfortable life can adversely affect the environment and may damage the ecological balance on earth. The advantaaages and disadvantages of agriculture will be discussed in the following articles. Humans also cut and process trees to make houses, furniture, paper nd decorative products. As a result of the timber industry and fires, forests are destroyed, causing air pollution and erosion. The activities of humans sometimes damage the ecological balance of nature. Industrialization produces benefits for people, and problems for the ecological balance.

Agriculture

The rapidly growing world population has brought food problems to the agenda. New methods in agriculture and stock-breeding are developed and used to produce food more abundantly. In cereal-grain agriculture, artificial fertilizers are used to produce a larger harvest in a shorter time. Insecticides are used against insects and herbicides against weeds to kill them and protect the crop. The use of technology to increase productivity is called **intensive agriculture**. Scientists and engineers have developed new systems to reduce the costs of intensive agriculture. The side effects of these methods are not understood until later. In stockbreeding, animals are fed special foods in a closed place. Since the animals move very little and gain weight, they are butchered sooner. Fattening livestock for market increases the cost of their meat.

Figure: Regular irrigation increases the quality and efficiency of agriculture, but irregular irrigation causes more problems than it solves, even causing aridity of the soil and reducing efficiency

Irrigation

One of the most important requirements of agriculture is water. Especially in arid places, it rains at some times of the year and it is dry at others. Dams are built to save water in arid places. Water collects behind the dams and is used for irrigation. With the proper use of irrigation, a larger harvest is possible. Despite the advantages of irrigation, excess irrigation brings some dangers to the environment.

- Irrigation drains minerals away from the soil through leaching.
- Salt present deep in the soil dissolves in the water and rises up, causing the soil to become salty and dry.
- Microorganisms carrying contagious diseases are spread through irrigation canals.
- Fresh water fish and, in turn, the food chain are affected.

The Effects of Mechanized Agriculture on Natural Life

The transition from simple agricultural tools to modern agricultural methods started with the Industrial Revolution. The use of modern agricultural machines has decreased the human effort required, while the quality and performance of the product has increased. Though there are a lot of advantages to using agricultural machines, there are some disadvantages as well.
Some of these are stated below.

- Since modern agricultural devices cannot be used in narrow fields, these fields were widened by cutting trees.
- Some species were destroyed or became extinct as a result.
- The weight of the machines compresses the soil and decreases its permeability for water, causing the accumulation of water above the soil.
- The use of modern agricultural machines increased the costs and the sale prices.
- With the removal of ecological boundaries, natural events like wind and flood cause erosion and evaporation of excess water.

Figure: Certainly agricultural tools have reduced the work of people and increased their efficiency. When these tools are used according to regulations, soil erosion and excess evaporation can be prevented. There are, however, disadvantages to using these tools.

Monocultivation (Growth of the same product every year)

Since every agricultural product has a different price in the market, farmers tend to grow the crops that bring more money. Accordingly, farmers may grow the same crop every year. The advantage of growing the same crop every year is the ability to use the same machines. In this way the cost of mechanization and labor falls.

The disadvantages of monocultivation are: Since the same species is grown every year the same minerals are removed excessively, which causes the soil to become arid. Though this condition is compensated for by the application of artificial fertilizers to the soil, the cost increases. The repeated growth of the same species boosts the insect population.

Artificial fertilizers

In this century, the use of artificial fertilizers started the green revolution. In most parts of the world arid areas are converted to agriculture fields. At the same time the productivity of the existing fields is increased. The elements C, N, O, P, H and K are very essential in the structure of organic molecules. Plants obtain C, H and O from air and N, P and K from the soil. The abundance of these minerals in the soil increases the quality of the products. Most of the fertilizers used in the world are of the N–P–K variety. In 1990, 20 million tons of NPK fertilizer were used around the world. The use of fertilizers increases not only the quality but also the costs, so it must be used efficiently.

Humans, like other organisms, are participants in the food chain and part of the balance of nature. Like other heterotrophs they eat, excrete and need heat and shelter. All of these necessities are met by nature. However, the technology developed by humans for a better and more comfortable life can adversely affect the environment and may damage the ecological balance on earth.

Fertilizers typically provide, in varying proportions, the threemajor plant nutrients (nitrogen, phosphorus, and potassium), the secondary plant nutrients (calcium, sulfur, magnesium), and sometimes trace elements (or micronutrients) with a role in plant nutrition: boron, manganese, iron, zinc, copper and molybdenum.

The benefits of artificial fertilizers:

- The use and storage of artificial fertilizers is easier.
- The type and dose of the minerals can be adjusted according to the needs of the soil.
- The soil can be planted and even provide more than one crop per year because it does not need to be left fallow.

- The drawbacks of artificial fertilizers:

- Since artificial fertilizers do not contain humus, the quality of the soil decreases gradually, becoming more susceptible to erosion.
- Excess use of fertilizers is a waste of money and energy.
- Rain leaches soluble substances from the soil. Excess fertilizer is carried away to rivers and lakes. The transport of nitrate and phosphate fertilizers to lakes and rivers causes the destruction of natural life. If the nitrate solution seeps into drinking water, it may threaten human life. The cultivation of crops like wheat and barley enables the efficient use of fertilizers without waste.
- Artificial fertilizers disrupt the structure and texture of the soil, gradually making it more difficult to cultivate.
- Since the mineral concentration increases in the soil, plants can't absorb water through their roots. This condition may cause the death of the plant.

Use of Herbicides in Biological Struggle

Mineral-rich soil is a suitable place for weeds as well as crops. Weeds compete with crop plants for light, water and minerals. The simplest method of fighting them is to dig them up. Since this takes too much time and effort chemicals are used to kill them. The chemicals, called herbicides, kill the weeds and save the crops. The herbicides target the broad-leaved plants to kill. Small-leaved crops are not killed by the herbicides. Not all herbicides are selective–some of them kill other organisms as well. The use of selective herbicides is one of the inevitable methods of modern agriculture.

Otherwise the amount and quality of the harvest will decrease. Insects, weeds and disease destroy one-third of the world's total agricultural production. Insects rank first among these. For example, weevils are a real nuisance in wheat fields. Potato beetles attack tuberous plants like potatoes. Insects are killed with certain chemicals called insecticides. There are also beneficial insects that provide pollination. They must be saved while killing the others.

Erosion and forests

The richness of the composition of the soil is very important for the growth of plants. Soil, a thin layer on the uppermost part of the earth's surface, is enriched by the activities of decomposers that break down the remains of dead plants and animals. But rivers and floods wash away this productive layer. Trees that block and lower the speed of the water, and hold the soil with roots protect the soil layer. A feature of forests more important than soil conservation is the maintenance of the oxygen balance of the earth. The thoughtless and negligent cutting of forests, the oxygen tank of organisms, threatens the future of all living things.

Energy

Energy is an inevitable part of our lives. Transportation, heating, illumination and other activites like the use of houshold electrical devices demand electricity. Excess dependence on electricity has forced scientists to look for alternative energy sources. Countries prepare and apply their energy policies according to the needs of their economies and their reserves of natural resources. Countries with many rivers produce hydro-electricity. Even though dams cause the least damage to the environment, they alter the natural water cycle and flood plain which consequently results in climate change. As a result of climate change, some species decrease in number or disappear, while other species reproduce more and increase in number. The reclamation of the area around the dam takes a long time.

A nuclear power plant (NPP) is a thermal power station in which the heat source is one or more nuclear reactors generating nuclear power. Nuclear power plants are base load stations, which work best when the power output is constant (although boiling water reactors can come down to half power at night). Their units range in power from about 40 MWe to over 1000 MWe. New units under construction in 2005 are typically in the range 600-1200 MWe.

Some countries use coal, natural gas, oil and other fossil fuels to produce electricity. The smoke and gases that are released as by-products of the burning of fossil fuels pollute the air. Consequently natural life is affected and ecosystems change.

The most dangerous but the cheapest and most effective energy source is nuclear energy. Many countries use energy produced in nuclear power plants, especially countries without reserves of fossil fuels and water. When they work without any problems, nuclear power plants are very economical, but they are a big potential threat to the environmen.

For example, the Chernobyl nuclear plant was providing electricity to a certain region of the Ukraine. An exercise conducted carelessly caused the reactor to explode. This disaster adversely affected the Ukraine and the effects are still visible. The explosion and dispersion of radiation affected other countries as well.

Industrialization

Natural life was preserved and the products and activities of man did not harm the environment until the end of the 1800s. The rapid development of technology as a result of the industrial revolution, which made life easier for humans in many respects, brought with it its own problems. The release of CO_2 from the chimneys of factories caused global warming. The nitrogen and sulphur exhaust from some factories caused air pollution.

Moreover, man-made substances remain in the environment for a long time and don't recycle for many years, if ever. The release of these products into the environment brings water and soil pollution.

The pollution that comes with industrialization doesn't affect only the industrialized countries but also affects other, under-developed countries as well.

Over-application of chemical fertilizers, or application of chemical fertilizers at a time when the ground is waterlogged or the crop is not able to use the chemicals, can lead to surface runoff (particularly phosphorus) or leaching into groundwater (particularly nitrates). One of the adverse effects of excess fertilizer in lacustrine systems are algal blooms, which can lead to excessive mortality rates for fish and other aquatic organisms.

Nuclear power plants are classified according to the type of reactor used. However some installations have several independent units, and these may use different classes of reactor. In addition, some of the plant types below in the future may have passively safe features.

Fission reactors: Fission power reactors generate heat by nuclear fission of fissile isotopes of uranium and plutonium.

Fusion reactors: Nuclear fusion offers the possibility of the release of very large amounts of energy with a minimal production of radioactive waste and improved safety. However, there remain considerable scientific, technical, and economic obstacles to the generation of commercial electric power using nuclear fusion.

Setting up and using a Terrarium

To examine a natural population in an ecosystem, you may set up a model population in the laboratory. In order to make such a model work, you should be informed about the organisms and what kind of environment they live in and which organisms they interact with. A terrarium is like an aquarium prepared for terrestrial organisms.

You can get a glass container by buying one from a supplier or you can make one yourself. The top opening of the terrarium must be closed with a flywhisk. You can put different populations into the terrarium. We will mention some of these here.

Preparing a terrarium containing a decaying log

For this you need to find a decaying log. You may cut the log to a suitable size for your terrarium using an axe. It is not advised to use soil.

There are many organisms living on the decaying log, such as ants, bacteria, some plants, spiders, centipedes and some other insects. Among these organisms there are eggs and larvae as well. You can easily observe the growth and development of these eggs and larvae into adults.

To feed the organisms put some bread crumbs and a wet sponge in the terrarium. Add some water to keep the terrarium moist. Try to identify the species of organisms and their roles in the population.

Preparing a terrarium containing a desert population. Put a large amount of sand (white sand) and a few pieces of rock into your terrarium. In this condition, animals or plants or both can live together.

You should add plants adapted to desert conditions and storing water (e.g. cactus); and of animals you may put insects, spiders, and lizards. To feed the lizard you may add earthworms and insects, and don't forget to add a water bowl.

Discuss how these plants are adapted to these conditions.

Preparing a terrarium containing populations of forestfloor organisms

Put a lot of soil onto the floor of the terrarium. Press the soil in a certain area and add some water. You may cover the surface of the soil with mosses and ferns, and plant tree seedlings. You may even add some mushrooms.

If fed, land or water frogs can live in this condition as well.

Think of other organisms that you may add to this system.

Preparing an aquarium containing populations of aquatic organisms.

Put some sand and small sea stones in the aquarium. Some ornamental objects, snail shells, and different shaped stones may be used to beautify the aquarium.

You should prepare the necessary conditions for the survival of the organisms that you are going to add. The temperature of the water, cleanliness, oxygen content, and places for shelter and reproduction must all be considered. Therefore, an automatic heater, aeration tubes and pump, filter, thermometer, and some chemicals may be obtained. After preparing the environment with these things you may add some plants and algae. You may also add some fish species, frogs, aquatic turtles and snakes. Determine the food chain among the organisms in the aquarium.

Global warming:

Global warming is related to the increasing of (CO_2) percent in atmosphere, this increase affects heat separation on earth surface eventually raising the earth's heat way above normal rate , this is known as (Green house effect).

The global warming caused by the impact of visible rays (one of sun wave lengths) with any septum, this impact will transfer these rays in the form of heat.

So, when these rays reach earth surface will be transferred to heat and still captured in the atmosphere.

Whenever the percent of (CO_2) gas increased in atmosphere , the amount of captured heat will increase too.

There are other gasses have the ability to increase the amount of heat such as : water vapor, CH_4 , NO_3 , and others.

Global warming is the most significant signs of the climate change on earth in the current era.

The effects of global warming can be classified as following:

1- Eextreme weather changes such as extreme temperature of weather in summer in last decade.

2- Rising sea levels, will submerge some coastal cities.

3- Rising the percent of water acidity, will affect the bio diversity in aquatic biomes.

4- Desertification: means that most of dry lands will become deserts.

5- Increase of wildfires: due to extreme high temperature of weather.

6- Drought of land: due to the shortage of water supply, drought affect food security , many plants will dry and died.

7- Extinction: of some living species due to extreme environmental conditions.

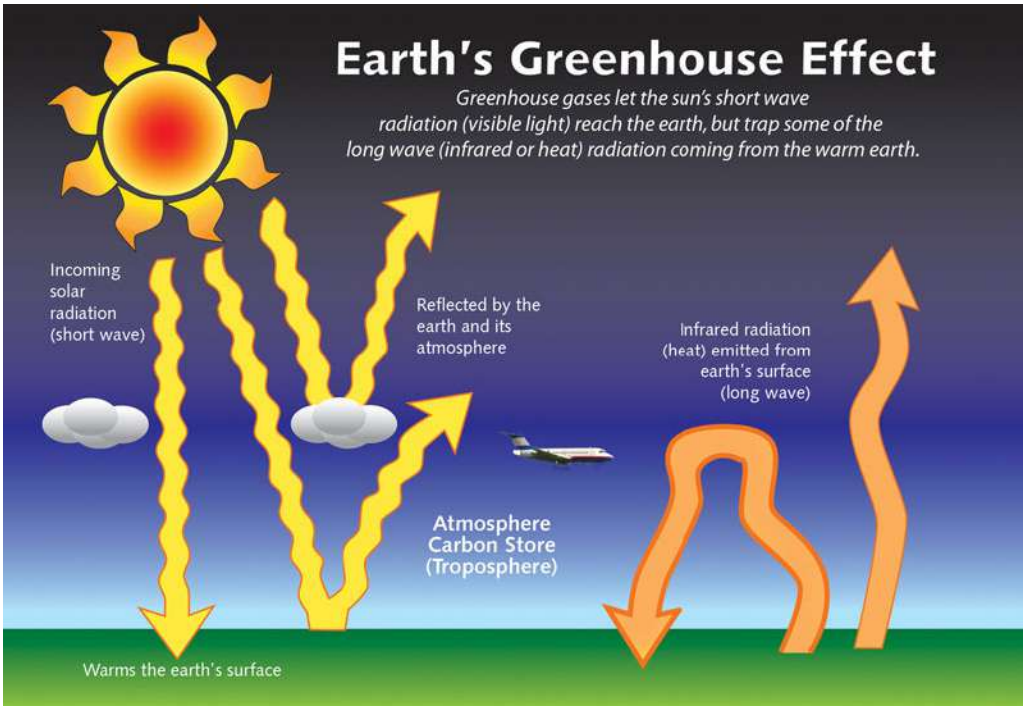


Figure . The Green House Effect mechanism

Ozone layer:

Ozone or (O_3) is one of the natural components of atmosphere, it lays in the stratosphere layer, the second layer of atmosphere.

Although the percent ozone is very small (about 0.3p.p.m), but it plays tremendous role in preservation of earth natural balance.

Ozone is responsible of absorbing harmful ultraviolet rays (about 80%) . without ozone these rays will reach earth causing great damage to life and the existence of living organisms.

In late 1970s scientists declared that the ozone layer witnessed obvious changes, the ozone is notably depleted because of chemical wastes (CO_2 and other gasses of industrial wastes) .

Also they noticed that more percent of (U.V) radiation start to reach the earth.

The ultraviolet rays cause dangerous diseases to human such as : skin cancer and some genetic disorders.

Also cause skin dehydration to animals such as reptiles and mammals.

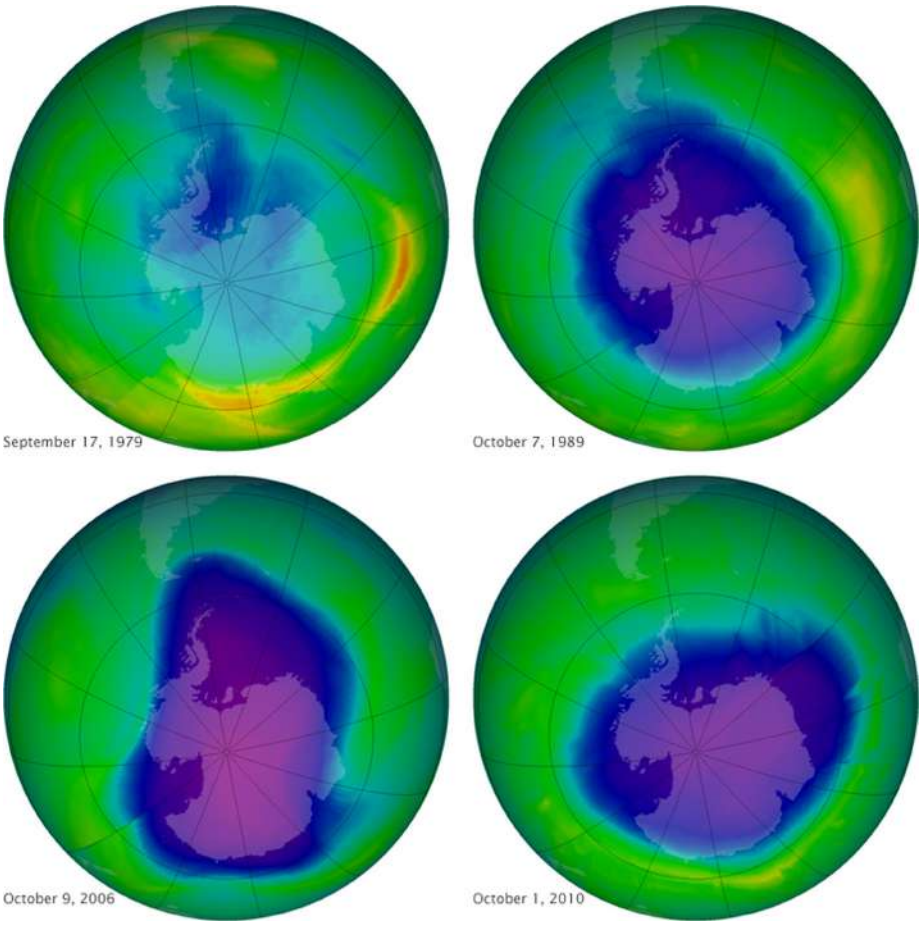


Figure Ozone layer depletion through last decades.

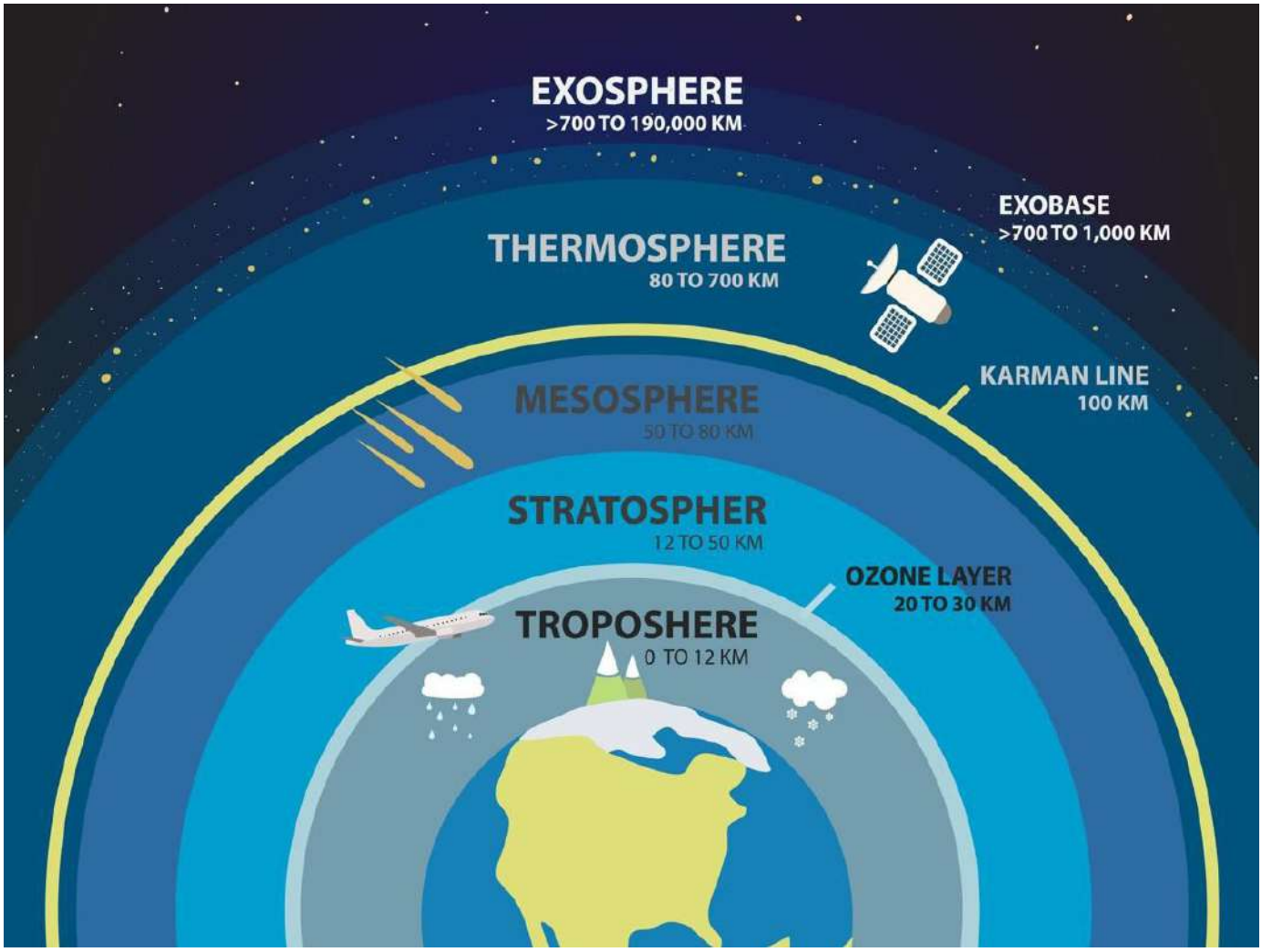


Figure Ozone layer position in atmosphere.

SELF CHECK

HUMAN & BIOSPHERE

A. Key Terms

Pollution	Radiation
Irrigation	Erosion
DDT	Intensive agriculture

B. Review Questions

1. How can we control noises to not harm our body?
2. Explain the effects of radiation on environment?
3. What are the dangers of irrigation to the environment?
4. What are the benefits of artificial fertilizer?
5. What are the measures against environmental pollution?

C. Fill in the blanks

1. The ratio of oxygen in air is ..... while ratio of carbondioxide is .....
2. ..... is produced by the movement of boats and ships or from damps.
3. ..... binds to hemoglobin strongly in the lungs and prevents the binding of oxygen.
4. The reason for the rise in the CO_2 level in the atmosphere is the ..... and .....
5. The symptoms of lead poisoning are ....., ... and .....

D. True or False

1. Mineral rich soil is not suitable for weed but suitable only for crops.
2. The use of artficial fertilizers is easier than usage of natural fertilizer.
3. Irrigation drains minerals away from the soil.
4. Monocultivation is very beneficial for soil.
5. The ozone layer reflects most of the UV light.

تَمَّ

بحمدہ تعالیٰ