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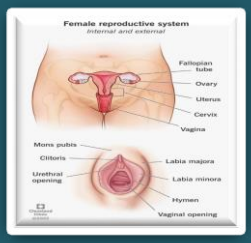
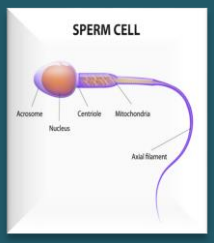
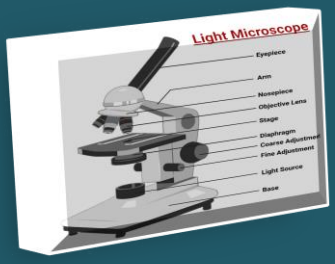
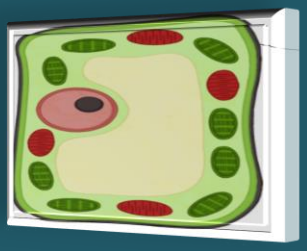
Biology

Grade 9









Prepared by: Virtual Study

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Unit 1

Introduction to Biology

1.1 Definition of Biology

Biology: came from two Greek words bios means life, and logos meaning study.

Biology is the scientific study of life or living things.

It seems very difficult to objectively define **life** in a simple sentence. But, we recognize life mainly by common characteristics shared by living systems. Living things:
• are composed of one or more cells
• are complex and highly ordered
• can respond to stimuli, grow, reproduce, etc.
• transmit genetic information to their offspring
• need the energy to accomplish work
• can maintain relatively constant internal conditions (homeostasis)
• are capable of evolutionary adaptation to the environment .etc.

What is a scientific study?
Biologists study about living things using a **scientific method** that involves asking questions, suggesting possible answers; and testing for the validity of the answers through experimentation. This scientific study follows the study of structures and processes that we can verify observe and measure, either directly or indirectly with the help of tools and technology, such as microscopes.

The study of biology is a point of merging information and tools from all natural sciences. For example information about naturally occurring elements in living organisms, chemical bonding, molecules, acids, bases and other related things can be studied using the tools and principles of chemistry. Other scientific concept like conversion of radiant energy into organic molecules by photo-synthesis is studied with the knowledge of chemistry and Physics.

1.2 The Scientific Method

Biologists are always curious about why things happen or how things happen. By asking questions and seeking science-based responses known as the scientific method, they come up with new theories to explain new findings. The scientific method involves a series of steps that guide scientists through such scientific investigations. Biologists study the living world by posing questions about it. The general steps of the Scientific methods are:

Observation

The scientific study begins with careful observations (often a problem to solve) that lead to a question. The observations can be made either directly (e.g. using your sense organs) or indirectly using scientific tools such as microscopes.

Asking Questions

The observations usually lead the scientist to ask questions (inquiry).

Forming of a hypothesis

A hypothesis is proposed scientific explanations (possible answers) for a set of question (s).To solve a problem, one can propose several hypotheses. Scientific hypotheses should be testable.

Testing the hypothesis

Hypothesis can be tested through experimentation. Any scientific experiment must have the ability to be duplicated because the "answer "the scientist comes up with (whether it supports or rejects the original hypothesis) can't become part of the scientific knowledge unless other scientists can perform the same experiment and achieve the similar results. If a hypothesis is not supported by experimental data, one can propose a new hypothesis.

Making conclusions about the findings

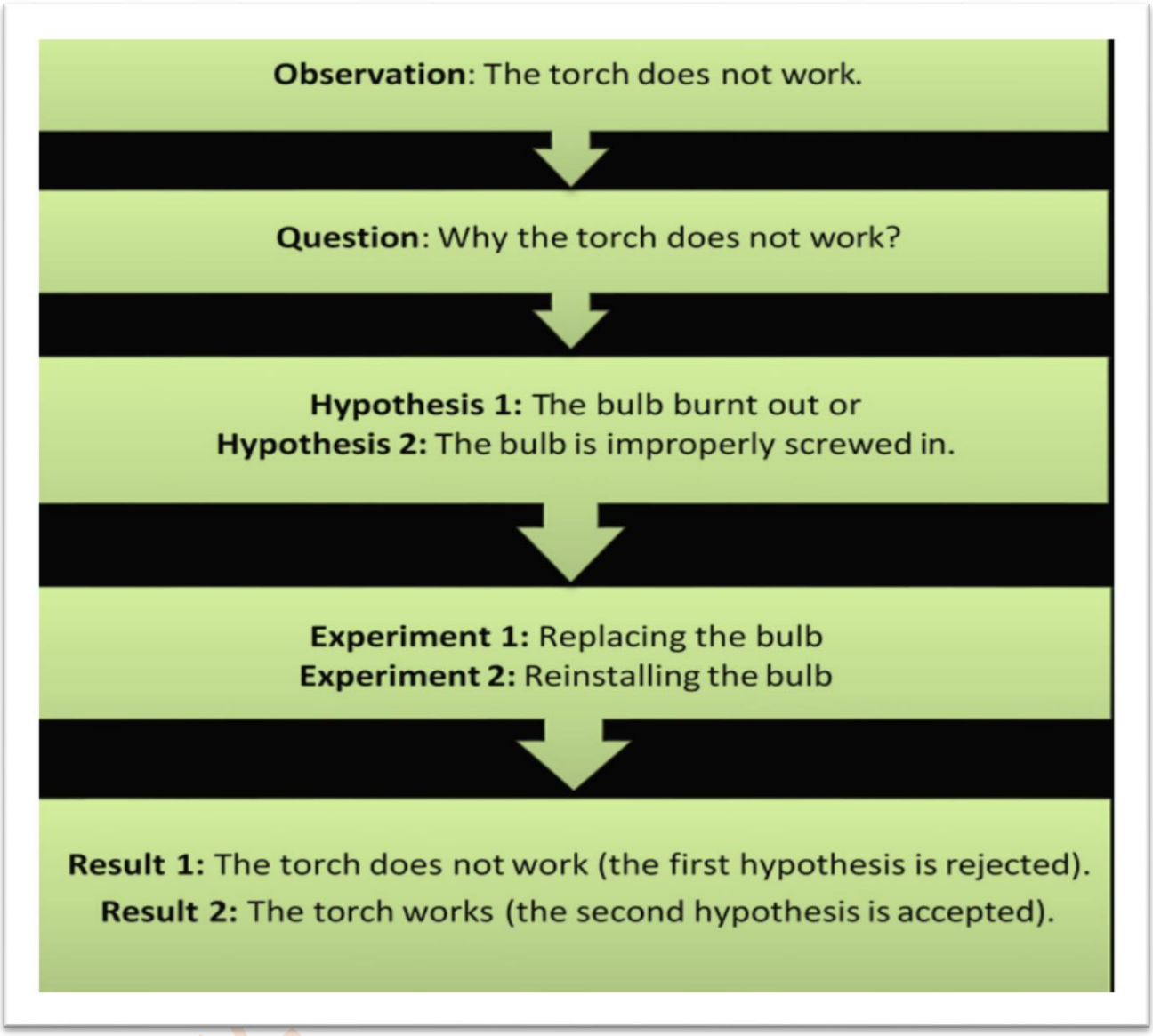
Scientists consider their original hypotheses and ask whether they could still be right in light of the new information gathered during the experiment. If so, the hypotheses can remain as possible explanations for how things work. If not, scientists reject the hypotheses and try to come up with alternate explanations (new hypotheses) that can explain what they've seen.

Communicating the findings

When scientists complete some work, they write a paper that explains exactly what they did and the results they obtained. Then, they submit the paper to a scientific journal in their field. In addition, the findings will be printed in scientific journals and assist teachers and students in the field.

Example of a hypothesis testing in everyday life

Suppose you want to use your torch (hand lamp) to find a missing pen in your bedroom. When you switch the torch on, it is not working. The following flow chart will illustrate hypothesis testing for a torch that doesn't work.



Application of the scientific method to common problems in our surroundings

1.3 Tools of a Biologist

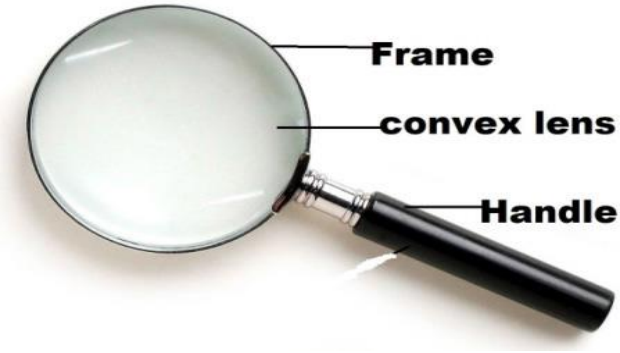
Biologists use different types of tools in the laboratory and field for scientific investigations. Some of the tools are used for measuring, some are used for observation and some are used for culturing microorganisms.

1.3.1. Laboratory tools of biologist

Hand lens

Most cells cannot be seen with the naked eye. A hand lens has a higher magnification than our naked eye. It consists of a convex lens fixed within a circular metallic loop and is attached to a

metallic or wooden handle.
The main function of hand lens is to provide an enlarged image of the object placed under it. But hand lens is not sufficient to observe the detail in cells. There is a need for providing high magnifications tools such as microscope.



Hand lens

The Microscope

The important function of microscope is magnification and resolution. **Magnification** is the number of times larger an image is, than the real size of the object. **Resolution** can be defined as the ability to Distinguish between two separate points.

One of the most important tools of the biologist is a microscope. A microscope is an instrument used to study objects that are too small to be seen with a naked eye. The microscope magnifies the image of small objects making them visible to the human eye. For example, microscopes are used to observe the shape of bacteria, fungi and parasites.

There are several kinds of microscopes. The major types are:
• Light microscope and
• Electron microscope
A light microscope is called light microscope because it uses a beam of light to view specimens. There are two types of light microscopes, Simple light microscope which consists of a single lens while **a compound light microscope** consists of two or more glass lenses.

A compound light microscope is the most common microscope used in biology. It consists of two lens systems (a combination of lenses) to magnify the image of an object up to 2000x. Each lens has a different magnifying power. A compound light microscope with a single eyepiece is called **monocular;** one with two eye-pieces is said to be **binocular.**

When we observe an image under light microscope, light rays are focused on to the image on a microscope slide. This Light which transmitted through the specimen is then focused by two types of lenses known as eye and objective lens. The enlarged produced by these two lenses. A compound light microscope magnification is the product of eye and objective lenses, ×10

eyepiece and ×40 objective, the total magnification is ×400.

Electron microscopes on the other hand use a beam of electrons (instead of a beam of light) and electromagnets (instead of glass lenses) to enlarge the image of an object. These microscopes provide a higher magnification than light microscopes and are used for observing extremely small microorganisms such as viruses.

Glass slides and cover slips:
The microscope slides are used to support an specimens being examined under the microscope.

The cover slips are the small square or circle shaped thin glass sheets that are used to cover specimens on the glass slide to protect from further addition of any chemical or dirt and it is also used to protect the microscope and prevent the slide from drying by locking the moisture. Cover slides provide better view under the microscope.
Although the tool most closely associated with a biologist is the microscope, there are several common tools used by biologists in the laboratory and on field.


Glass slide and cover slides

Autoclave: is the equipment used to sterilize (kill microorganisms) different biological samples. An *autoclave* sterilizes contaminated materials including culture media, and bacterial spores by exposing them to high temperatures and highly pressurized steam.

Autoclave

Incubator: is a device used to maintain a specific environment for **culturing.** An incubator is an instrument that maintains the temperature best suited for the growth of different types of microorganisms.

A Bacteriological incubator

Petri dishes: are flat dishes with a matching cover of a slightly larger diameter. They are available in glass and plastic form. Petri dishes are used with gelling culturing media, such as agar, and placed in the autoclave to sterilize it.

Petri dishes

Culture tubes: are available in a huge range of sizes, shapes, materials, and so on. They are used to culture microorganisms. Culture tubes may be used with solid (gel) culturing media or with liquid (broth) culturing media, and then placed in the autoclave for sterilization.

Test tubes

Flasks: is an apparatus having a flat bottom and a long narrow neck, which allows easy mixing of the solution without spilling out the content. it is also used to gently heat the content inside with a gentle swirling motion of the flask . It is essentially a large-volume culture tube that is used only with broth media and flasks are used to produce large populations of microorganisms. They are available in a variety of shapes and sizes

Flasks

Balance: is useful for making up solutions accurately, weighing specimens, and so on.

Balance

Dropper: A dropper consists of a glass tube that has a small opening at one end and is attached to a vacuum rubber bulb at the other end. A dropper is used when it is required to control the amount of solution being added to a reaction.

Dropper

Tongs

Tongs are metallic scissors-shaped laboratory instruments. It is used to Lifting or picking up hot objects such as heated crucible, beakers, dishes, or flasks.

Tongs

Dissecting Tool Kit

Dissecting Tool Kit is used to dissect animals such as frogs, fetal pigs, mice, etc. It consists of all the necessary tools required to carry out the process of dissection such as a catheter, groove probe, scalpel, surgical scissors (straight and curved), mayo scissors (straight and curved), dissecting forceps (with and without teeth), dissecting pin, etc.

dissecting kit

Dissecting pan

Dissecting pan is equipment is used as a pan on which the specimen is kept while it is being dissected to study its internal organs.

Dissecting pan

Crucible

Crucible is a small container made up of ceramic or metal which is able to withstand high temperatures, and therefore, it is generally used to melt elements.

Crucible

Beaker

Beaker is a cylindrical glass container used for making up solutions, holding hot or cold water or ice baths, and so on.

Beakers

Hotplate

Hotplate is useful for heating solutions, making up an agar culturing medium, and so on.

Hot plate

pH meter is used to measure the pH (acidity or basicity) of substances.

pH mete

Thermometer is an instrument that measures the temperature of Substances.

Thermometer

Forceps are used to hold or pick up small objects. They are available in a variety of shapes and sizes.

Forceps

Spatula

A spatula is used for mixing substances into a solution, stirring the solution, and scrapping objects. It is shaped like a spoon

Spatula

Wash Bottles

Wash bottles which are mainly used to rinse various laboratory materials. Wash bottles are flexible in nature that allows the user to adjust the water pressure as per the need by squeezing the bottle accordingly.

Wash bottl

Bunsen burner or alcohol burner

This apparatus produces a single open flame and it is used for heating and sterilization purposes in the various experiments conducted in labs.

Bunsen burner

1.3.2. Field tools

Insect nets –It is insect collecting nets which is composed of some sort of net bag made of cloth or fine mesh that is attached to a wire loop, which is attached to a wooden or metal pole.

Insect net

Fishing net is a net used for fishing. Nets are devices made from fibers woven in a grid-like structure. Some fishing nets are also called fish traps. Fishing nets are usually meshes formed by tying a relatively thin thread.

Fish net

1.4. Handling and using a light Microscope

Most microscopes have several different powerful lenses attached to them, allowing the viewer to inspect the content at more than100 times its actual size. Biology as modern science would not exist without the microscope, and good microscopes are essential for day to-day activities for most biologists. In addition to their importance, microscopes are extremely expensive, therefore it is very important to know the function of all structures of microscope and handle the device properly before we are using it in the laboratory.

1.4.1. The parts and function of the light microscope

Microscopes are generally made up of structural parts for holding and supporting the microscope and its components and the optical parts which are used for magnification and viewing of the specimen images. This section define the parts of a microscope and the functions they perform to enable the visualization of specimens.

1. Eyepiece

Eyepiece is the part found at the top of the microscope and is used to look through the microscope. It is also named as the ocular. Its standard magnification is 10x with an optional eyepiece having magnifications from 5X to 30X.

2. Eyepiece tube

Eyepiece tube is the eyepiece holder. It carries the eyepiece just above the objective lens. In

some microscopes such as the binoculars, the eyepiece tube is flexible and can be rotated for maximum visualization.

3. Objective lenses

Objective lenses are major lenses that further magnify the specimen at different intensities with multiple objective lenses. Mostly they have a magnification power of 40x-100X.

4. Arm

Arm is a holder connected to all components that function as a support for the microscope so that the microscope can be used properly.

5. Body tube

Body tube connects the eyepiece to the objective lenses.

6. Nose piece

Nose piece is rotating mount that holds many objective lenses.. It is movable hence it allows changing the magnification.

7. The Adjustment knobs

The Adjustment knobs are knobs that are used to focus the microscope. There are two types of adjustment knobs i.e. fine adjustment knobs and coarse adjustment knobs.

Fine adjustment: regulate the distance between object and objective, to achieve the necessary sharpness. The fine focus moves the stage only minimally

Coarse adjustment: Brings specimen into general focus. Coarse adjustment also moves the stage to adjust the difference between the object and the objective. The function of the coarse focus is to capture the exact distance roughly and quickly.

8. Stage

Stage is the section in which the specimen is placed for viewing.

9. Stage clip

Stage clip acts as a holder for the object plate and ensures that it doesn't fall out of place accidentally.

10. Aperture

Aperture is a hole on the microscope stage, through which the transmitted light from the source reaches the stage.

11. Microscopic illuminator

Microscopic illuminator is the microscopes light source, located at the base. It is used instead of a mirror. It captures light from an external source of a low voltage of about 100v.

12. Condensers

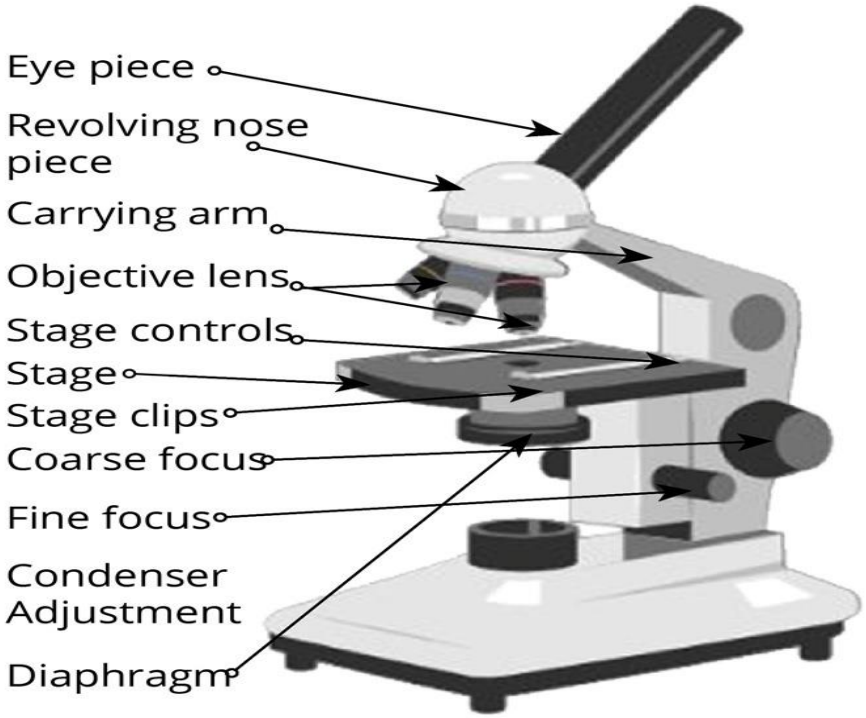
Condensers are lenses that are used to collect and focus light from the illuminator into the specimen. They are found under the stage next to the diaphragm of the microscope. They play a major role in ensuring clear sharp images are produced with a high magnification of 400X and above.

13. Diaphragm

Diaphragm is also known as the iris. It is found under the stage of the microscope and its primary role is to control the amount of light that reaches the specimen. It's an adjustable apparatus, hence controlling the light intensity and the size of the beam of light that gets to the specimen.

14. Base

Base is the very bottom part. Base serves to accommodate all parts of the light microscope.



1.4.2 Handling and using a light microscope

• Be very careful when removing the Microscope from the cabinet.

• Carry the microscope properly, always grip the microscope by the arm and put your hand beneath its base. Hold the microscope upright at all times. Do not bump it against anything.
• Make sure that the slide is clean and dry before putting it on the stage.

• Put the slide on the stage, with the most promising region exactly in the middle of the hole in the stage that the light comes through.

• Always focus on low power (4X objective) first even if eventually you need high power magnification.

• Focus with the larger coarse-focusing knobs first, then when you have nearly got the image in focus make it really sharp using the smaller fine-focusing knobs.

• If you want to increase the magnification, move the slide so the most promising region is exactly in the middle of the field of view and then change to a higher magnification lens.

• Use immersion oil only with the 100X objective (oil immersion lens) in place.

• Use only one drop of oil.

• Always focus by moving the lens and the specimen further apart, never closer to each other.

• Never touch the surfaces of the lenses with your fingers or anything else

• Lower the stage and then remove the slide when you are done.

• Always clean the microscope when you are done. (use a lens paper and the alcohol)

• Always place the 4X objective over the stage and be sure the stage is at its lowest position before putting the microscope away.

• Always turn off the light before putting the microscope away.

• Always return the microscope to the correct cabinet.

• Always place the oculars toward the back of the cabinet

• Always wrap the cord correctly before putting the microscope away.

1.5. General Laboratory Safety Rules

Safety can also refer to the control of recognized hazards in order to achieve an acceptable level of risk. Laboratory safety is important before we do any activities in the laboratory:
• working carefully in the laboratory,
• Dealing with minor problems before they become major problems,
• keeping safety constantly in mind are some of the safety rules.

Important general laboratory safety rules are

1. Following the instructions:
It is critical to read and listen the laboratory procedure and be familiar with all the steps, from start to finish. It is very important to know how to use all of the lab equipment before you begin.

2. Knowing the location of safety equipment
It is mandatory to have a fire extinguisher and first-aid kit readily in the laboratory. It's important to know the location of the safety equipment and how to use it. It's a good idea to periodically check equipment to make sure it is in working order. Review lab safety signs and look for them before starting an experiment.

3. Dressing for the laboratory

It is important to wear protective cloths including a laboratory coat, safety goggles, gloves, hearing protection, long pants, a long-sleeve shirt, and leather shoes or boots that fully cover your feet(NO sandals).Wear a disposable respirator mask when you handle chemicals that are toxic. The dressing procedure should be based on the nature of the experiment.

4. Never eat or drink in the laboratory.

Don't eat or drink in the science laboratory. It is forbidden to store food or beverages in the same refrigerator that contains experiments, chemicals, or cultures.

5. Never taste or sniff chemicals.

Avoid tasting or smelling chemicals or biological cultures. Tasting or smelling some chemicals can be dangerous or even deadly. The best way to know what's in a container is to label it and read before use, so get in the habit of making a label for glassware before adding the chemical.

6. Act responsibly in the laboratory.

Never randomly mixing chemicals to see what happens. It may result an explosion, fire, or release of toxic gases.

7. Cleaning the experiment area in the laboratory and storing the Waste properly.

Every laboratory session should begin and end with your glassware, chemicals, and laboratory equipment clean and stored properly.

8. Handling chemicals properly

Wear a disposable respirator mask when handle chemicals that are toxic. Never allow laboratory chemicals to contact your bare skin.

9. Know what to do with laboratory accidents

If someone burn or if he exposed to chemical immediately flood the burned area with cold tap water for several minutes to minimize the damage done by the burn.

10. All laboratory personnel should place emphasis on safety and chemical hygiene at all times:

Never leave containers of chemicals open. All containers must have appropriate labels. UN labeled chemicals should never be used.

Review Questions

I. Choose the correct answer for the following questions

1. Which of the following is not a property of life?
   a. populations of organisms rarely change over time.
   b. living things exhibit complex but ordered organization.
   c. organisms take in energy and use it to perform all of life's activities.
   d. organisms reproduce their own kind.

2. Which of the following is the correct procedure of scientific method?
   a. Experiment conclusion application Question observation
   b. Question observation experiment analysis prediction result
   c. Observation question hypothesis prediction, experiment results conclusion
   d. Observation question opinion conclusion hypothesis

3. Hypothesis in biology is best described as

a. possible explanation of an observation.
b. an observation that supports a theory.
c. a general principle that explains some aspect of life.
d. an unchanging statement that correctly predicts some aspect of life.

4. Which of the following is not the correct method of handling chemicals?
a. wearing a disposable respirator mask when handling chemicals that are toxic.
b. never allow laboratory chemicals to contact your bare skin.
c. never put chemicals open
d. return and pour the unused (left over) chemicals to its original container

II. Write short answer for the following questions

5. Write the main difference between light and Electron microscope
6. Write the function of the following common laboratory tools.

Types of tools	Function
Flasks	
Test tubes	
Wash bottle	
Dropper	
Test tube rack	
Spatula	
Dissecting Pan	
Wash bottle	
Mortar and pestle	

7. Look at the following laboratory safety signs and write their meaning

8. Why does a microscope have several objective lenses?
9. What will happen to the field of view in a microscope as you close the diaphragm? Explain

your answer
10. Why should you always focus a microscope by moving the objective lens away from the 0specimen?
11. Explain the importance of adding oil immersion when using high power objective? How?

Answers to Review Questions

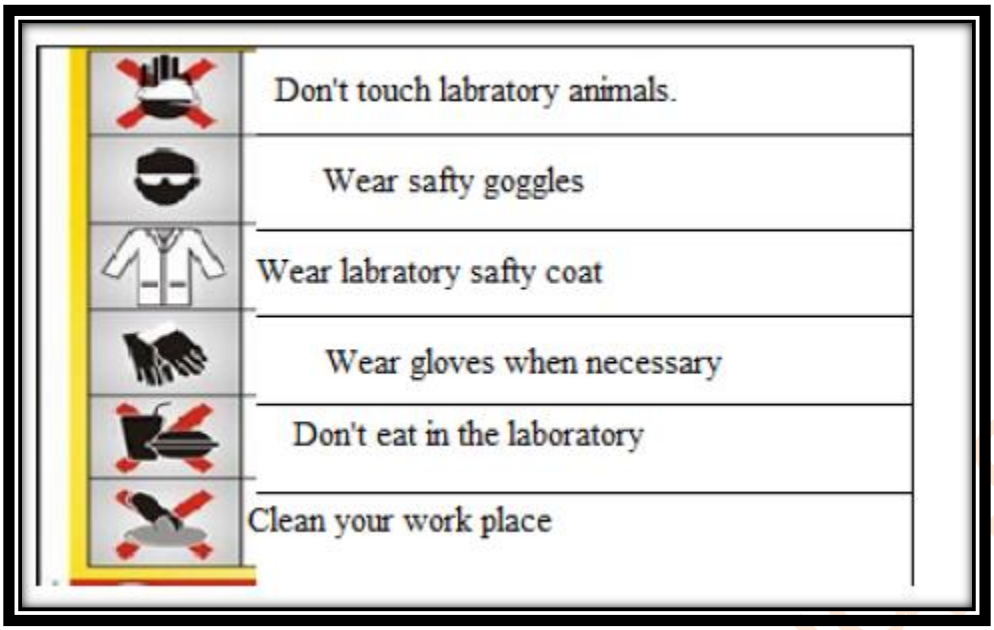
I. Choose the correct answer for the following questions
1. A 2. C 3. A 4. D

II. Write short answer for the following questions.

5. The difference between light and electron microscope is: light microscopes use a beam of Light to view specimens and in the case of electron microscope it use a beam of electrons (instead of a beam of light) and electromagnets (instead of glass lenses) to enlarge the image of an object.

6. Write the function of the following common laboratory tools:
Test tubes: used to culture microorganisms.
Wash bottle: To wash and scrub glass wear.
Dropper: used to transfer small volume liquids.
Test tube rack: to hold or put test tube
Spatula: used to pick laboratory chemicals or media from stalk container.
Dissecting pan: holds specimen being dissected.
Mortar and pestle: used to grind substances
Forceps: Used to hold up or pick up small materials
Flasks: flasks are useful for culture, heating substances, and for temporary storage of solutions and liquid specimens.

7. Symbols of laboratory safety rules.



8. Microscope have several objective lenses to facilitate a quick change in the magnification of a Specimen and high power objective lens provides a higher degree of magnification, which allows to zoom in closer to the object being studied and see more detail and a lower power lens will provide a wider field of vision.

9. The diaphragm on the microscope is used to change the amount of light that is being allowed To enter through the slide. Closing the diaphragm will decrease the amount of illumination of the Specimen but increases the amount of contrast. The light to the field is reduced as the diaphragm Is closed. Smaller diameter and therefore lets in less light.

10. In order to focus on an object, one should move the stage away from the objective lenses Rather than towards each other in order to prevent crashing the lens into the slide.

11. **Oil immersion** is a technique used to increase the resolving power of a microscope and improve the image quality. The oil immersion increase the resolving power by decreases the light refraction (bending of the light), allowing more light to pass through the specimen to the objectives lens. Oil immersion eliminates any air gaps and loss of light due to refraction and maximizes the amount of light that goes through the objective lens.

Unit 2

Characteristics and Classification of Organisms

2.1 Characteristics of living things

Living things have variety of shapes and forms. Thus, biologists study life in many different ways. Biologists often live with wildlife, collect fossils, or listen to whales.

Some of the properties that are shared by all living things are listed below:

All living things are made up of one or more cells:

Those made up of one cell, such as bacteria are termed 'unicellular' and those made up of more than one cell, such as plants are termed 'multi-cellular'.

All living things require energy:

All organisms use a source of energy for their metabolic activities. For example, every muscle in your body is powered by the energy you obtain from your diet. Some organisms use energy from the sunlight to make their foods through the process of photosynthesis. Such organisms, for example plants, are known as producers or autotrophs. Other organisms cannot make their own food but consume others. Such organisms are known as consumers or heterotrophs.

All living organisms respond to stimuli:

organisms can detect or sense stimuli (change) in the internal or external environment and make appropriate responses.

All living things can grow:

Growth is a permanent increase in size and mass due to an increase in cell number or cell size or both. Even bacteria and single-celled creatures show an increase in size. Multicellular organisms which increase the number of cells in their bodies become more complicated and change their shape and size.

All living things can reproduce:

Reproduction is the process that makes more of the same kind of organism. Single-celled organisms may simply keep dividing into two. However, multicellular plants and animals may reproduce sexually or asexually.

All living things can excrete:

Excretion is the removal of the metabolic wastes produced in cells as a result of chemical reactions (metabolism). For example, respiration and other chemical reactions in the cells produce waste products such as carbon dioxide. Living organisms expel such substances from their bodies in various ways.

All living things display ordered complexity:

All living things are both complex and highly ordered. The levels of organization in biological systems begin with atoms and molecules and increase in complexity. Your body is composed of many different kinds of cells each containing many complex molecular structures. Many nonliving things may also be complex, but they do not exhibit this degree of ordered complexity.

Most living things maintain homeostasis:

Most organisms maintain relatively constant internal conditions that are different from their Environment. Homeostasis is the regulation of an organism's internal conditions to maintain stability. For example, your body temperature remains stable despite changes in outside temperatures.

All living things possess adaptations that evolve overtime:

All organisms interact with other organisms and their environment in ways that influence their survival, and as a result, organisms evolve adaptations to their environments

Characteristics of life

2.2 Taxonomy of living things

2.2.1 Principles of classification

One tool biologists use to organize and understand living organisms is classification. Classification is the process of grouping things based on their similarities. The science of naming, identifying and classifying organisms is known as **taxonomy.** Scientists who study taxonomy are called taxonomists. Biologists classify organisms into different categories mostly by judging the degrees of their apparent similarities and differences.

These include the external and internal structures of the organism as well as where the organism lives. Taxonomists also consider the genetic makeup of organisms to reveal their evolutionary relationships to other organisms. The assumption is that the greater the degree of physical similarity between them, the closer their biological relationship is. They try to identify and classify organisms based on a number of features (e.g., morphological, physiological, molecular, behavioral, and/or ecological characters).

2.2.2. Taxonomic hierarchies in biological classification

Thousands of years ago, the Greek philosopher **Aristotle** (384-322 BC) developed the first widely accepted biological classification systems. He used simple morphological characters to classify plants into trees, shrubs and herbs. He also divided animals into two groups those which had red blood and those that did not have. Though it was useful for a while, Aristotle grouped some organisms that had very little in common. For example, he grouped birds, bats, and flying insects because they could fly. Later on in the 1700s, a Swedish Botanist **Carolus Linnaeus** (1707–1778), who is also known as the father of taxonomy, introduced a taxonomic hierarchy of classification. He was the first person to propose an orderly system for classifying organisms.

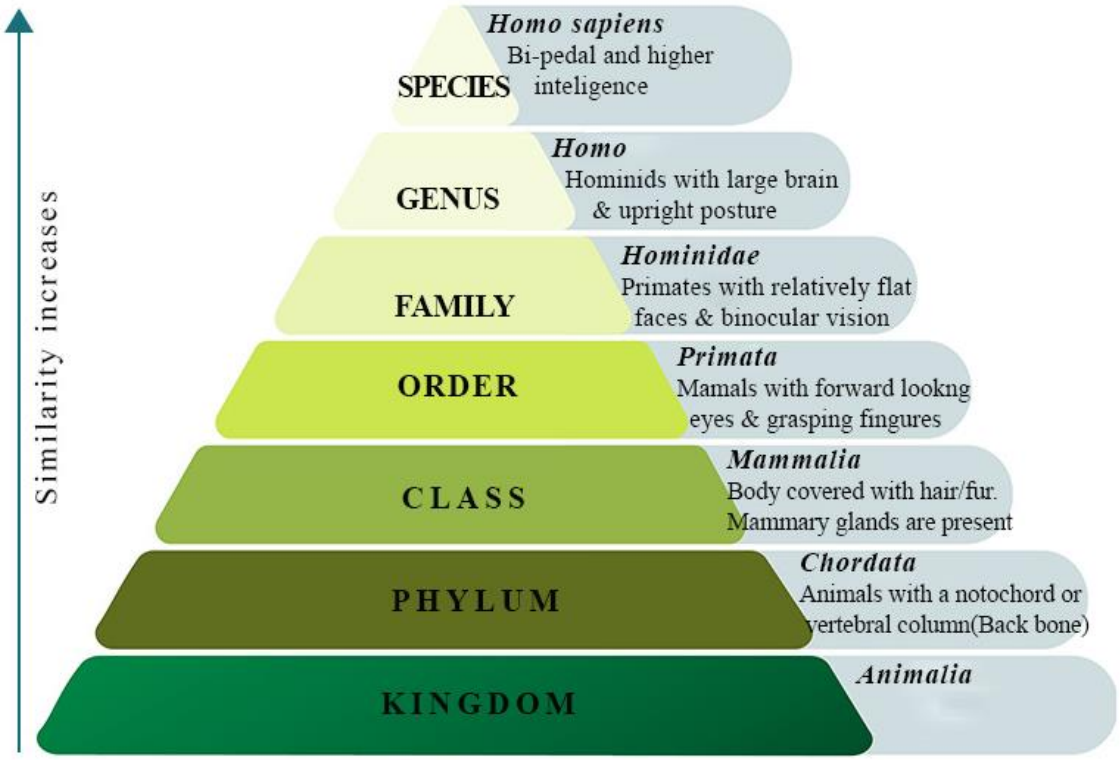
Taxonomic hierarchy is the process of arranging various organisms into successive levels of the biological classification either in a decreasing or an increasing order. In the Linnaean classification system, all organisms are placed in a ranked hierarchy. The kingdom is ranked the highest followed by Phylum (division), class, order, family, genus, and species.

Each rank in a taxonomic hierarchy is termed taxon (plural, taxa). Linnaeus' developed a two Kingdom system of classification. He classified all living organisms under kingdoms Plantae and Animalia that included all plants and animals, respectively. This system did not distinguish between the eukaryotes and prokaryotes, unicellular and multicellular organisms; and photosynthetic (green algae) and non-photosynthetic (fungi) organisms.

On the broadest level, biologists divide the diversity of life into three domains: Bacteria, Archaea, and Eukarya. Every organism on Earth belongs to one of these three domains. The first two domains, Bacteria and Archaea, identify two very different groups of organisms that have prokaryotic cells, relatively small and simple cells that lack a nucleus or other compartments bounded by internal membranes. Eukaryotes have relatively large and complex cells that contain a nucleus and other membrane-enclosed compartments. They are grouped into the domain Eukarya. The domaineukarya includes groups such protists, fungi, plants and animals. Domain is the rank above kingdom.

Domain ➡ Kingdom ➡ Phylum ➡ Class ➡ Order ➡ Family ➡ Genus ➡ Species

Eukarya ➡ Animalia ➡ Chordata ➡ Mammalia ➡ Pimate ➡ Hominidae ➡ Homo ➡ Homo sapiens



Taxonomic hierarchy

2.3 Relevance of classification

Classification gives biologists a framework that allows them to study the relationships between living (extant) and extinct organisms. For example, this framework allows biologists to study the relationship between birds and dinosaurs. Biologists have found that the bones of some dinosaurs have large internal spaces. So do the bones of birds.Because of these findings, some biologists believe that dinosaurs are more closely related to birds than to reptiles.

Taxonomy can be a useful tool for scientists who work in such areas as agriculture, forestry, and medicine. Taxonomy can also help the economy. For example, taxonomists can discover new sources of lumber, foods, medicines, and energy.

2.4 Common Ethiopian animals and plants

Ethiopia is endowed with high biological diversity (biodiversity) due to its geographical location, topographical diversity and diverse climatic features. The country is a hot spot for a diversity of wild plant and animal species with a high degree of endemicity.

Furthermore, Ethiopia is a primary centre of diversity for field crops such as noug (*Guizotia abyssinica*), tef (*Eragrostis tef*) and the Ethiopian mustard (*Brassica carinata*). Besides, field crops such as barley, sorghum, durum wheat, finger millet, faba bean, chickpea, lentil, and

cowpea have wide diversity in Ethiopia.

Scientific names of some common plants and animals in Ethiopia

Common name	Taxon						
	Kingdom	Phylum/ Division	Class	Order	Family	Genus	Species
Elephant	Animalia	Chordate	Mammalia	Proboscidea	Elephanti-dae	Loxodonta	Loxodonta africana
Ethiopian Wolf	Animalia	Chordate	Mammalia	Carivora	Canidae	Canis	Canissimen-sis
Gelada	Animalia	Chordate	Mammalia	Primate	Cercopith-ecidae	Thero-pithecus	Theropithe-cus gelada
Lion	Animalia	Chordate	Mammalia	Carivora	Felidae	Panthera	Panthera leo
Walia	Animalia	Chordate	Mammalia	Artiodactyla	Bovida	Capra	Capra walie
Ostrich	Animalia	Chordate	Ave	Struthioni-formes	Struthion-idae	Struthio	Struthio camelus
Watled Ibis	Animalia	Chordate	Ave	Pelecani-formes	Threskior-nithidae	Bostrychia	Bostrychia carunculata
Enset	Plantae	Angio-spermata	Monocy-lodoneae	Zingiberales	Mussaseae	Ensete	Ensete ven-tricosum
Maize	Plantae	Angio-spermata	Lilospida	Cyperales	Poacea	Zea	Zea mays
Noug	Plantae	Angio-spermata	Eudicots	Asterales	Asteraceae	Guizotia	Guizotia abyssinica
Tef	Plantae	Angio-spermata	Lilospida	Cyperales	Poacea	Eragrotes	Eragrstos tef
Wheat	Plantae	Angio-spermata	Lilospida	Cyperales	Poacea	Triticum	Triticum aestivum

Dichotomous keys

Dichotomous keysare used to identify unfamiliar organisms. They simplify the process of identification. Each key is made up of pairs of contrasting features (dichotomous means two branches), starting with quite general characteristics and progressing to more specific ones.

By following the key and making appropriate choices it is possible to identify the organism correctly.

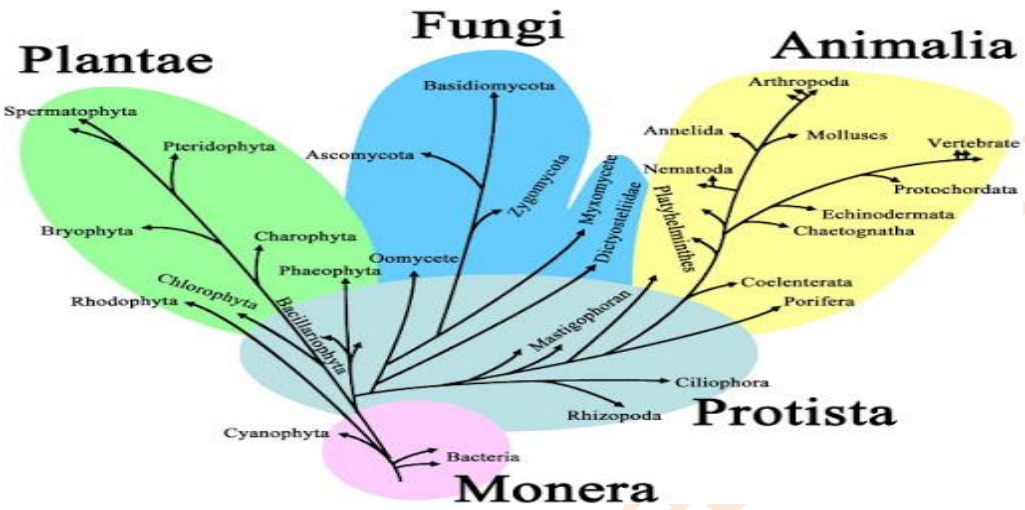
2.5 The five-kingdom system of classification

Classification of organisms into plants and animals was easily done and understood, but a large number of organisms did not fall into either category. Hence the two kingdom classification used for a longtime was found inadequate. Besides, gross morphology a need was also felt for including other characteristics like cell structure, nature of cell wall, mode of nutrition, habitat, methods of reproduction, evolutionary relationships, etc.

Whittaker (1969) proposed a five kingdom classification to solve the pitfalls of the two kingdom system of classification. The main criteria for classification used by him include cell structure,

body organization, mode of nutrition, reproduction and phylogenetic relationships. Whittaker's five-kingdom scheme consists of animals, plants, fungi, monera and protists.

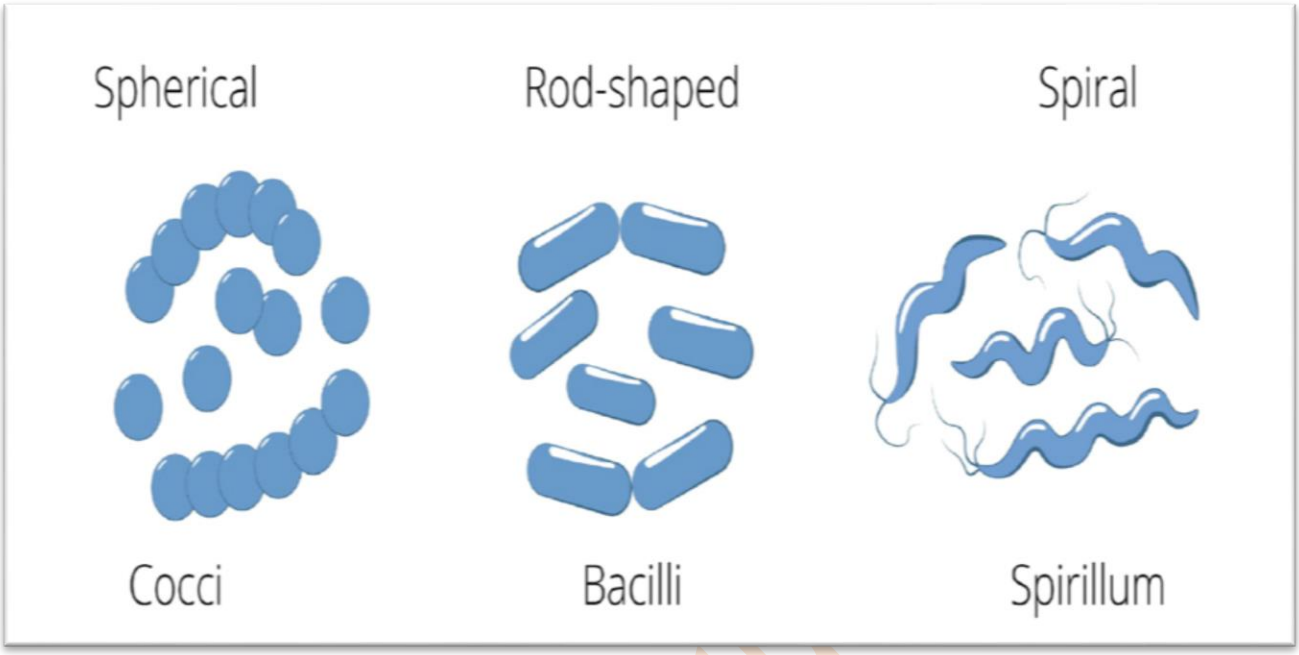
It is still not easy to fit all organisms into the five-kingdom scheme. For example, many protista with chlorophyll (the protophyta) show important resemblances to some members of the algae, but the algae are classified into the plant kingdom.



The five kingdoms of life

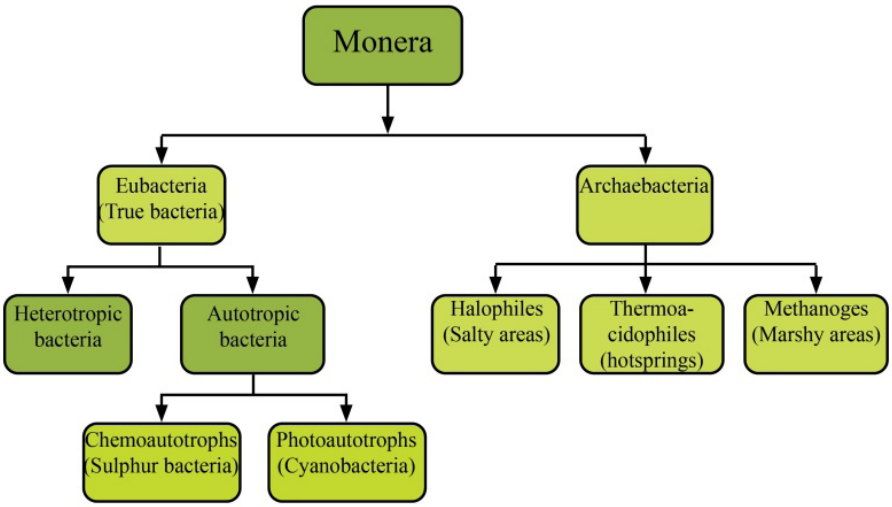
Kingdom Monera

Monera includes **eubacteria** and **archaebacteria.** Eubacteria (bacteria) have strong cell walls. They exist in various shapes and forms. Some eubacteria are heterotrophs; otherscan make their (autotrophs). Some autotrophic bacteria make their own food the way plants do; they are photosynthetic. Others make energy by chemical reactions; chemosynthetic. The eubacteria live in most habitats, except the most extreme. Some eubacteria cause diseases, like strep throat and pneumonia. Most eubacteria, however, are harmless and helpful.



Examples major groups of Monera

Archaebacteria (Archaea) have very different cell walls than bacteria,ut like bacteria, archaebacteria make their own food. They are chemosynthetic and photosynthetic. Archaebacteria live in extreme environments. They live in such places as swamps, deep-ocean hotwater vents and seawater evaporating ponds. The environments in which the archaebacteria live often have no oxygen.

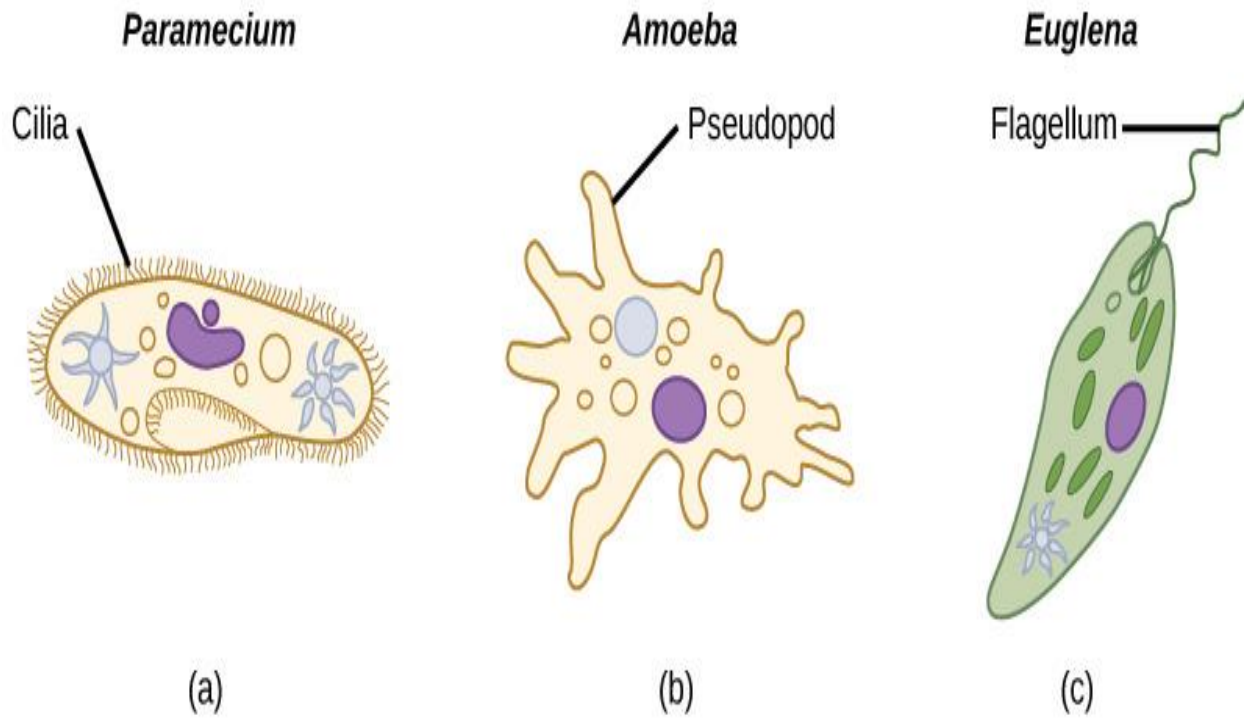


Some representative of taxa of kingdom monera

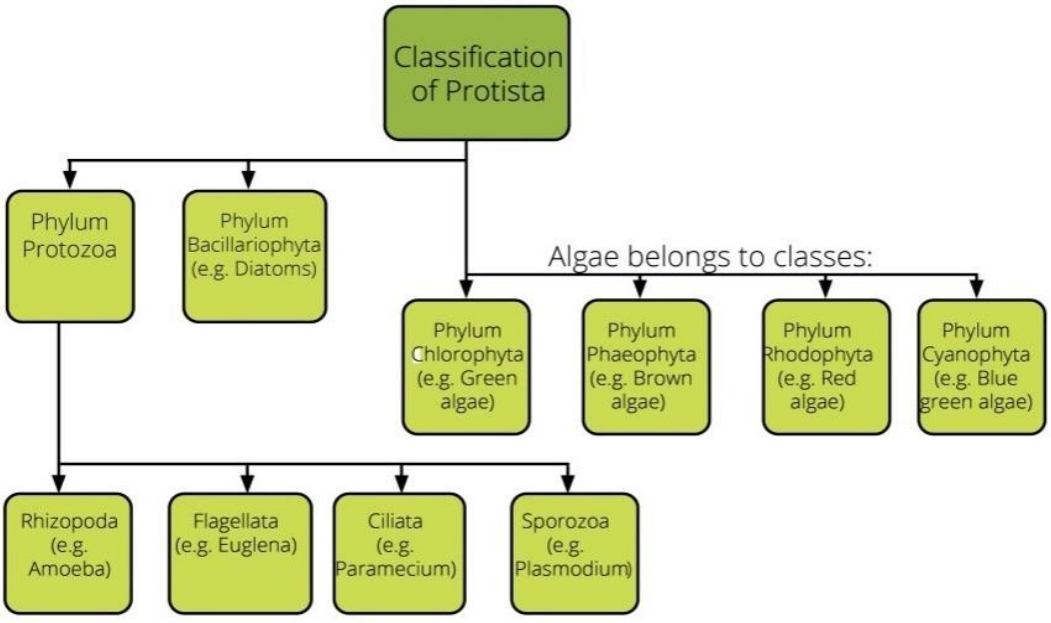
Kingdom Protista

There is no such thing as a typical protist. Kingdom protista contains the most diverse organisms of all the kingdoms.There are single-celled (unicellular) protists as well as many-celled (multicellular) protists. Some are microscopic, others are very large. Some can make their own food, some cannot. Protists have only one thing in common—they are all eukaryotes. That means most of their metabolic processes (chemical reactions) take place inside their membrane-bound organelles. Other than that, organisms classified as protists are quite different from each other.

Some protists, called protozoans, seem to be like animals except that they only have one cell. Others, called algae, seem to be like plants except they do not have roots, stems, or leaves. Algae are photosynthetic and autotrophic. Unicellular algae are the basis of aquatic food chains and produce much of the oxygen in Earth's atmosphere. Still, other protists seem to be like fungi except that they do not have the same kind of cell walls that fungi have.



Examples major groups of protists



Some representative taxa of kingdom Protista

Kingdom Fungi

Fungi are eukaryotic organisms that include microorganisms such asyeasts, moulds and mushrooms. Except for unicellular yeasts, fungi are filamentous multicellular organisms.

Their bodies consist of long, slender thread-like structures called hyphae. Hyphae play an important role in how they obtain food. Fungi possess a cell wall that is made up of chitin and polysaccharides.

Like animals, fungi are heterotrophic in nutrition. But unlike animals, fungi do not ingest (eat) their food. Instead, a fungus absorbs nutrients from the environment outside of its body. Many fungi accomplish this task by secreting powerful enzymes into their surroundings; digest compounds from a wide range of sources, living or dead.
These enzymes break down complex molecules into smaller organic compounds that the fungi can absorb into their bodies and use

Examples of fungi

Most fungi absorb soluble organic matter from dead substrates and hence are called saprophytes (decomposers). Decomposer fungi break down and absorb nutrients from nonliving organic material, such as fallen logs, animal corpses, and the wastes of living organisms.

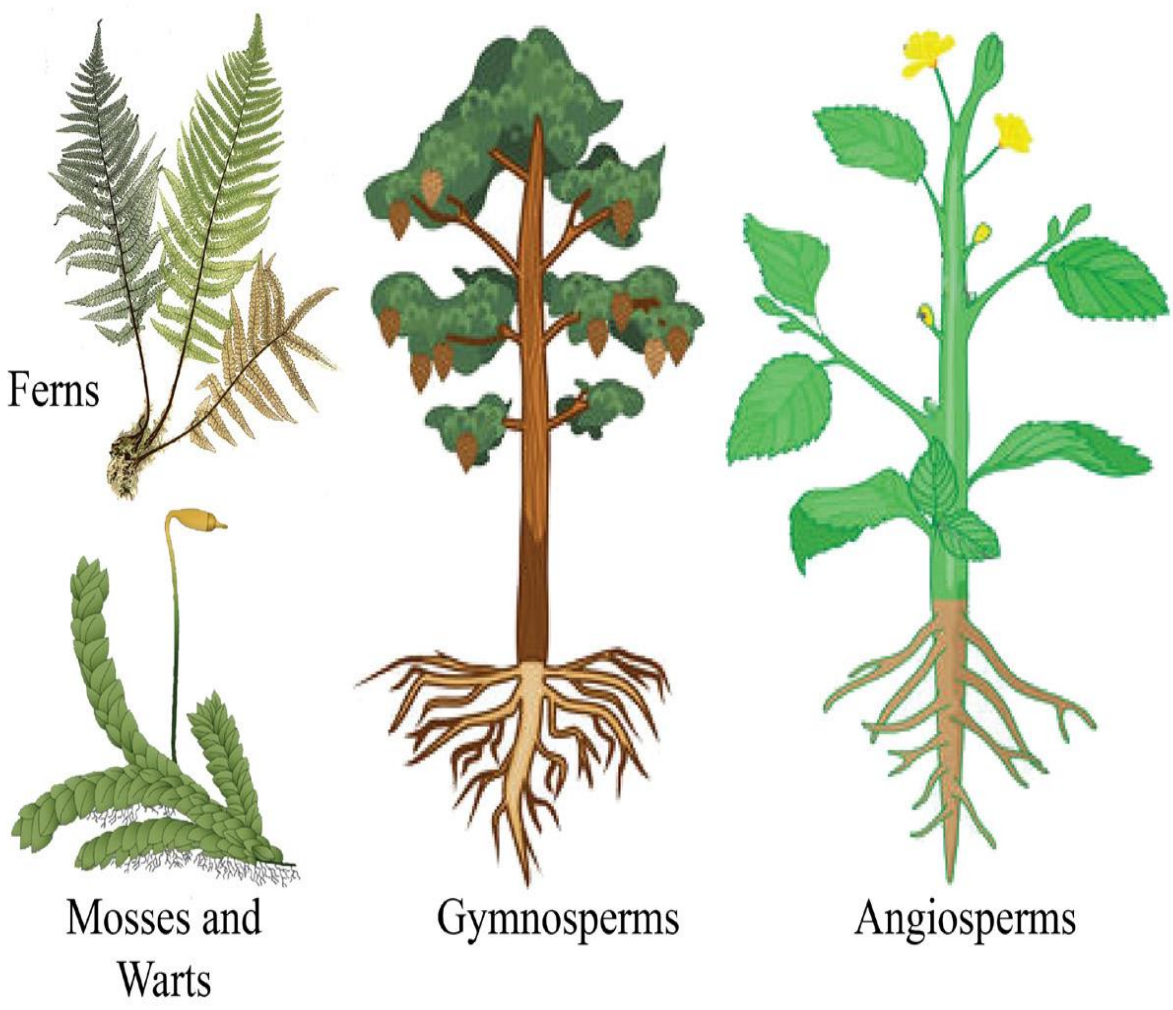
Fungi cannot make their own food. They are heterotrophs. Fungi use a process called extracellular digestion to obtain nutrients. This means food is digested outside a fungus's cells and then the digested food is absorbed. For example, some hyphae of a fungus will grow into an orange. They release digestive enzymes into the orange that break down the large organic molecules into smaller molecules. These small molecules are absorbed into the hyphae and move into the flowing cytoplasm.

Fungi can reproduce either by vegetative means (fragmentation, fission and budding), asexual reproduction through spores formation and sexually. The various spores are produced in distinct structures called fruiting bodies
Yeast (saccharomyces service) is a very important fungus used for making injera rise and allows us to make alcohol (Tej, Tella, Beer etc).

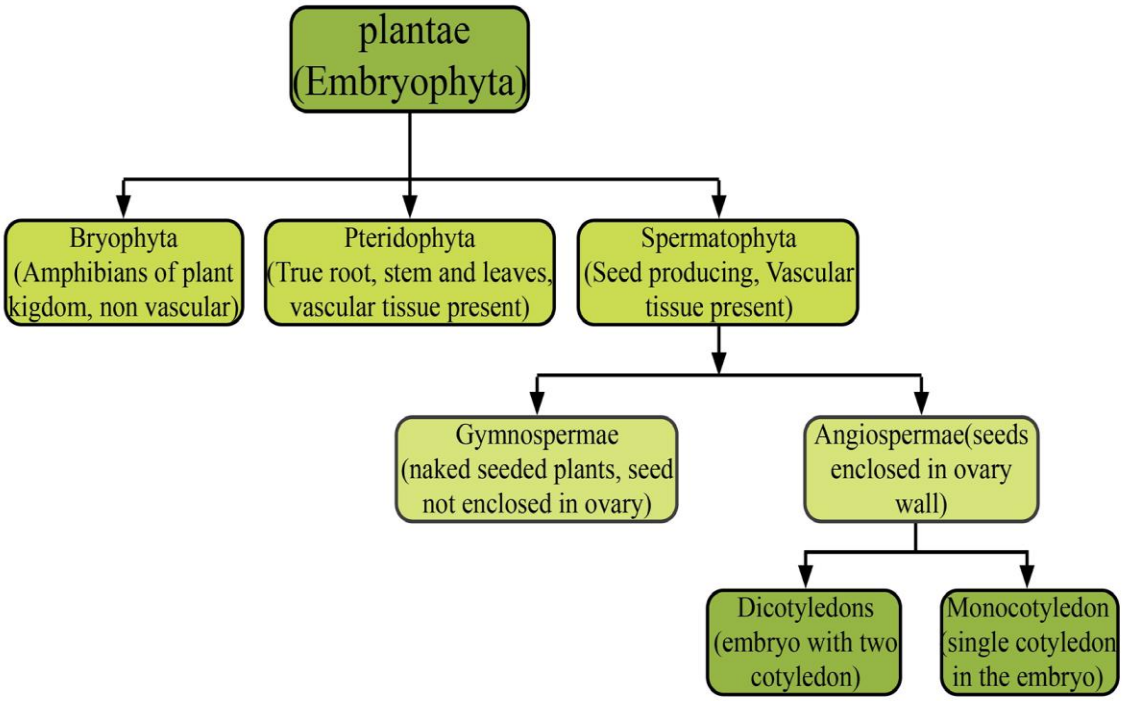
Kingdom Plantae

Kingdom Plantae includes all eukaryotic, and multicellular autotrophic organisms. Plants make their own food through the process of photosynthesis. Plants have chloroplast and chlorophyll

pigment, which is required for photosynthesis. Photosynthesis also provides oxygen in the atmosphere. They do not move from place to place; they are stationary. Their cells contain a rigid cell wall made up of cellulose. They reproduce asexually by vegetative propagation or sexually.



Examples major groups of plants



Classification of the plant kingdom

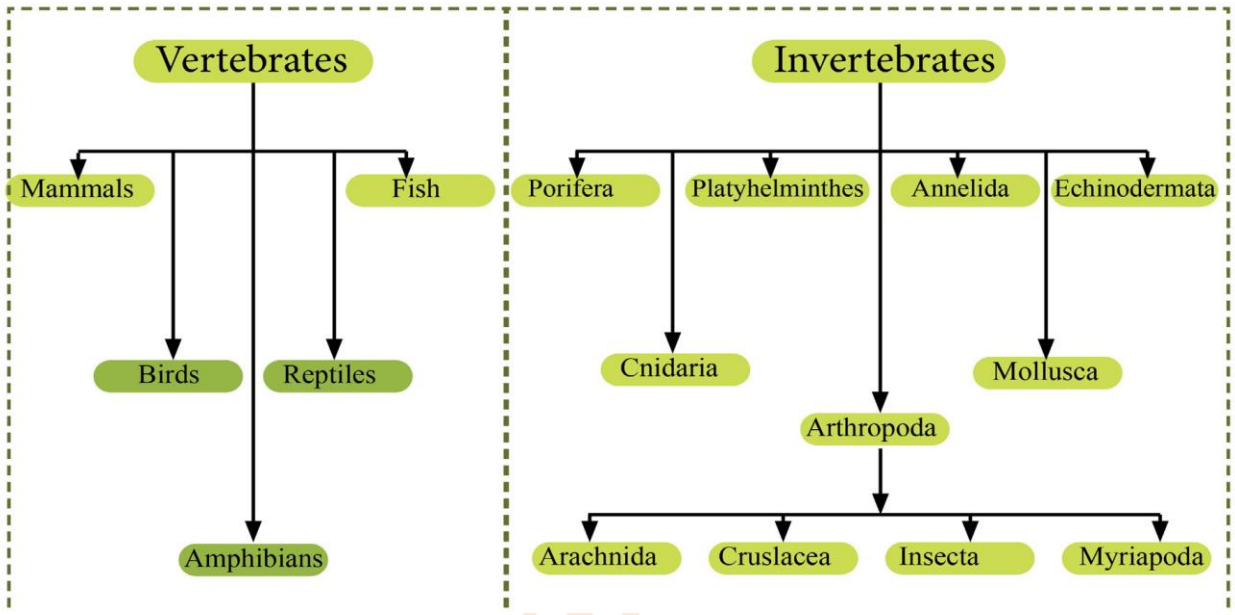
Kingdom Animalia

Kingdom Animalia includes all multicellular, heterotrophic, eukaryotic animals. Constructing a good definition of an animal is not straightforward, as there are exceptions to nearly every criterion for distinguishing animals from other life forms. However, several characteristics of animals, when taken together, sufficiently define them.

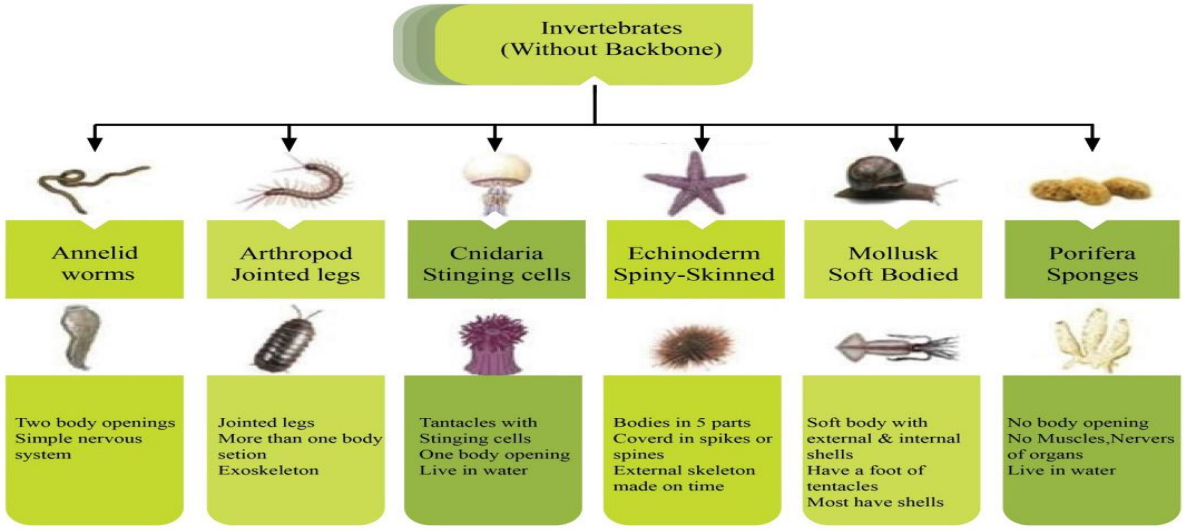
Animals differ from both plants and fungi in their mode of nutrition. Unlike plants, animals are not photosynthetic. Animals consume food obtained from other organisms (i.e. they are heterotrophs). But unlike fungi, most animals do not feed by absorption; instead, animals ingest their food and then use enzymes to digest it within their bodies.

In contrast to plants and fungi, however, animals lack the structural support of cell walls. Instead, animal cells are held together by structural proteins, the most abundant being collagen, which is found only in animals. Many animals have two types of specialized cells not seen in other multicellular organisms: muscle cells and nerve cells. In most animals, these cells are organized into muscle tissue and nervous tissue, respectively, and are responsible for moving the body and conducting nerve impulses.

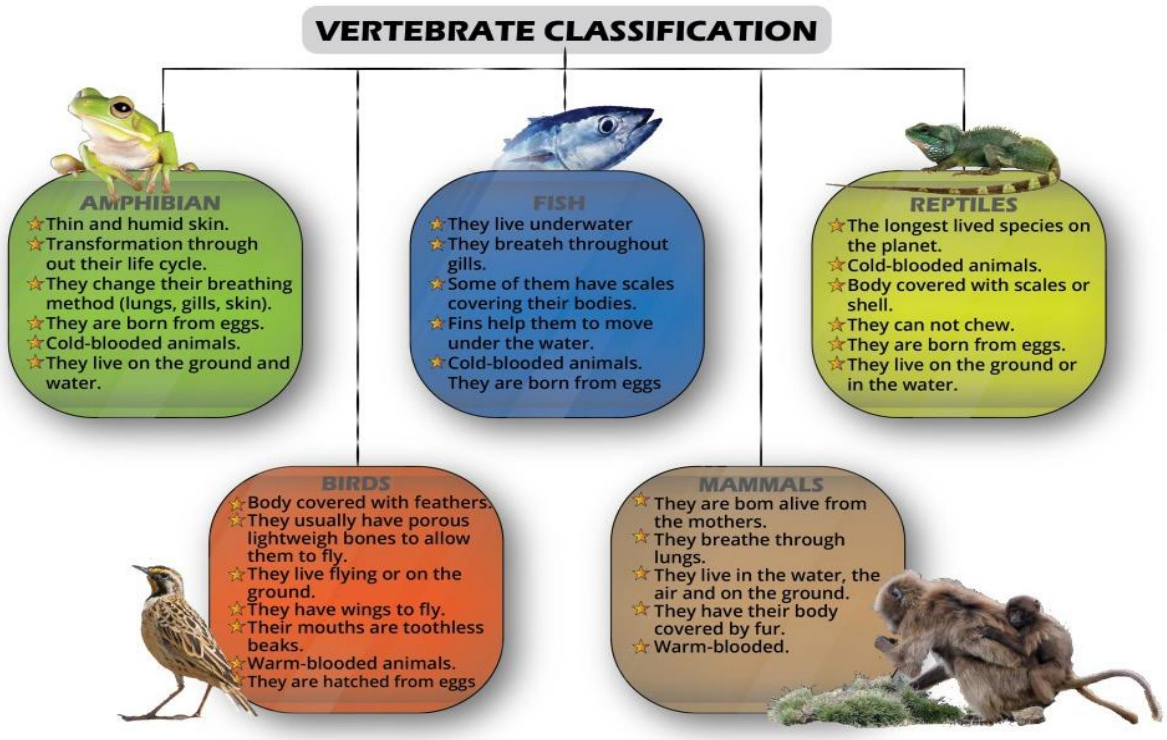
Most animals reproduce sexually. Animals are very diverse. They are generally classified into two groups based on the presence or absence of backbone as invertebrates (animals with no backbone) and vertebrates (animals with a backbone.



Major groups of animals



Major groups of invertebrates



Major groups of vertebrates

2.7 Renowned Taxonomists in Ethiopia

Ethiopia is known for high degree species diversity and endemcity. However, only few studies have been done to identify, name and classify the biodiversity at different levels (e.g., gene, species, and ecosystem).. Among the factors that led to inadequate level of studies done in Ethiopia in the field of biodiversity could be due to the few number of scientists educated and trained in taxonomy despite the country's rich biodiversity.

Yet, as the result of efforts made over the past six decades, our country has trained and educated a couple of renowned taxonomists that contributed the publication of volumes of books on the Flora of Ethiopia, for example. Among these scientists are Dr. Mesfin Taddese, Professor Sebsebe Demissew, Professor Ensermu Kelbessa and Professor Silesh Nemomissa to mention a few of them. In addition, there are few other zoologists like Professor Abebe Getahun; who contributed to the field of animal taxonomy.

Review Questions

Part One (True or False items): Say true if the statement is correct false if the statement is wrong

1. Archaea have very different cell walls from bacteria.
2. Classification is the process of grouping things based on their similarities.
3. Ethiopia is a primary center for *Eragrostis tef* and *Guizotia abyssinica*.
4. Gymnosperm are seed plant that does not make flowers or fruits

5. Linnaeus' developed a four Kingdom system of classification.
6. Some autotrophic bacteria make their own food the way plants do and they are chemosynthetic.
7. The Greek philosopher Aristotle (384-322 BC) developed the first widely accepted biological classification systems.
8. Fungi can reproduce either by vegetative, asexual reproduction through spores formation and sexually.
9. Many animals have two types of specialized cells not seen in other multicellular organisms.
10. Unicellular algae are the basis of aquatic food chains and produce much of the oxygen in Earth's atmosphere.

Part Two (Multiple Choices items): Choose the best answer among the give alternatives.

1. A process by which an organism produces offspring is called.....
A. reproduction B. homeostasis C. development D. inheritance
2. Bacteria that serve as decomposers are
A. photoautotrophs B. chemoautotrophs. C. photoheterotrophs D. chemoheterotrophs
3. All fungi.....
A. are multicelled B. are heterotrophs C. form flagellated spores D. all of the above
4. Most fungi obtain nutrients from .....
A. nonliving organic matter B. living animals C. living plants D. photosynthesis
5. Fungal infections are most common in.....
A. plants B. mammal's C. insects D. birds
6. ..... is the transmission of DNA to offspring.

A. reproduction B. homeostasis C. development D. inheritance

7. Bacteria, Archaea, and Eukarya are three.....
A. famalies B. kigdom C. classes D. domain

8. Organisms require..... and .....to maintain themselves, grow, and reproduce.
A. DNA; energy B. nutrients; energy C. food; sunlight D. DNA; cells

Part Three: Critical thinking questions

1. How do viruses affect human health?
2. What are the major groups of vertebrates?
3. What ecological roles do bacteria play?
4. What ecological roles do fungi play?
5. Write the ecological and economic importance of insects
6. What structural and functional features do bacteria and archaea share?
7. How are plants important?

Answers to Review Questions

Part One (True or False items): Say true if the statement is correct false if the statement is wrong

1, True
2; True
3, True
4, True
5, False
6, False
7, True
8, True
9, True
10, True

Part Two: Multiple Choices: Choose the best answer among the give alternatives

1. A	2.D	3.D	4.A
5. A	6.A	7.D	8. B

Part Tree: Critical thinking questions

1 Viruses cause many diseases, most short-lived and relatively mild, but some that are deadly.

2 Fish, amphibians, reptiles, birds & mammals.

3 Bacteria benefit other organisms by putting oxygen into the air, fixing nitrogen, and acting as decomposers. Some bacteria are human pathogens.

4 Fungi decompose materials, thus releasing nutrients that producers can take up and use. Fungi form mutually beneficial partnerships with plants and green algae. Some ants farm fungus as a source of food. Some fungi are pathogens that invade the tissues of plants and animals.
5 Ecological and economic importance of insects are: pollinators, food sources, removal of wastes and remains, crops pests, disease vectors, parasites & pathogens, etc.

6 Both groups have cell wall & no a nucleus. Both reproduce by binary fission.

7 Food sources (e.g., wheat, rice, tef, potato, tomato, maize, Soybeans, lentils, peas, peanuts, etc.), medicine, source of fabrics (e.g., linen, ramie, hemp, burlap, and cotton), fire wood, construction, ecological, etc.

Unit 3

Cells

3.1. What is a cell?

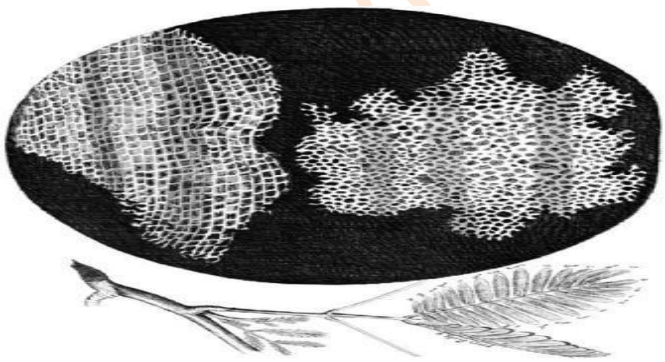
Cell is the smallest and the basic unit of living things. All living things are composed of cells. Some of these living things consist of a single cell and are called unicellular organisms.

For example, paramecium is a unicellular organism. Most of the unicellular organisms are invisible with naked eyes, but there are some exceptions like chicken egg cells which can be seen with naked eyes. The other groups of living things such as plants and animals including humans which consist of many cells are called multicellular organisms. The body of multicellular organisms is composed of many cells of specialized types which work cooperatively.

For example, in the case of human body, everything you do, every action and every thought are possible because of the processes that occur at the cellular level. Each activity of our body is a result of the cooperative work of muscle cells for movement, nerve cells for gathering information and brain cell for interpretation of message to action.

3.2. Cell theory

An English scientist, **Robert Hooke** was the first to observe cells and to use the word cell for structures in living organisms. He did this in 1665 after examining thin slices of plant material **cork.** He was surprised by the regular appearance of the structure, which are 'pore like' regular structures that Hooke called **'cells'**. Each cell appeared to be an empty box surrounded by a wall. Hooke had discovered and described a cell, without realizing that it is the fundamental unit of all living things.



Drawing of cork cells published by Hooke

After Hooke discovered cells in the first half of the seventh century, other early Dutch Microbiologist **Anton van Leeuwenhoek** (1632—1723) used his lenses in building numerous

microscopes, some with magnifications approaching 300X. In 1674 he likely observed protozoa for the first time and several years' later he observed bacteria. Those "very little animalcules" he was able to isolate from different sources, such as rainwater, pond and well water, and the human mouth and intestine. Leeuwenhoek is universally acknowledged as the father of microbiology because, he discovered microorganisms like protists and bacteria.

More than 150 years later, German scientists, **Matthias Schleiden** and **Theodor Schwann** were the first to explain the basic views of **what we now call cell theory.**

In 1838, German botanist Matthias Schleiden, a botanist stated that all plants are made up of cells, and a year in 1839, another German zoologist Theodor Schwann reported that all animals are made up of cells. The two German biologists, established cells as the natural unit and function in living things, the entire animals and plants are made up of these cells. Then a German pathologist**, Rudolf Virchow** (1856) established the idea that cells arise only by the division of existing cells. Based on the above discoveries, the principle of cell theory is developed. The cell theory states that:

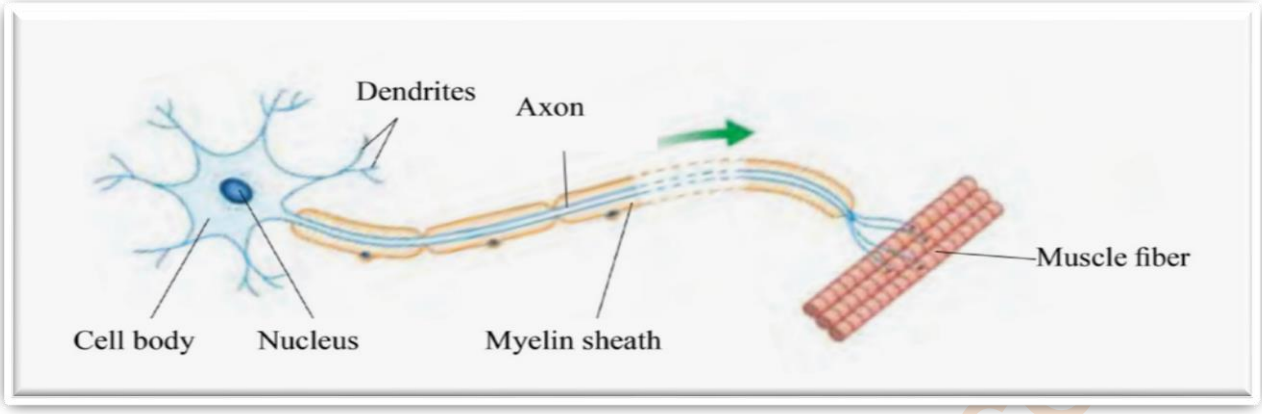
1. Living organisms are composed of one or more cells.
2. Cells are the smallest unit of life
3. Cells arise only by the division of a pre-existing cell.

Cells vary considerably in size and shape but they share certain common features:

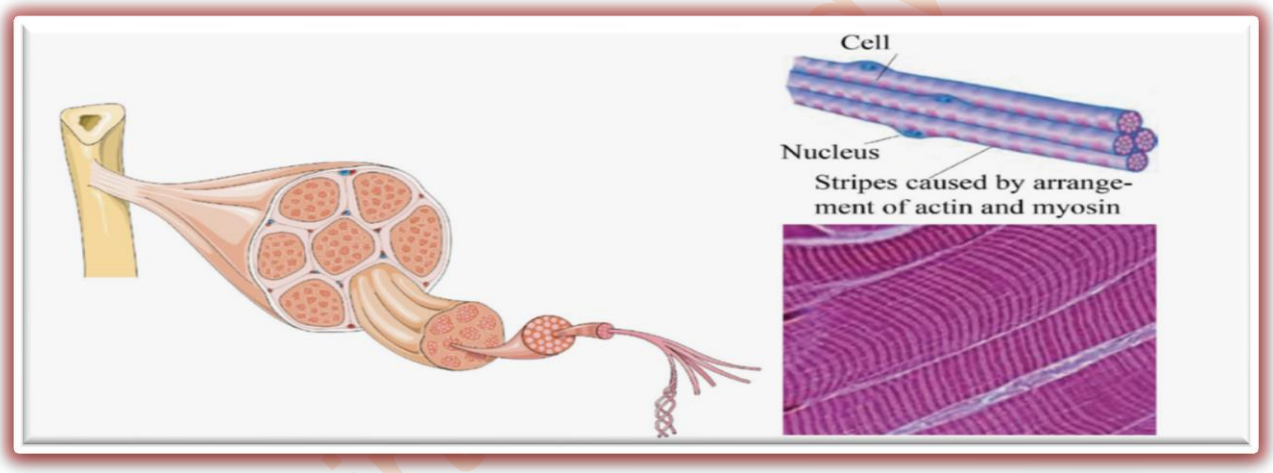
• Every living cell is surrounded by a membrane, which separates the cell contents from everything else outside.
• Cells contain genetic material which stores all of the instructions needed for the cell's activities. Many of these activities are chemical reactions, catalyzed by enzymes produced inside the cell.
• Cells have their own energy release system that powers all of the cell's activities, So cells can be thought of as the smallest living structures – nothing smaller can survive.

3.3. Cell structure and function

Cells have different **structures** which have different **functions**. The organization of cells varies between different organisms. In multicellular organisms, some cells have the same shape and same function but other cells have different shapes and different functions. For example, in the human body, the shape and function of nerve cells are different from that of muscle cells.



Nerve cell

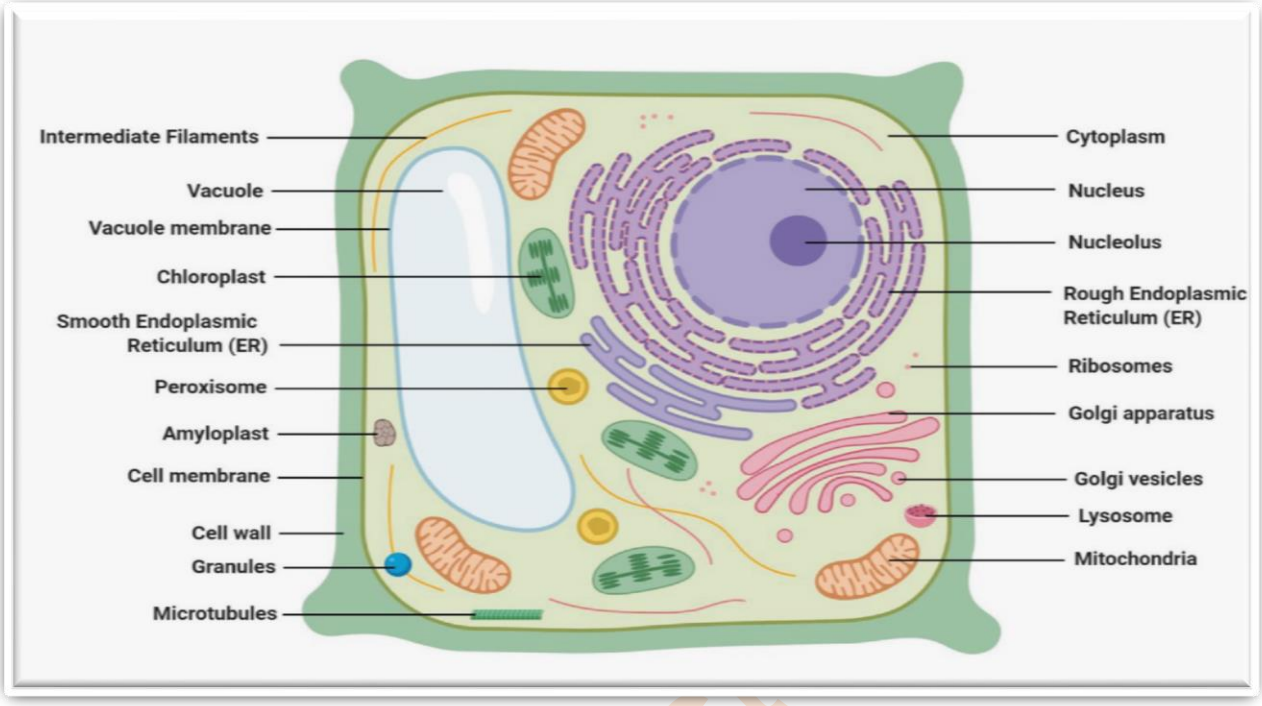


Muscle cells

Cells look like one another in certain important ways. One important similarity between plant and animal cells is the presence of common cell structures. The major structures these cells have in common are:

1. Nucleus
2. Cytoplasm, and
3. Cell (plasma) membrane.

In addition to the above structures, there are many tiny structures in the cytoplasm called **organelles**. An organelle is a distinct structure within a cell having a specific function. Some of these organelles have a membrane, while others without membrane.



Structure of typical plant cell

Cell wall

Cell wall is a rigid structure of a plant cell that provides structural support and gives shape to the cell. It is found external to the cell membrane. Fungal cells, some Protista cells such as algae and bacterial cells also have cell walls. **Animal cells have no cell wall.**

Cell membrane

Cell membrane is an outer covering that separates the cell's interior from its surrounding environment. Cell membrane is a very thin selectively permeable structure. Cell membrane controls what enters into and leaves a cell. It controls the entry of organic molecules, ions, water, and oxygen into and out of a cell. Wastes, such as carbon dioxide also leave a cell by passing through a cell membrane.

Cytoplasm

Cytoplasm is a thick fluid-filled region in the cell containing cell organelles. The fluid material of the cytoplasm consists of 70 to 80 percent water with different organic (proteins, carbohydrates) and inorganic (ions such as sodium, potassium, calcium) molecules dissolved in it. It is also the site where several chemical reactions such as protein synthesis take place.

Nucleus

Nucleus is the largest organelle surrounded by the **double-membrane**. Inside a nucleus, there are thread-like structures called chromosomes that contain a very long molecule of DNA (Deoxyribonucleic acid). The nucleus determines what the cell will be, for example, a blood cell, a liver cell, a muscle cell or a nerve cell. The nucleus also controls cell division. Within a nucleus there is a darker area called the nucleolus, this is the site where new ribosomes are made.

Ribosomes

Ribosomes are small cellular structures that are found in large numbers in all cells. The function of ribosomes is to **synthesize proteins**. They are found either freely in the cytoplasm or attached to the rough endoplasmic reticulum.

Endoplasmic Reticulum

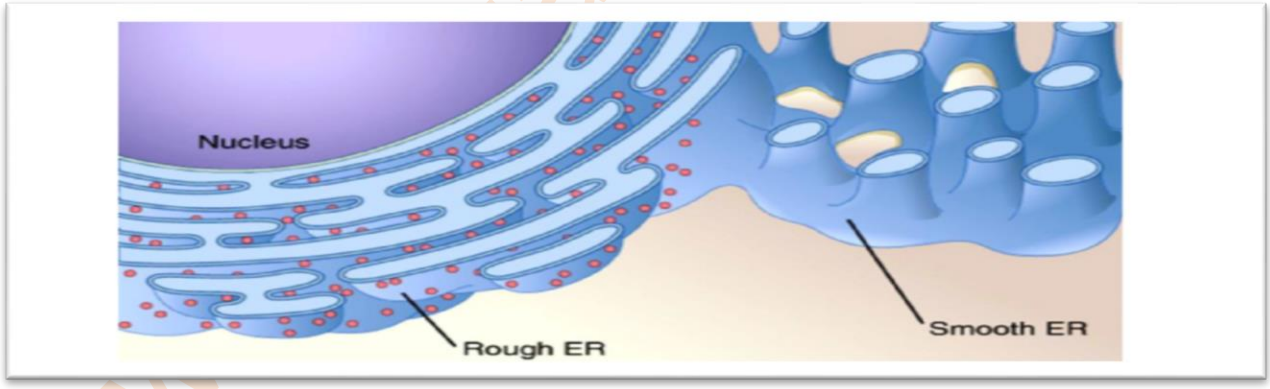
The endoplasmic reticulum is a complex system of interconnected **double membranes**. They contain fluid-filled spaces between the membranes which allow materials to be transported throughout the cell. There are two distinct types of the endoplasmic reticulum.

Rough Endoplasmic Reticulum

It gets its name from the dotted appearance of its surface. These dotted structures on it are the ribosomes. Proteins can be made by these ribosomes. Proteins can be made and stored in the rough endoplasmic reticulum and transported around the cell in the small sacs called vesicles.

Smooth endoplasmic reticulum

This is endoplasmic reticulum without ribosomes. It is important in the manufacturing of lipids.



The Rough and Smooth Endoplasmic Reticulum

Vesicles

Vesicles are a **small stack-like** collection of the membranous sac. They store and transport and ship materials where they need to go. For example**, a protein** made by the rough endoplasmic reticulum may be placed inside a transport vesicle and shipped to the Golgi bodies, where it would be modified and tagged for shipment elsewhere. These vesicles are found in the cell by fusing with the Golgi apparatus.

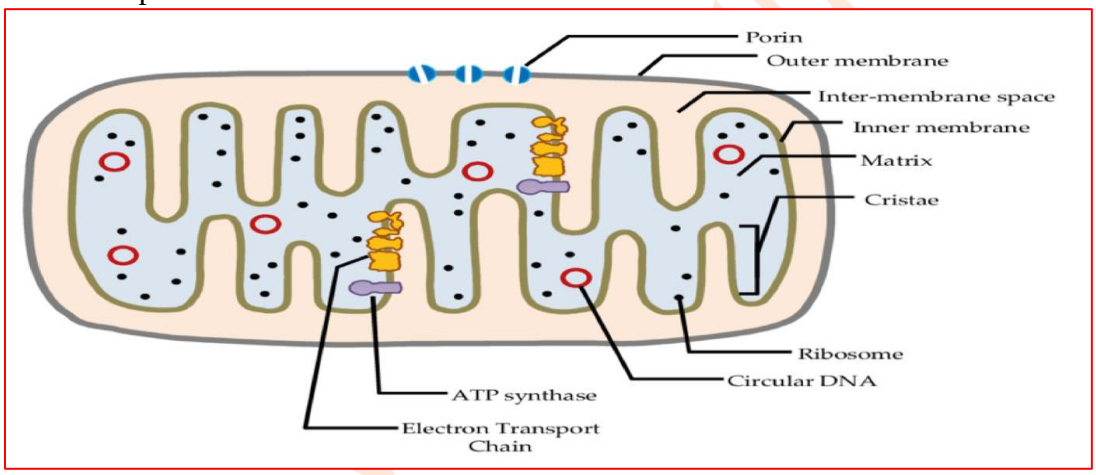
Golgi apparatus (Golgi body, Golgi complex)

Golgi apparatus is a smooth, concave, membranous structure. The Golgi apparatus with the vesicles functions in the collection, packaging, and distribution of molecules within the cell or even outside the cell.

Proteins and lipids manufactured on the rough and smooth endoplasmic reticulum are transported into the Golgi apparatus and modified as they pass through it. These modified proteins and lipids are then packaged into vesicles that pinch off from the Golgi apparatus. These vesicles then diffuse to other locations in the cell, distributing the newly synthesized molecules to their appropriate place.

Mitochondria

Mitochondria are relatively **large organelles** found in the cells. It has **a double membrane**; the outer one controls the entry and exit of materials. The inner membrane forms many folds on which some of the chemical reactions of respiration take place and the site for the synthesis of much energy. Mitochondria are often described as the 'powerhouse' of the cell since they are the sites of respiration.



Mitochondria

Lysosomes

Lysosomes are little membrane-bound packages of **digestive enzymes.** They contain digestive enzymes which can be used to digest bacteria or other cells taken into the cell . It is also break down unwanted or damaged organelles within the cell.

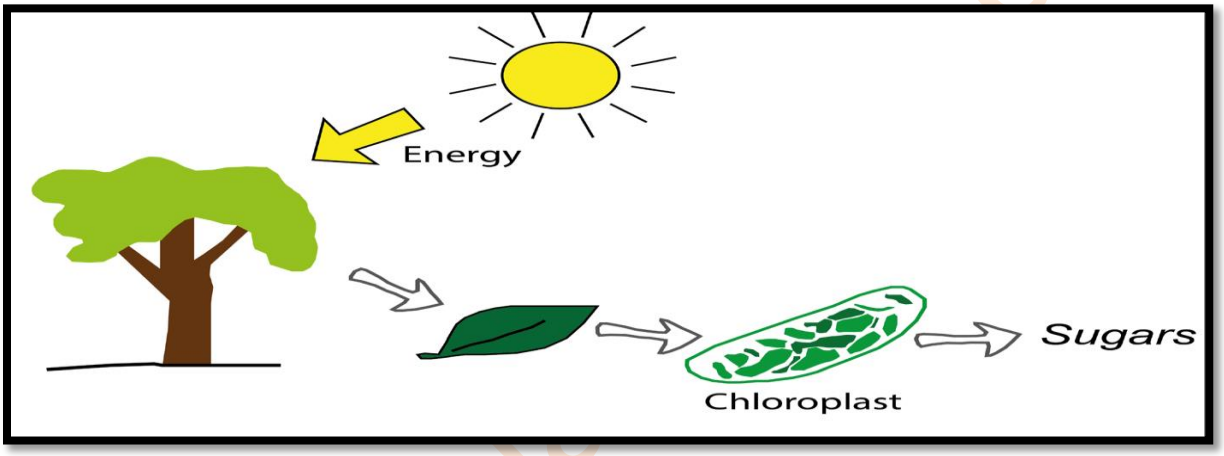
Vacuoles

These are organelles that consist simply of a single membrane with fluid inside. Many plant cells have large vacuoles that occupy more than half of the cell volume. Vacuoles are small in the case of animal cell. Vacuoles perform a variety of functions in different kinds of cells. Food vacuole found in some animals to digest food and in the case of some unicellular organisms there is a contractile vacuole which is function is to expel excess water.

For example, amoebas and many other unicellular eukaryotes have food vacuole in order to eat smaller organisms or food particles, by a process called phagocytosis. Many unicellular protists living in fresh water have contractile vacuoles that pump excess water out of the cell, thereby keeping a suitable concentration of ions and molecules inside the cell.

Chloroplasts

Chloroplasts are also **double membrane**-bounded organelles that occur in the cell of green plants, mostly in the cells of the **leaves.** They are the site for photosynthesis. They contain a green pigment called chlorophyll that can trap the sunlight energy for T=the synthesis of **carbohydrates.**



Chloroplast trapping sunlight energy to synthesize sugar

Centrioles and microtubules

The cytoplasm of cells consists of small cylindrical fibers called microtubules that have a variety of roles, including moving chromosomes during cell division. In addition, animal cells have Structures called centrioles that anchor to microtubules during cell division.

Cilia and flagella

Cilia and flagella are the most common organelles for locomotion in unicellular organisms.

Cilia are short, hair-like structures. Cilia are used for locomotion. It can also be used to create a current in the fluid next to the cell. For example, cilia occur in large numbers on the lining (epithelium) of the air tubes serving the lungs (bronchi).

Flagella are long, thread-like structures, present in lesser number. Flagellum extends from the plasma membrane and enables an entire cell to move. When present, the cell has just one flagellum or a few flagella. When present, cilia are smaller and many.

Cilia and Flagella

3.4 Types of cells

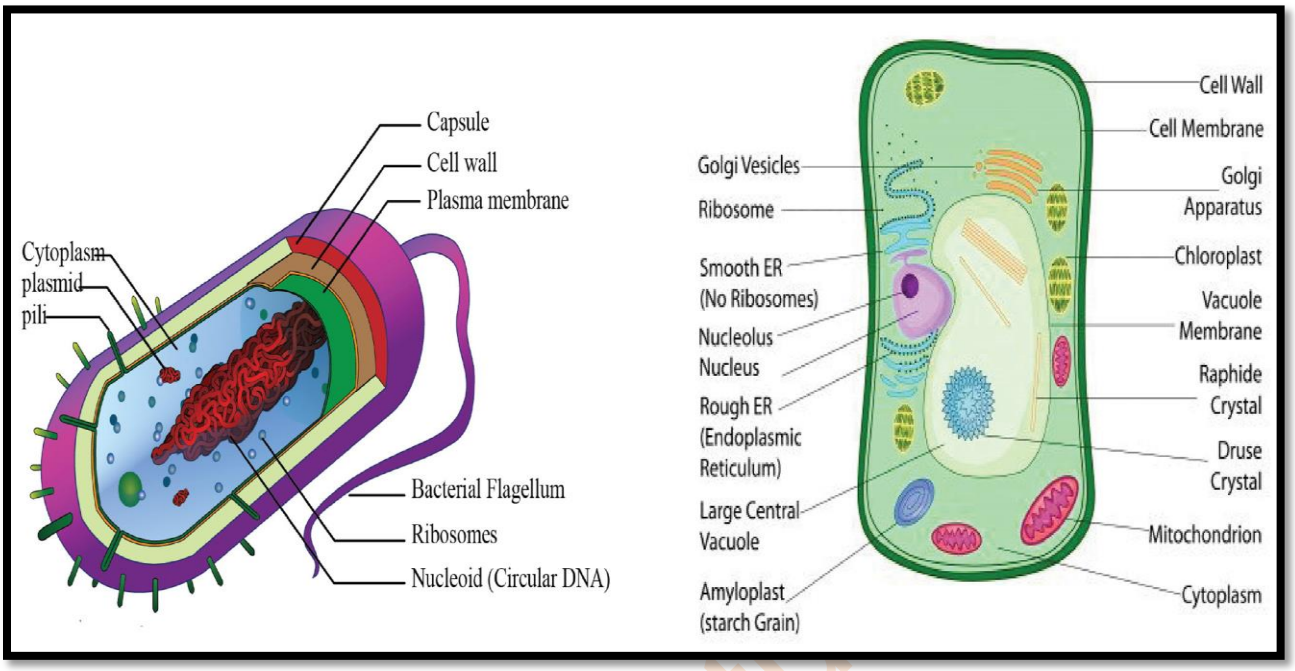
Based on cell structure and cellular organization, cells are grouped into two types. These are **Prokaryotic cells** and **Eukaryotic cells.** Prokaryotic cells are usually much smaller than eukaryotic cells. They have a much simpler structure and are thought to be the first cells to have evolved. Prokaryotic cells such as bacterial cells don't have membrane-bound organelles or a nucleus. Eukaryotes such as plants and animals cells, in contrast, have membrane-bound organelles and a nucleus.

Prokaryotic cells

Prokaryotes are different from eukaryotic cells because of the absence of a nucleus and other membrane-bounded organelles. These Prokaryotic cells are generally much smaller than eukaryotic cells. Most prokaryotic organisms are **unicellular.** The cell wall acts as an extra layer of protection, helps the cell maintain its shape, and prevents dehydration.

Eukaryotic cells

Unlike prokaryotes, eukaryotes have a nucleus and other membrane bound organelles. For example, each organ in an animal's body is specialized to perform a particular role, each organelle in a eukaryotic cell has a distinctive structure and function. Prokaryotic organisms are unicellular but eukaryotic organisms are usually **multicellular.**



A. Structure of a typical prokaryotic cell structure (Example, Bacteria cell) **B**. Structure of a typical eukaryotic cell (Example, plant cell)

Comparison of prokaryotic and eukaryotic cells

Structure	Eukaryotic cells	Prokaryotic cells
Organelles	Membrane-bound organelles (for example, nucleus, ER)	No Membrane-bound organelles
Ribosomes	relatively large	relatively small
Chromosomes	DNA arranged in long strands, associated with proteins	DNA present, not associated with proteins, circular plasmids may also be present
Cell wall	always present in plant cells, made of cellulose, never present in animal cells	always present, primarily made of Peptidoglycan
Cilia and flagella	sometimes present	some have flagella, but these have a different structure from those in eukaryotic cells

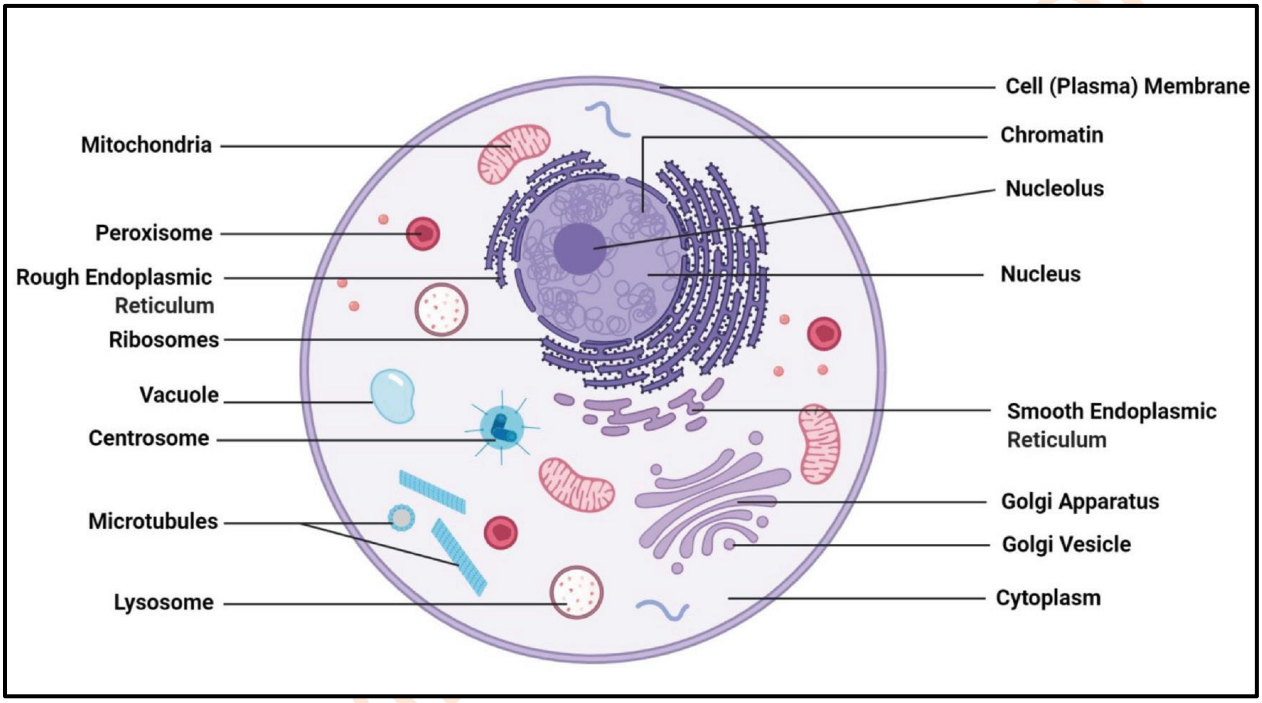
3.5. Animal and plant cells

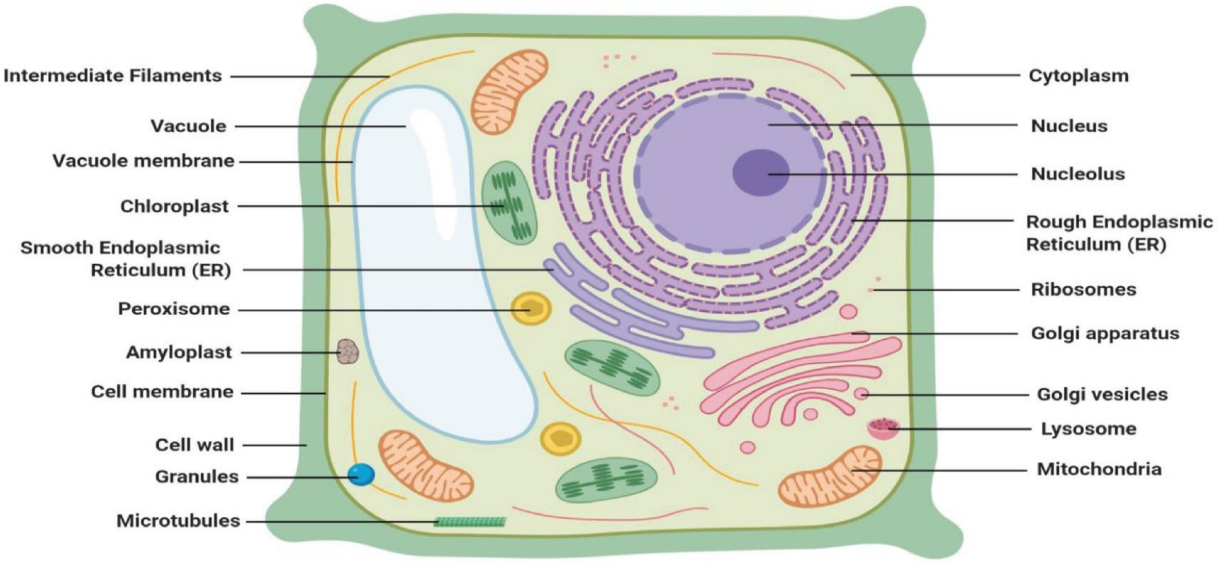
Animal and plant cells have certain features in common like cell membrane, nucleus, cytoplasm, and organelles like mitochondria, and Golgi apparatus. The animal and plant cell structures have also some differences. For example, cell wall, chloroplast and large

Permanent vacuoles are found in plant cells while centriole is found only in animal cells. In addition, plant cells are usually larger and are more easily visible under alight microscope than animal cells. The plant vacuole is surrounded by a membrane and contains fluid.

The fluid in the vacuole is a solution of pigments, enzymes, sugars and other organic compounds (including some waste products), mineral salts, oxygen and carbon dioxide. Vacuoles help to regulate the osmotic properties of cells (the flow of water inwards and outwards). Chloroplasts are found in the green parts of the plant, mainly in the leaves.

A





B

A. Animal cell as seen with an electron microscope
B. Plant cells as seen with an electron microscope

3.6 The cell and its environment

The Cell membrane

As previously mentioned, the cell membrane is a selectively (semi) permeable structure that controls what enters and leaves cells.

Cells need food materials to get energy or to build up its cell structures. Cells also need salts and water, which play a part in chemical reactions in the cell. Cells also need to remove unnecessary substances such as carbon dioxide.

The structure of a cell known as cell membrane is **semi-permeable**; it controls the entering of necessary substances and the removal of unnecessary ones. Materials can pass through the cell membrane either **passively by diffusion** and **osmosis or actively by active transport.**

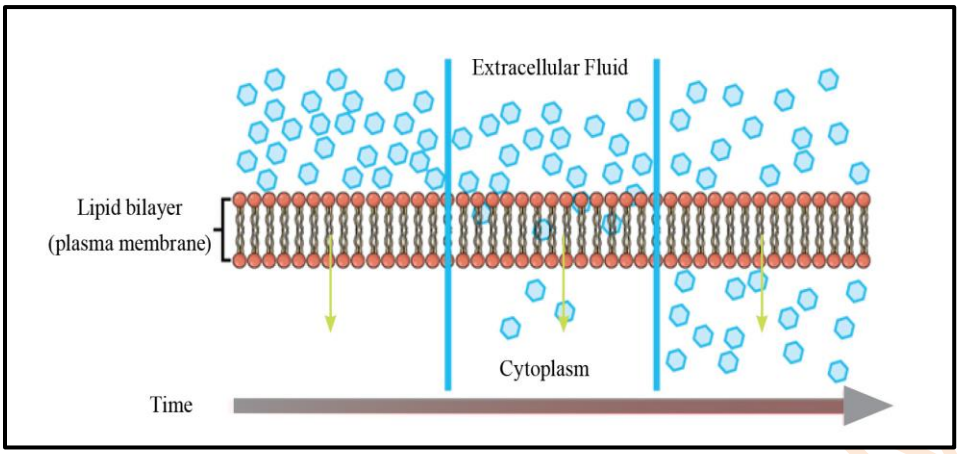
3.6.1 Passive transport

Passive transport is the movement of substances down a concentration gradient. This movement is from an area of high concentration to an area of lower concentrate on with-out the need for input of energy.

Diffusion

This is the movement of molecules from a region of **high concentration** to a region of **low concentration** down the concentration gradient. Diffusion is a passive transport of molecules; the molecules need only spread themselves, or diffuse, across the membrane. The diffusion of gases and solutes is important for any activity of the cell. For example, oxygen is important for

respiration and get into the cell by diffusion.



Diffusion through a semi-permeable membrane of cell.

Factors influencing the rate of diffusion:

Concentration gradient: the higher the difference in the concentration of a substance on either side of a membrane, the faster it will tend to diffuse from higher concentration to lower.

Temperature: increase in temperature causes an increase in the kinetic energy that molecules and ions possess enabling them to move faster.

Mass of the molecule: heavier molecules move more slowly; therefore, they diffuse more slowly while lighter molecules diffuse faster.

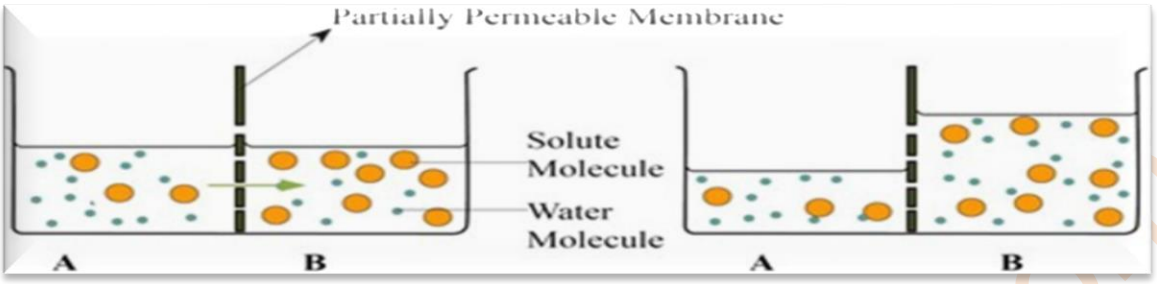
Distance travelled: the farther the distance that a substance must travel, the slower the diffusion rate.

Surface area: The greater the surface area, the faster the total diffusion is. Cells that are involved in rapid absorption, such as those in the kidney or the intestine, often have their 'free' surface membrane formed into hundreds of tiny projections called microvilli which increase the absorbing surface.

Osmosis : Osmosis is a special case of diffusion. Like other substances water can also move passively through cell membrane. It moves from a region of high concentration of water molecules (lower solute concentration) to a region of lower concentration of water molecules (higher solute concentration).

The movement of water is affected by the concentration of substances (solutes) dissolved in the

water. Basically, water moves from areas where there is more water to areas where less water is.



Osmosis

1. before osmosis: two solutions are separated partially permeable membrane. B has a higher solute concentration than A. The soluble molecules are too large to pass through the pores in the membrane but the water molecules are small enough.
2. As the arrows in diagram A indicate, more water molecules moved from A to B than from B to A, so the net movement has been from A to B, raising the level of the solution in B and lowering in A.

The movement of water into and out of the cell depends on the type of solution found in the cell surrounding (Environment found outside the cell). When a cell is in a **hypertonic solution**, water moves out of the cell, causing the cell to **shrink or plasmolysis.**

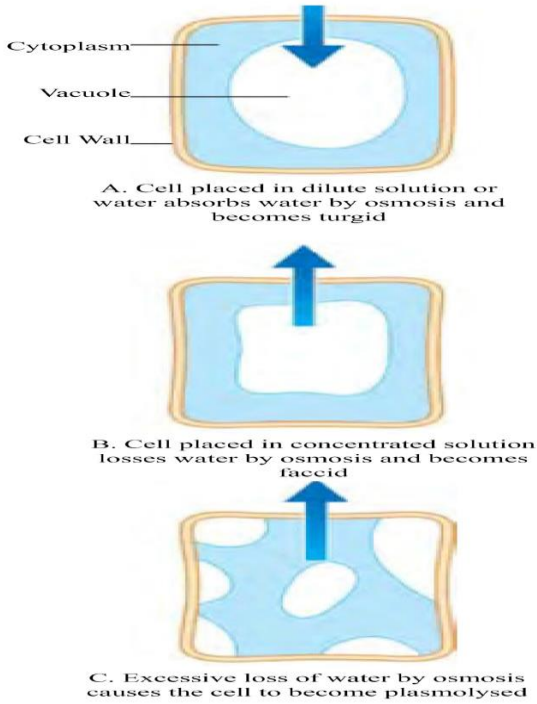
In an isotonic solution, water diffuses into and out of the cell at the same rate, with no change in cell size. **In a hypotonic solution**, water moves into the cell and pressure are applied to the plasma membrane causing **turgidity of the cell.** The strong cell wall of plant cells can resist this pressure to keep the cell from rupturing. This is not the case with animal cells as animal cells lack cell wall.

Osmosis in Plant cells

Osmosis in plants is very important to bring strength and rigidity to the plant cell. If a plant cell is surrounded by water or a solution more dilute than its contents (hypotonic solution), water will pass into the vacuole of the plant. The vacuole will expand and press outwards on the cytoplasm and cell wall. Then, the rigid cell wall expands and exerts the pressure back, preventing the cell from taking in too much water and bursting. The plant becomes very turgid, due to the pressure of water pressing outwards on the cell wall.

Turgor pressure is necessary for plants to retain their upright posture and the extended state of their leaves. In contrast, if a plant cell is surrounded by water or a solution less dilute than its contents (hypertonic solution), plant cells lose water and there will no longer be any water

pressure pressing outwards against the cell walls, the plasma membrane shrinks pulls away from the cell and the cell get plasmolysed. The plasmolysed cell wilts and eventually dies.



Osmosis in plant

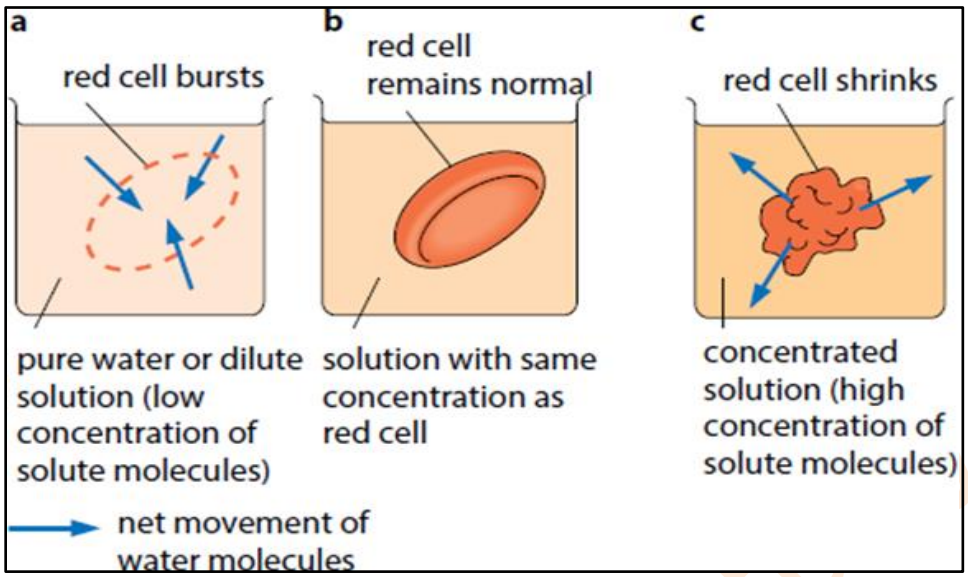
Osmosis in Animal Cells

The excessive uptake or loss of water by animal cells causes damages to cells. The survival of an animal cell, thus, depends on its ability to balance water uptake and loss.

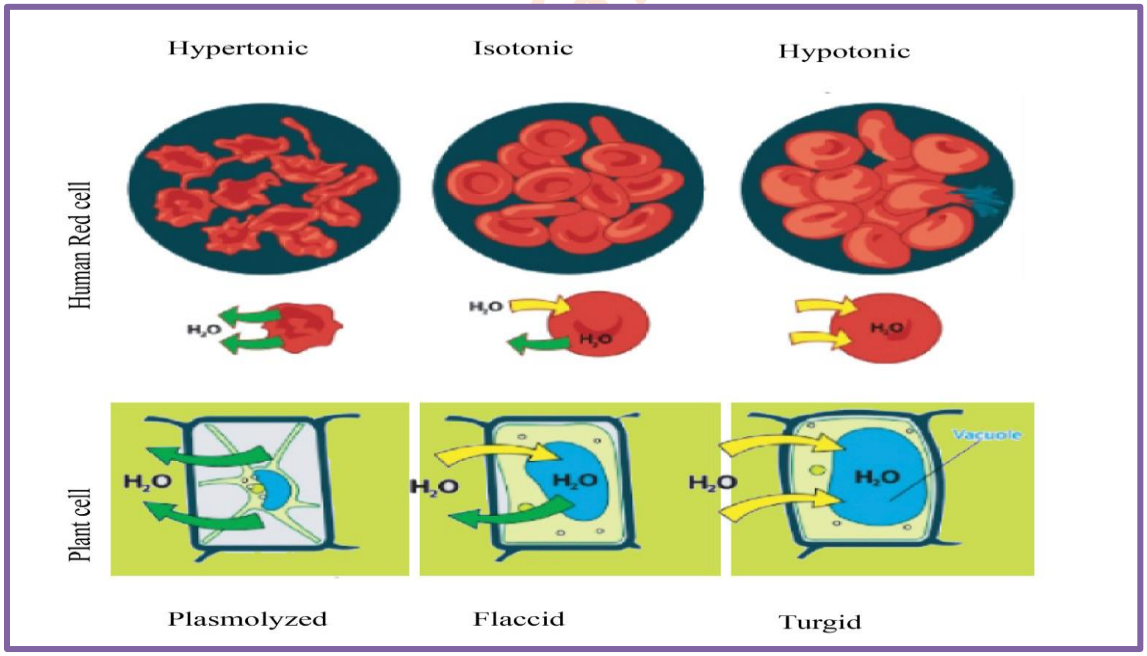
In the case of animals particularly vertebrates, the concentration of water in the blood is monitored by the brain and adjusted by the kidneys. The regulation of water flow is by keeping the blood concentration within narrow limits, the concentration of the tissue fluid remains more or less constant.

The animal cell should be surrounded by fluid or blood plasma which has the same concentration of water as the cell contents; there is no net flow of water into or out of the cells. If not balanced, osmosis can cause a serious problem in the animal cell. For Example, if the surrounding solution has a high concentration of water (hypotonic) than the cells, water will move into the cells by osmosis.
Water entering the cell will make the cell swell up. Animal cells have no cell wall and the membrane has little strength, water would continue to enter and the cells will eventually burst. This process is called hemolysis of the cell which can occur in red blood cells. Conversely, if the

surrounding solution has a low concentration of water (hypertonic) than the cells, water will pass out of the cell by osmosis and the cell will shrink.



(A) Shows that if the water concentration of the solution surrounding the red blood cell is too high, the water moves to the cell and the cell swells and bursts. **(B)** If the water concentration in red blood cell and the surrounding solution is the same. **(C)**If the water concentration of the solution surrounding the red blood cell is low, the water moves from the cell to the surrounding solution and the cell shrinks.



Osmosis in plants and animal cell

Osmosis in Ameba

Unicellular protozoans such as amoeba have contractile vacuoles. Contractile vacuole are membranous structures which controls the intracellular water balance by accumulating and expelling excess water out of the cell, allowing cells to survive under hypotonic stress as in pond water participate in osmoregulation of the cell and prevent the bursting of cells.

The unicellular protozoans which dwell in freshwater consume excess water, with the help of contractile vacuoles they drain excess water out. It also helps them to protect the cell in the absence of cell wall. Without these vacuoles, they might take in too much water, swell and burst out.

3.6.2 Active transport

Active transport is the movement of molecules from areas where they're less concentrated to areas where they're more concentrated using **energy**. Active transport enables cells to use their stored energy to concentrate molecules inside or outside of the cell.
Active transport enables cells to use their stored energy to concentrate molecules inside or outside of the cell.

Active Transport is the movement of particles through a cell membrane from a region of lower concentration to a region of higher concentration against a concentration gradient, using the energy released during respiration. Cells sometimes take in substances even though there is already a higher concentration inside than outside. The substance is absorbed against the concentration gradient. Less commonly, cells sometimes pump substances out, even though there is already a larger concentration outside. Some of the examples are: ion uptake by root hairs and uptake of glucose by epithelial cells of villi.

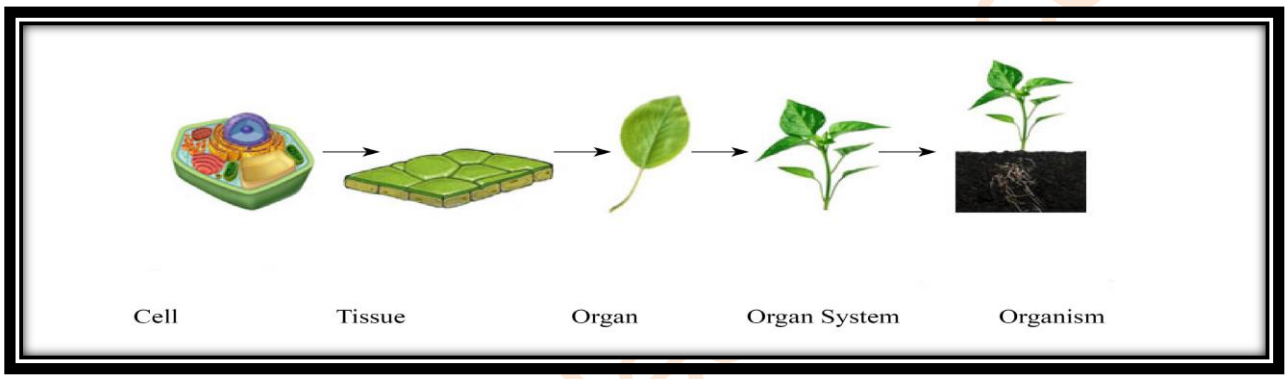
3.7. Levels of Biological Organization

Life forms a hierarchy of organization from atoms to complex multicellular organisms. Atoms are joined together to form molecules, which are assembled into more complex structures such as organelles. These in turn form subsystems that provide different functions. Cells can be organized into tissues, then into organs and organ systems such as the nervous system. This organization then extends beyond individual organisms to populations, communities, ecosystems, and finally the biosphere.
The organization of the biological world is hierarchical—that is, each level builds on the level below it:
The cellular level. At the cellular level, **atoms,** the fundamental elements of matter, are joined by s chemical bond into clusters called **molecules**. Complex biological molecules are assembled into tiny structures called **organelles** within membrane-bounded units we call **cells.**

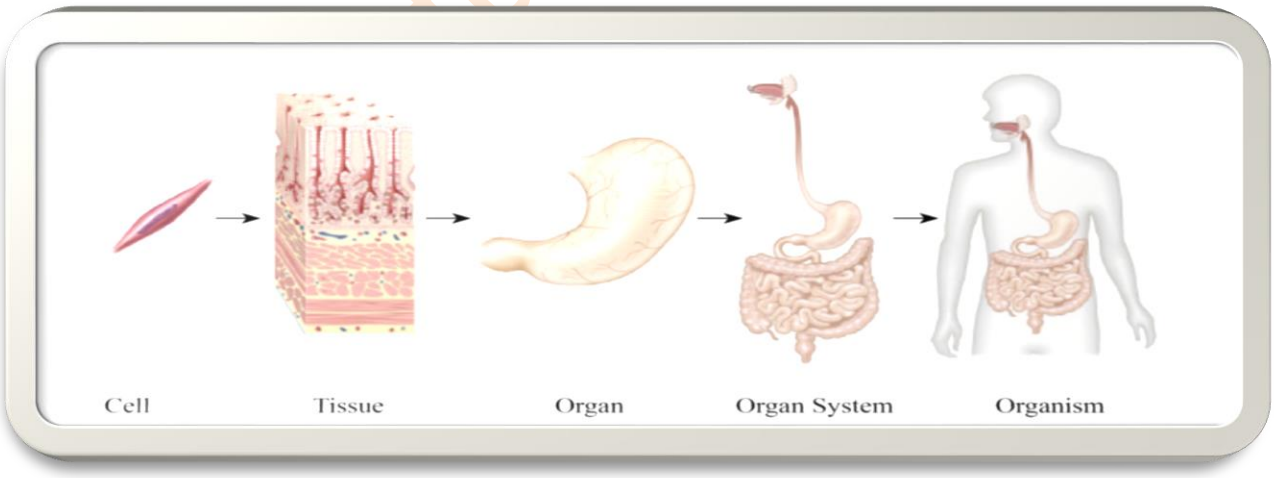
Most cells, when they have finished dividing and growing, become specialized. When cells are specialized, they do one particular job, they develop a distinct shape and special kinds of chemical changes take place in their cytoplasm

The organism level. Cells in complex multicellular organisms exhibit three levels of an organization. The most basic level is that of tissues (for example nerve tissue), which are groups of similar cells that act as a functional unit. The cells of each type have a similar structure and function so that the tissue itself can be said to have a particular function; for example, muscles contract to cause movement, xylem carries water in plants. The tissues of the leaf include the epidermis, palisade tissue, spongy tissue, xylem and phloem.

Tissues, in turn, are grouped into organs body structures composed of several different tissues that act as structural and functional units. For example, your brain is an organ composed of nerve cells. Organs consist of several tissues grouped to make a structure with a special function.



Level of organization in plants



Level of organization in Animals

Review Questions

i. Match the following organelles under column 'B' with their functions under column 'A'

A	B
1. Protein export	a. Mitochondria
2. Control cellular activity	b. Golgi apparatus
3. Digestion	c. Nucleus
4. Powerhouse of the cell	d. Lysosome
5. Photosynthesis	e. Chloroplast

ii. Choose the best answer for the following questions

1. Which one of the following structures is found in animal cells, but not in plant cells?
A. cell surface membrane B. centriole C. chloroplast D. Golgi body
2. When the cell or the surrounding environment contains a relatively high concentration of water, we call it:
A. isotonic B. hypertonic C. hypotonic D. Osmotic
3. Which structure is found in plant cells but not in animal cells?
A. Cell membrane B. Mitochondrion C. Cell wall D. Nucleus
4. In which direction does the transport of water occur when a cell containing 1% sodium chloride is placed in seawater that contains 10 % sodium chloride?
A. From the cell to seawater B. From seawater to cell
5. If you look into a microscope and view an unknown cell. What structure might you see that would tell you that the cell is eukaryotic?
A. DNA B. nucleoid region C. a plasma membrane D. membrane-enclosed structures Called organelles.

iii. Fill in the blank space with appropriate words

1. A structure that supports and strengthen plant cell is_____
2. A structure that breaks down a captured bacterium and damaged organelle in the cell is._____
3. The sac-like structure used to transport protein is _____.
4. A structure made up of a group of tissues, working together to perform a specific Function is_____.
5. When the osmotic pressure is the same on both sides of a semipermeable membrane, each solution is said to be_____.

iv. Answer the following questions.

1. What would happen to a person's red blood cells if the person is given an injection of pure water (0% saline)?
2. Name three structures in plant cells that animal cells lack.
3. Name two structures that may be found in animal cells but not in plant cells.
4. List the structural features that prokaryotic and eukaryotic cells have in common. Briefly explain why each of the structures you have listed is essential.

5. Assume that you are observing animal cell under the microscope and the animal cell looks shrives what type of environment or solution is found around this animal cell.

1. Fill the following table space by saying YES or No

Cell structure s	cheek cell (animal)	Onion cell (plant)
Nucleus		
cell wall		
chloroplasts		
large vacuole		
Cytoplasm		

2. Fill the blank spaces of the table with appropriate level organization of some organ system

Cell	Tissue	organ	system
Red blood cell	cardiac muscle	Heart	
Egg, sperm	Epithelial tissue of male and female reproductive organ		Reproductive system
Mucous cell	Epithelial digestive tissue		Digestive system
Xylem or phloem cells	Xylem /phloem	root /stem	
Nerve cell	Nerve tissue		Nervous system

3. Fill in Fill the blank spaces of the table by saying YES or NO

	Diffusion	Osmosis	Active transport
It is the movement of substances like O_2			
It is movement of water			
Movement of ions like K^+			
Energy is required			

Answer to Review Questions

Matching

1. B, 2. C 3, d 4, a 5, e

Fill in the blanks

1. Cell wall. 2. Lysosomes. 3. Vesicles. 4. Organ. 5. Isotonic.

Choose the best answer

1.B 2.C 3.C 4.A 5. D

Short answer questions

1 The red blood cell burst by receiving more water.

2. Cell wall, chloroplast and large vacuole

3. Centrioles and lysosomes

4.similarity between eukaryotic and prokaryotic cells

- Cell membrane
- Genetic material
- Ribosomes
- Cytoplasm
- Cell size
- Cell arrangement
- True membrane –bounded nucleus

5. The cell surrounding environment is hypertonic (contain more solute than the cell)

1,complete this table by using ticks and crosses to indicate if the structures are present or not.

cell structures	cheek cell (animal)	onion cell (plant)
nucleus	x	X
cell wall		X
chloroplasts		X
large vacuole		X
cytoplasm	x	X

2. Fill in Fill the blank spaces of the table with appropriate level organization of some organ system

Cell	Tissue	Organ	system
Red blood cell	cardiac muscle	Heart	Circulatory system
Egg, sperm	Epithelial tissue of male and female reproductive organ	Ovary, testes	Reproductive system
Mucous cell	Epithelial digestive tissue	Stomach, intestine	Digestive system
Xylem or phloem cells	Xylem /phloem	root /stem	Vascular system
Nerve cell	Nerve tissue	Brain	Nervous system

3. Fill the blank spaces of the table by saying YES or NO

	Diffusion	Osmosis	Active transport
It is the movement of substances like O_2	YES	NO	NO
It is movement of water	NO	YES	NO
Movement of ions like K^+	NO	NO	YES
Energy is required	NO	NO	YES

Unit 4

Reproduction

4.1 Introduction to reproduction

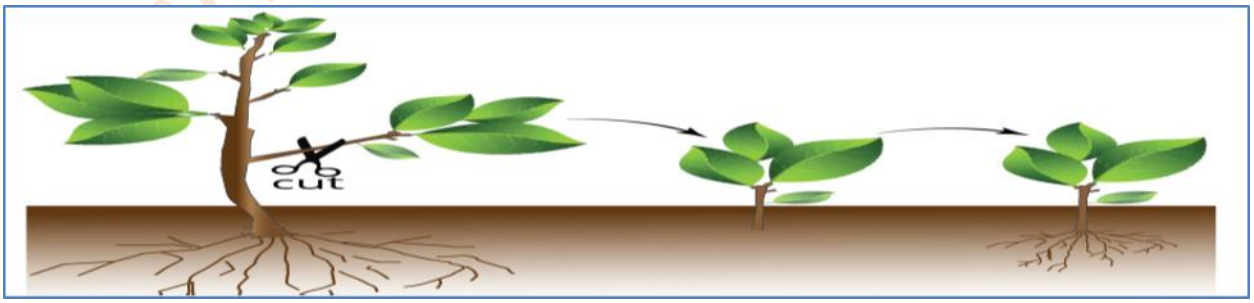
Reproduction is one of the unique characteristics of life. The ability of organisms to reproduce to form their own kind is the one characteristic that best distinguishes living things from nonliving matter. Two modes of reproduction are recognized: asexual and sexual. In asexual reproduction, there is only one parent and with no special reproductive organs or cells.

Each organism is capable of producing identical copies of it as soon as it becomes an adult. Sexual reproduction as a rule involves two parents, each of which contributes special germ cells (egg or sperm) that in union (fertilization) develop into a new individual.

4.2 Asexual reproduction

Asexual reproduction is the production of individuals without gametes (eggs or sperm). It includes a number of distinct processes, all without involving sex or a second parent. Asexual reproduction appears in bacteria and unicellular eukaryotes and in many invertebrates, fungi and plants. However, asexual reproduction is absent among vertebrates. The basic forms of asexual reproduction are fission (binary and multiple), budding, and fragmentation. For example, a small piece of stem planted in the soil may form roots and grow into a complete plant.

Asexual reproduction has couple of advantages - no mate is needed; no gametes are needed; all the good characteristics of the parent are passed on to the offspring; and offspring will grow in the same favorable environment as the parent. Plants that reproduce asexually usually store large amounts of food that allow survival. The disadvantages are there is little variation created, so adaptation to a changing environment (evolution) is unlikely. If the parent has no resistance to a particular disease, none of the offspring will have resistance. Lack of dispersal can lead to competition for nutrients, water and light.



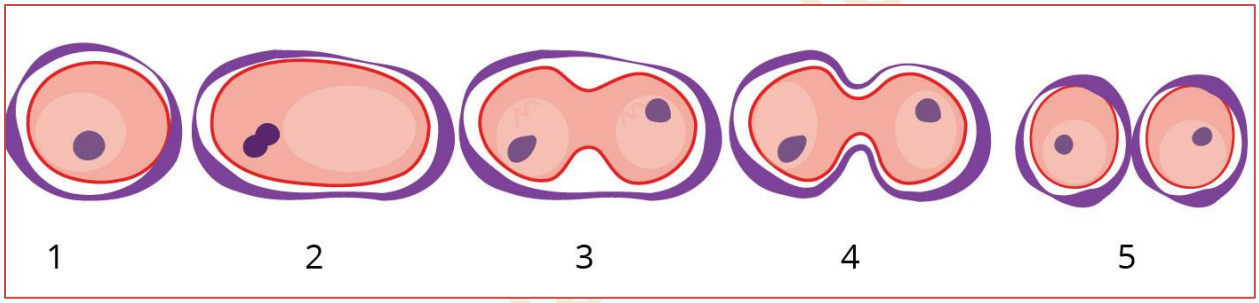
Vegetative propagation in plants

4.3 Types of asexual reproduction

4.3.1 Fission

In fission, the organism divides into two (binary fission) or more (multiple fission) equal parts. Binary fission is common among bacteria, algae and protozoa. In binary fission, the body of the unicellular parent divides by mitosis into two approximately equal parts, each of which grows into an individual similar to the parent. In bacteria, the cell simply divides into two and each new cell becomes an independent organism.

However, before a bacterium divides, the bacterial nucleus is replicated (copied) to produce two identical copies so that the daughter cells receive one copy each. Alternatively, the nucleus of the orgasms divide repeatedly and each daughter nucleus breaks away together with a small portion of the cytoplasm, resulting in the production of many daughter cells. This is common among some parasitic protozoa, for example, malarial parasites. Also, some invertebrates reproduce through fission.

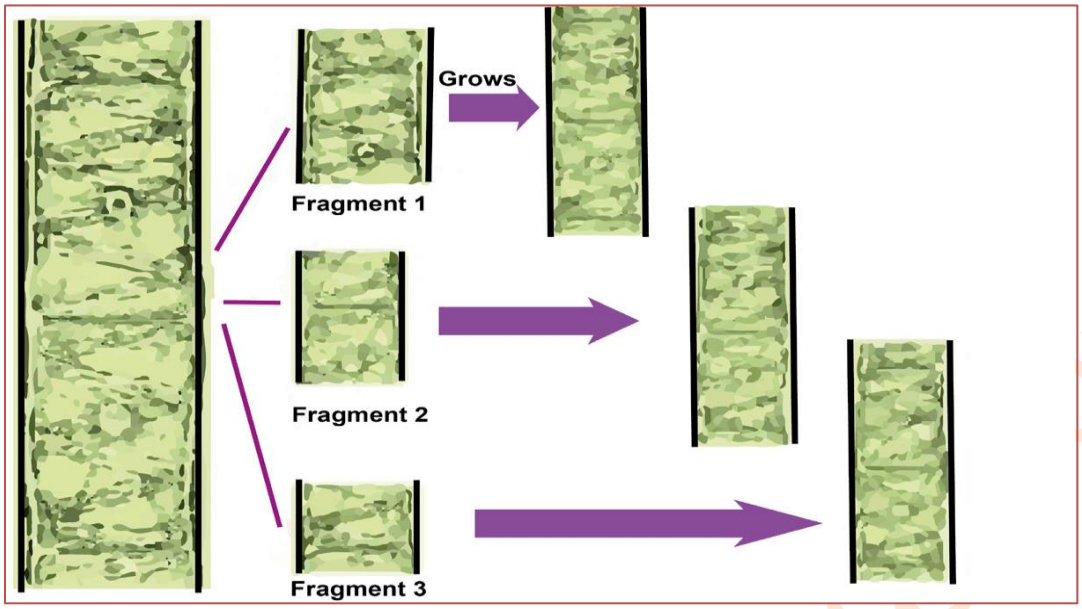


Binary fission in bacteria

4.3.2 Fragmentation

Fragmentation is one of the most common modes of **asexual reproduction** involving the breakdown of a parent organism into parts that develop into whole organism. Fragmentation is observed in fungi, plants, animals and algae. For Example, Spirogyra, the filamentous green algae undergoes fragmentation which results in many filaments.

Each filament grows into matured filament Also a multicellular animal (e.g. Worms) breaks into two or more parts, with each fragment capable of becoming a complete individual. Many invertebrates can reproduce asexually by simply breaking into two parts and then regenerating the missing parts of the fragments.

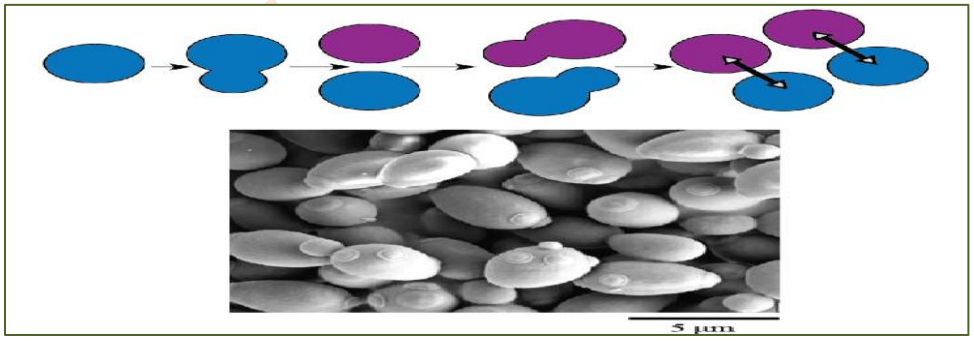


Fragmentation in filamentous green-algae

4.3.3 Budding

Another common type of asexual reproduction is **budding.** In this mode of reproduction, the organism divides into two unequal parts. It is common in fugal species and invertebrates. During the process, a bulge forms on the side of the cell, the nucleus divides mitotically, and the bud ultimately detaches itself from the mother cell.

For example, in some fungi such as **yeasts**, a bud develops on the surface of either the yeast cell or the hypha, with the cytoplasm of the bud being continuous with that of the parent cell. The nucleus of the parent cell then divides; one of the daughter nuclei migrates into the bud, and the other remains in the parent cell. Budding also occurs commonly in some invertebrate animals.



Budding in yeast

4.3.4 Vegetative propagation

Vegetative propagation is a method of asexual reproduction in plants where structures with

lateral meristems such as roots, stems, bud, and leaves give rise to new self-supporting individual. The following are types of vegetative reproduction.

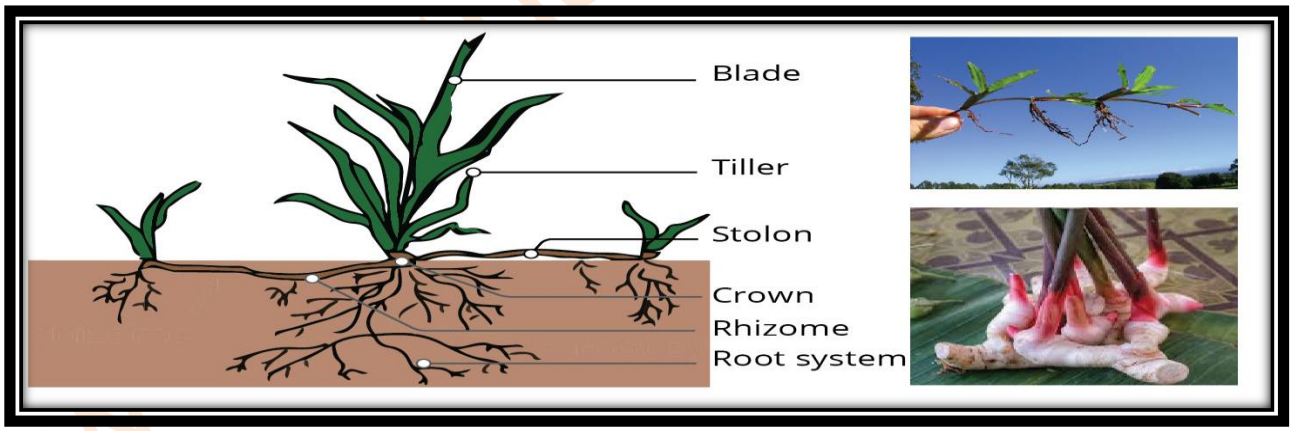
Stolons (runners)

Runners originate from auxiliary bud in a lower portion of plant and grow along the surface of the soil. In the cultivated strawberry, for example, leaves, flowers, and roots are produced at every other node on the runner. Just beyond each second node, the tip of the runner turns up and becomes thickened. This thickened portion produces first adventitious roots and then a new shoot that continues the runner. Thus a complete plant may develop and take root at the node, nourished for a time by food sent from the parent plant through the stolon. Eventually, the stolon dries up and withers, leaving an independent daughter plant growing a short distance away from the parent.

Rhizome

In many plants, horizontal shoots arise from lateral buds near the stem base and grow under the ground. Such underground horizontal stems are called rhizomes. At the nodes of the rhizome are buds, which may develop to produce shoots above the ground.

The shoots become independent plants when the connecting rhizome dies. Many grasses propagate by rhizomes; the couch grass.



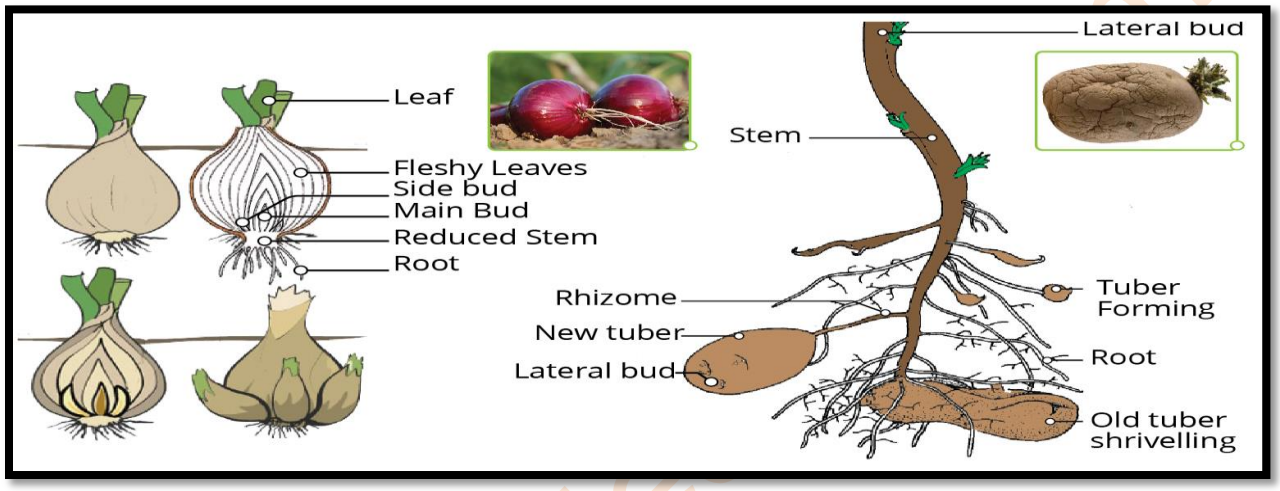
Reproduction using **stolon** and **rhizomes**

Corms: Corms are similar to rhizomes, except they are more rounded and fleshy (such as in gladiolus). Corms contain stored food that enables some plants to survive the winter.

Tubers: Tubers are modified stems that may store starch, as seen in the potato (Solanum sp.).

Tubers arise as swollen ends of stolons, and contain many adventitious or unusual buds. If the tubers are left in the ground or transplanted, the buds will produce shoots, using food stored in the tuber

Bulb: A bulb, which functions as an underground storage unit, is a modification of a stem that has the appearance of enlarged fleshy leaves emerging from the stem or surrounding the base of the stem.



Asexual reproduction with **tuber** and **bulb**

4.3.5 Parthenogenesis

Some species of animals (e.g., bees) are able to reproduce asexually. Among common honeybees (*Apis mellifera*), a queen bee might lay 2,000 eggs per day. Nearly all of these eggs are fertilized by sperm the queen has received during one of her nuptial fights, and each one of these eggs will develop into one of the worker bees of the colony every one of them a female.

A queen can, however, choose to let some of her eggs go unfertilized; no sperm from a male ever fuses with these eggs, yet bees develop within them and hatch from them. Since egg and sperm do not come together in this process, this is not sexual reproduction. Instead, each of these bees has been derived through parthenogenesis: a form of asexual reproduction in which an unfertilized egg develops into an adult organism. Among the honeybees, all the bees derived through parthenogenesis are males these are the few drones of a bee colony.

4.4 Sexual reproduction in Humans

Sexual reproduction involves the production of sex cells. It almost always involves two parent organisms. These sex cells are called gametes and they are made in reproductive organs. The gametes are produced through meiosis.

Sexual reproduction starts with the union of sperm and an egg in a process called fertilization. This can occur either inside (internal fertilization) or outside (external fertilization) the body of the female. Fertilization results in the formation of a single cell called a zygote. The zygote then

grows into a new individual. The female gametes are always larger than the male gametes and are not mobile.

4.5 Primary and secondary sexual characteristics

The human males are born with the **penis, scrotum** and **testicle** whereas females are born with **vagina, uterus**, and **ovaries.** These are the **primary sexual characteristics** in males and females, respectively. At puberty or adolescence these characteristics change markedly.

Puberty begins in the early teen years. **Puberty or adolescences** the time when secondary sex characteristics begin to develop. **Secondary sexual characteristics** begin to develop so that sexual maturity is reached. Sexual maturity means that the potential for sexual reproduction exists. Secondary sexual characteristics in males include:

- Growth and maintenance of the male sex organs,
- An increase in body hair, an increase in muscle mass,
- increased growth of the long bones of the arms and legs, and
- deepening of the voice.

The glands of the endocrine system release hormones which control the development and activity of the male reproductive system. The changes that occur during puberty are controlled by sex hormones. These hormones are secreted by the endocrine system. The onset of puberty in males causes the hypothalamus to produce several kinds of hormones. These hormones interact with the pituitary gland.

Puberty in females begins in the early teen years. In females, luteinizing hormone (LH) causes eggs to be released into the oviduct whereas FSH stimulates the development of follicles in the ovary. A follicle is a group of epithelial cells. These epithelial cells surround a developing egg cell. Follicle stimulating hormone (FSH) also causes a hormone called estrogen to be released from the ovary. It is responsible for the secondary sex characteristics of females. Secondary sexual characteristics in females include:

• Increase in growth rates of the long bones of the arms and legs.
• Develop more hair, especially under the arms and in the pubic area.
• The hips broaden, and more fat is deposited in the breasts, buttocks, and thighs.
• The menstrual cycle begins.

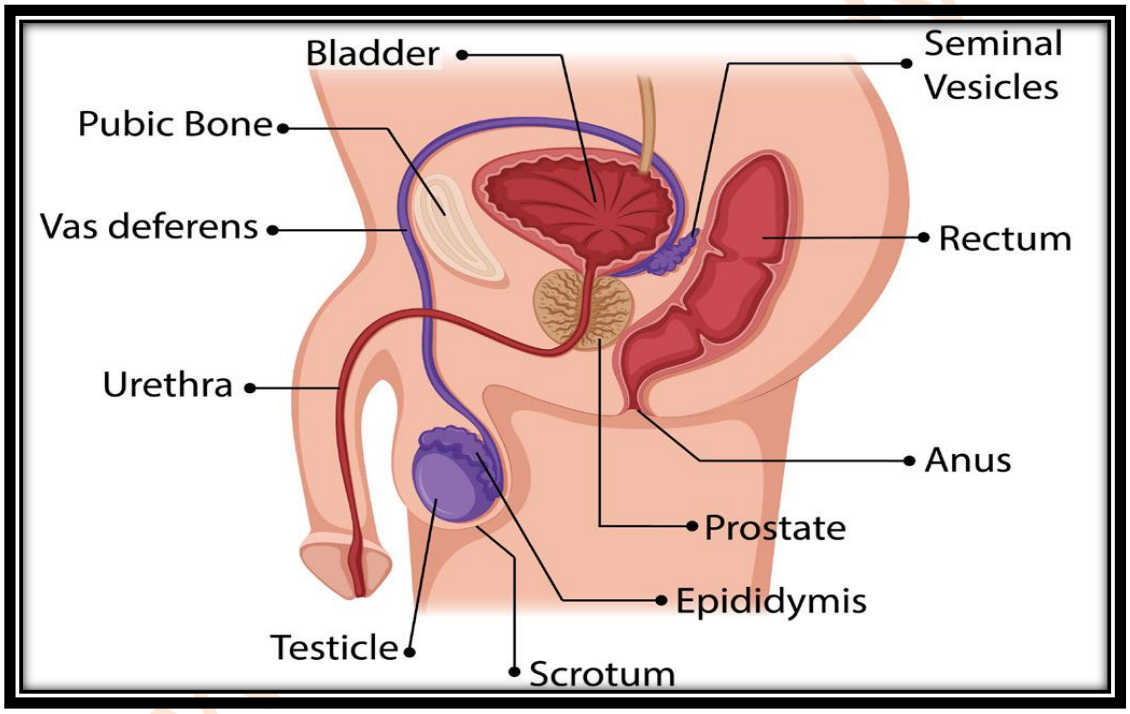
4. 6 Male reproductive structures

The male reproductive system of vertebrates, such as that of human males includes **testes, epididymis, vas deferens**, **accessory glands**, and **a penis**. Paired testes are the sites of sperm production. Each testis is composed of numerous seminiferous tubules, in which the sperm develop. The sperm are surrounded by cells, which nourish the developing sperm.

Between the tubules are cells which produce the male sex hormone (testosterone). In most mammals, the two testes are housed permanently in a sac-like scrotum suspended outside the

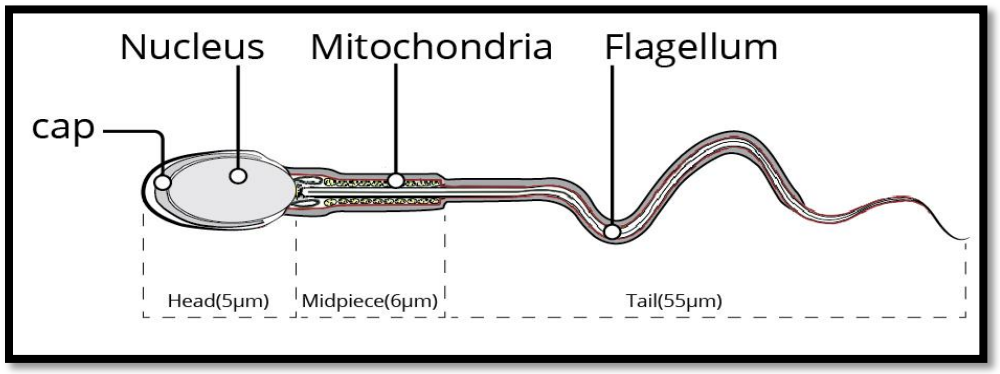
abdominal cavity. This odd arrangement provides an environment of slightly lower temperature, since in most mammals (including humans) viable sperm do not form at temperatures maintained within the body.

The sperm travels from the seminiferous tubules to epididymis, where sperm maturation occurs and then to a vas deferens, the ejaculatory duct. The vas deferens joins the urethra, a duct that carries both sperm and urinary products through the penis. Three sets of accessory glands open in to the reproductive channels: a pair of seminal vesicles, a single prostate gland, and the pair of bulbourethral glands.
Fluid secreted by these glands furnishes food to the sperm, lubricates the female reproductive tract for sperm, and counteracts the acidity of the vagina so that the sperm retain their viability longer after being deposited in the female. Semen is a mix of sperm, proteins, nutrients, ions, and signaling molecules. Sperm constitute less than 5 percent of semen volume.



Parts of male reproductive systems

The sperm has a **"head"** that is packed full of genetic material and covered by an **enzyme**. The enzymes help the sperm penetrate an egg. At its other end, the sperm has **a flagellum** that it uses to swim toward an egg. In the midsection contains many **mitochondria** that supply the energy required for flagellar movement.



Parts of a sperm cell

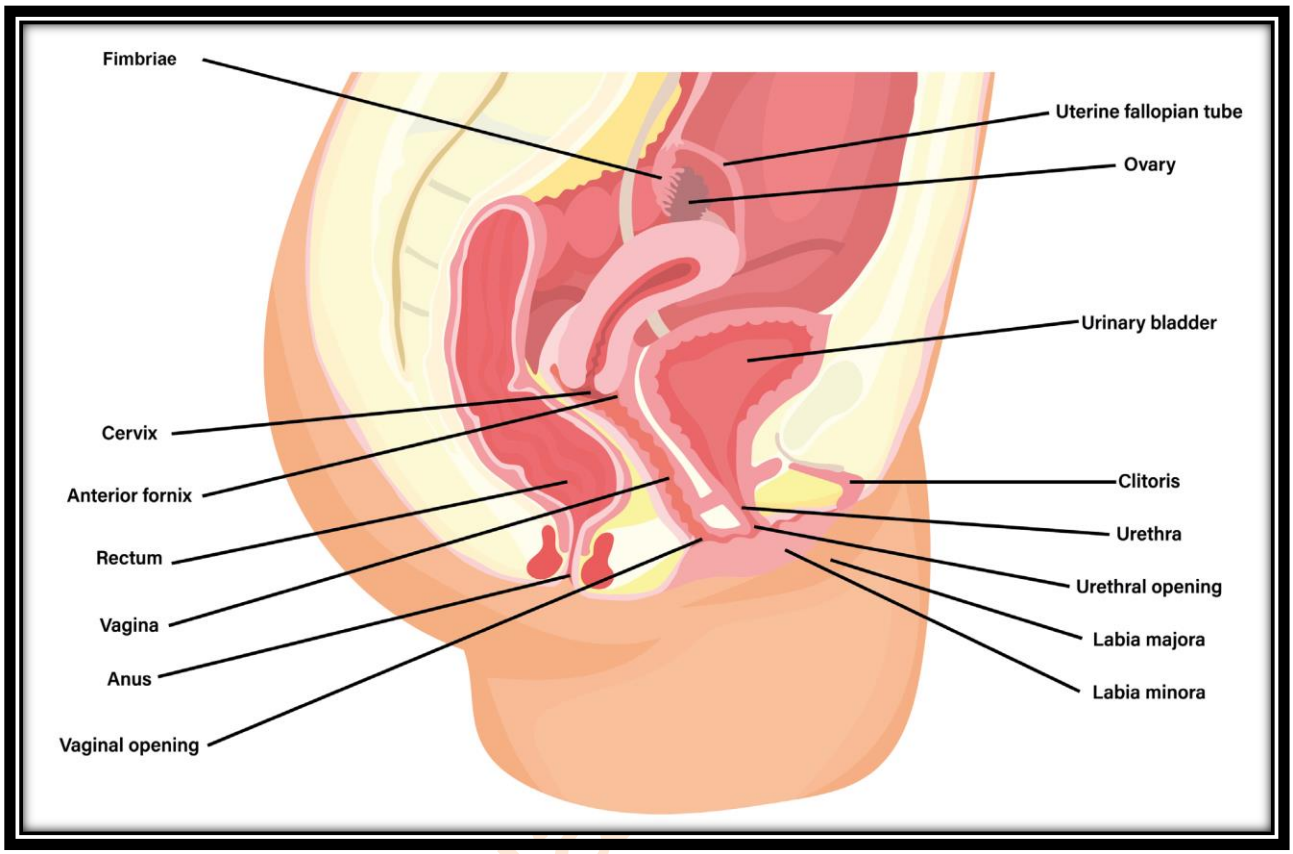
4.7. Female reproductive structures

A human female's gonads—her ovaries—lie deep inside her pelvic cavity.
They produce and release egg. They also secrete estrogens and progesterone, the main sex hormones in females. Estrogens trigger development of female secondary sexual characteristics and maintain the lining of their productive tract. Progesterone thickens the lining of the reproductive tract in preparation for pregnancy.

Adjacent to each ovary is an oviduct, a hollow tube that connects the ovary to the uterus. Both oviducts open onto the uterus, a hollow, pear shaped organ. The uterine lining consists of glandular epithelium, connective tissues, and blood vessels. The bottom of the uterus, a narrowed region called the cervix, opens into the vagina. The vagina, which extends from the cervix to the body's surface, is the organ of intercourse and the birth canal.

Externally visible organs of the reproductive tract are called **genitals.** Female genitals include two pairs of liplike skin folds that enclose the openings of the vagina and urethra. Adipose tissue fills the thick outer folds, the labia majora. Thin inner folds are the labia minora. The clitoris lies near the anterior junction of the labia minora. It contains erectile tissue and is highly sensitive to tactile stimulation. The opening into the vagina is often reduced in size in the virgin state by a membrane, the hymen, although in today's more physically active females, this membrane may be much reduced in extent.

The paired ovaries of the human female contain many thousands of eggs. During a woman's fertile years, except following fertilization, approximately 13 eggs mature each year, and usually the ovaries alternate in releasing eggs. Because a woman is fertile for only about 30 years, of the approximately 400,000 eggs in her ovaries at birth, only 300 to 400 have a chance to reach maturity; the others degenerate.
The uterine tubes or oviducts are lined with cilia for propelling the egg away from the ovary from which it was released. The two ducts open into the upper corners of the uterus, or womb, which is specialized for housing the embryo during its intrauterine existence. It consists of thick muscular walls, many blood vessels, and a specialized lining: the endometrium. The uterus is designed to hold more than one developing embryo.



Female reproductive systems

Ovulation

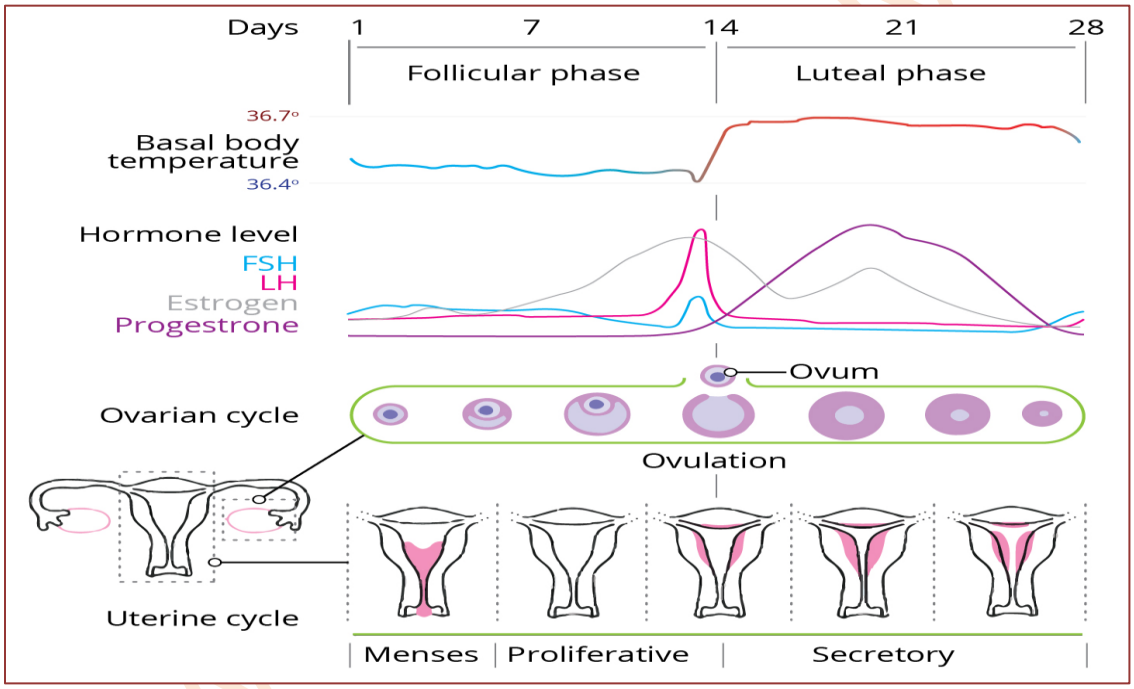
In humans, egg production occurs before birth. A girl is born with about 2 million eggs. At puberty hormonal changes prompt eggs to mature, one at a time, in an approximately twenty eight- day ovarian cycle. As the cycle begins, the follicle enlarges and a fluid filled cavity forms around it. About two weeks after the follicle began to mature, its wall ruptures and ovulation occurs. The egg and surrounding follicle cells are ejected into the adjacent oviduct. After ovulation, cells of the ruptured follicle develop into a hormone-secreting corpus luteum. If pregnancy does not occur, the corpus luteum breaks down, and a new follicle will begin to mature

4.8 The Menstrual cycle

The ovarian cycle described in the previous section is coordinated with cyclic changes in the uterus. We refer to the approximately monthly changes in the uterus as the menstrual cycle. The first day of the menstrual cycle is marked by onset of menstruation, which is the flow of bits of uterine lining and some blood from the uterus, through the cervix, and out of the vagina.

FSH stimulates maturation of an ovarian follicle. The interval of follicle maturation before ovulation is the follicular phase of the cycle. During this time, cells around the egg secrete estrogens that stimulate the endometrium to thicken. The rise in estrogens encourages the pituitary to release more LH. The flow of LH causes the follicle to swell and burst. LH trigger for ovulation. The luteal phase of the cycle begins after ovulation. LH stimulates formation of the corpus luteum, which secretes some estrogens and a lot of progesterone. These hormones cause the uterine lining to thicken and encourage blood vessels to grow through it. The uterus is now ready for pregnancy.

A woman enters menopause when all the follicles in her ovaries have either been released during menstrual cycles or have disintegrated as a result of aging. With no follicles left to mature, production of estrogen and progesterone is diminished and menstrual cycles cease. Menopause is known only in humans and two species of whales.



Menstrual cycle

4.8 Fertilization and pregnancy

Mating and fertilization

Mating; Sexual arousal in the male results in an **erection.** That is, the penis becomes firm and erects as a result of blood flowing into the erectile tissue. Arousal in the female stimulates the lining of the vagina to produce **mucus.** This lubricates the vagina and makes it easy for the erect penis to enter. In the act of copulation, the male inserts the penis into the female's vagina. The sensory stimulus in the male, which results in the ejaculation of **semen** into the top of the vagina.

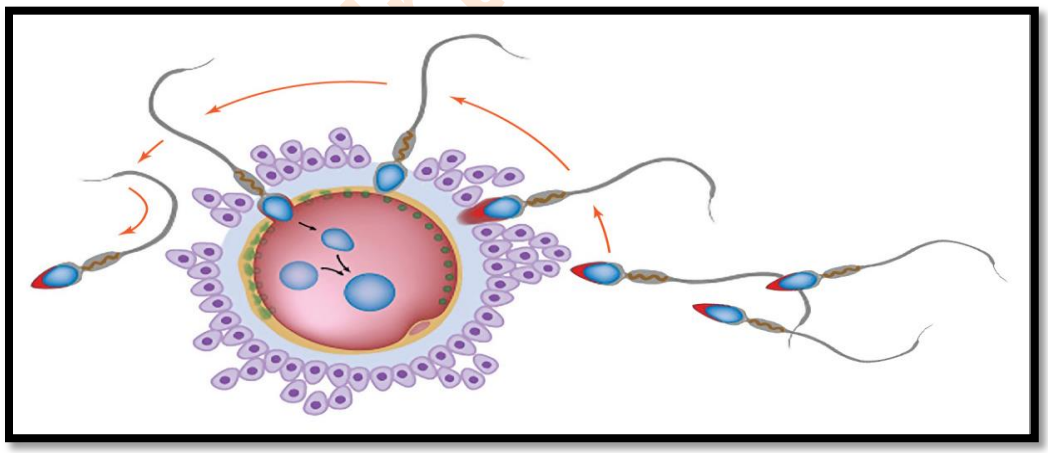
Fertilization; The sperm swims through the cervix and into the uterus by wriggling movements of their tails. They pass through the uterus and enter the oviduct. If there is an ovum in the oviduct, one of the sperm may bump into it and stick to its surface. The sperm then enters the cytoplasm of the egg and the male nucleus of the sperm fuses with the female nucleus. This is the moment of **fertilization.**

The released egg is thought to survive for about 24 hours; the sperm might be able to fertilize an ovum for about 2 or 3 days. So there is only a short period of about 4 days each month when fertilization might occur. If this fertile period can be estimated accurately, it can be used either to achieve or to avoid fertilization (conception).

Twins (Multiple births)

Many mammals give birth to more than one offspring at a time, each member of which has come from a separate egg. There are some mammals, however, that have only one offspring at a time, although occasionally they may have more than one.

Human twins may come from **one zygote** (identical or monozygotic twins) or **two zygotes** (non-identical, dizygotic, or fraternal twins). Fraternal twins do not resemble each other any more than other children born separately in the same family, but identical twins are, of course, strikingly alike and always of the same sex. Triplets, quadruplets, and quintuplets may include a pair of identical twins. The other babies in such multiple births usually come from separate zygotes. About 33% of identical twins have separate placentas, but the other identical twins share a common placenta.



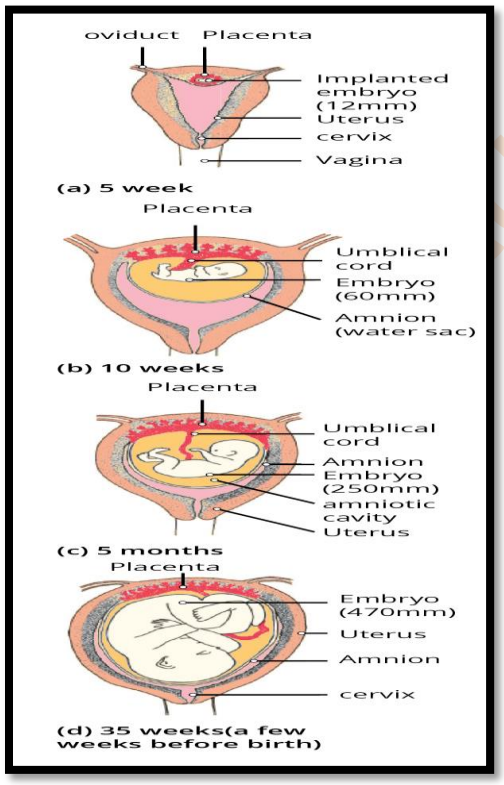
Fertilization

Pregnancy and development

The fertilized egg (zygote) first divides into two cells. Each of these divides again, so producing four cells. The cells continue to divide in this way to produce a solid ball of cells, an early stage in the development of the embryo. This early embryo travels down the oviduct to the uterus. Here it sinks into the lining of the uterus, a process called **implantation.** The embryo continues to grow and produces new cells that form **tissues and organs.**

After 8 weeks, when all the organs are formed, the embryo is called **a fetus**. One of the first organs to form is the **heart,** which pumps blood around the body of the embryo. Inside the uterus the embryo becomes enclosed in a fluid-filled sac called the **amnion or water sac,** which protects it from damage and prevents unequal pressures from acting on it. The fluid is called **amniotic fluid.**

The **oxygen and food** needed to keep the embryo alive and growing are obtained from the mother's blood by means of a structure called the placenta. The placenta becomes closely attached to the lining of the uterus and is attached to the embryo by a tube called the umbilical cord. Oxygen and nutrients such as glucose and amino acids pass across the placenta to the embryo's bloodstream. Carbon dioxide passes from the embryo's blood to that of the mother. Blood entering the placenta from the mother does not mix with the embryo's blood. Figure shows the human embryo from 5 to 35 weeks surrounded by the amnion and placenta.



Growth and development in the uterus (5 to 35 weeks)

4.10 Methods of birth control

Natural methods of family planning

• Abstinence

This is the most obvious way of preventing a pregnancy. This involves a couple avoiding sexual intercourse. In this way, sperm cannot come into contact with an egg and fertilization cannot happen. It is the effective method with added advantage of preventing exposure to sexually transmissible pathogens.

• Monitoring body temperature

If it were possible to know exactly when ovulation occurred, intercourse could be avoided for 3–4 days before and 1 day after ovulation. At the moment, however, there is no simple, reliable way to recognize ovulation, though it is usually 12–16 days before the onset of the next menstrual period. By keeping careful records of the intervals between menstrual periods, it is possible to calculate a potentially fertile period of about 10 days in mid-cycle, when sexual intercourse should be avoided if children are not wanted. On its own, this method is not very reliable but there are some physiological clues that help to make it more accurate. During or soon after ovulation, a woman's temperature rises by about 0.5 °C. It is reasonable to assume that 1 day after the temperature returns to normal, a woman will be infertile. There is 25% chance of pregnancy per year.

• Cervical mucus

Another clue comes from the type of mucus secreted by the cervix and lining of the vagina. As the time for ovulation approaches, the mucus becomes more fluid. Women can learn to detect these changes and so calculate their fertile period. By combining the 'calendar', 'temperature' And 'mucus' methods, it is possible to achieve about 80% 'success', i.e. only 20% unplanned pregnancies. Natural methods have no side effects and this method is permitted by most religions. Carried out with care and scientific precision about recording techniques it can be very effective. Depends on full co-operation of both partners and it is not always easy to pinpoint ovulation so pregnancy can result. There is a chance of 10 pregnancies per 100 women per year.

Artificial methods of family planning (barrier methods)

- **Sheath or condom**

A thin rubber sheath is placed on the erect penis before sexual intercourse. The sheath traps the sperm and prevents them from reaching the uterus. It also prevents the transmission of sexually Transmitted infections (STIs). There is no side effects do not need medical advice, used every time you have sex offers protection against sexually transmitted diseases such as syphilis and HIV/AIDS. It can interrupt intercourse. Sheath may tear or get damaged during intercourse, allowing semen to get through. There is a chance of 2.5 pregnancies per 100 woman years.

- **Diaphragm**

A thin rubber disc, placed in the vagina before intercourse, covers the cervix and stops sperm entering the uterus. Condoms and diaphragms, used in conjunction with chemicals that immobilize sperm, are about 95% effective. However, a diaphragm does not prevent the risk of transmission of STIs. There are no side effects, offers some protection against cervical cancer. It must be initially fitted by a doctor. May be incorrectly positioned or damaged and allow sperm past. Gives better protection against pregnancy when combined with spermicide. There is a chance of 2.5 pregnancies per 100 woman years.

- **Femidom**

This is a female condom. It is a sheath or pouch, made of polyurethane or rubber, with a flexible ring at each end. The ring at the closed end of the sheath is inserted into the vagina to hold the femidom in place. The ring at the open end is placed outside the vagina. During sexual intercourse, semen is trapped inside the femidom.

A femidom reduces the risk of infection by STIs. There is no side effects, don't need medical advice, used every time you have sex it protects from infection with HIV/AIDS or other sexually transmitted diseases. It can only be used once, can be expensive, gives better protection against pregnancy when used with spermicide, and takes practice to insert it properly.

- **Spermicides**

Spermicides are chemicals which, though harmless to the tissues, can kill or immobilize sperm. The spermicide, in the form of a cream, gel or foam, is placed in the vagina. On their own, spermicides are not very reliable but, in conjunction with condoms or diaphragms, they are effective.

- **Intra-uterine device (IUD)**

A small T-shaped plastic and copper device, also known as a coil, can be inserted by a doctor or nurse into the wall of the uterus, where it probably prevents implantation of a fertilized ovum. It is about 98% effective but there is a small risk of developing uterine infections, and it does not protect against STIs. Once inserted, no further steps need to be taken. It is relatively effective at preventing implantation and pregnancy. It can cause pain and heavy periods; can cause uterine infections which may lead to infertility. If pregnancy does occur, it has a high chance of being in the Fallopian tubes (ectopic pregnancy). There is a chance 2.5 pregnancy per 100 woman years.

- **Intra-uterine system (IUS)**

This is similar to an IUD; is T-shaped and releases the hormone progesterone slowly over a long period of time (up to 5 years). The hormone prevents ovulation. An IUS does not protect against STIs.

- **Contraceptive pill**

The pill contains chemicals, which have the same effect on the body as the hormones oestrogen and progesterone. When mixed in suitable proportions these hormones suppress ovulation and so prevent conception. The pills need to be taken each day for the 21 days between menstrual periods. There are many varieties of contraceptive pill in which the relative proportions of oestrogen- and progesterone-like chemicals vary. They are 99% effective, but long-term use of

some types may increase the risk of cancer of the breast and cervix. The pill does not protect against STIs.

- **Contraceptive implant**

This is a small plastic tube of about 4 cm long which is inserted under the skin of the upper arm of a woman by a doctor or nurse. Once in place, it slowly releases the hormone progesterone, preventing pregnancy. It lasts for about 3 years. It does not protect against STIs, but has more than a 99% success rate in preventing pregnancy.

- **Contraceptive injection**

This injection, given to women, contains progesterone and stays effective for between 8 and 12 weeks. It works by thickening the mucus in the cervix, stopping sperm reaching an egg. It also thins the lining of the uterus, making it unsuitable for implantation of an embryo. It does not protect against STIs.

Surgical methods

- **Male sterilization – vasectomy**

This is a simple and safe surgical operation in which the man's sperm ducts are cut and the ends sealed. This means that his semen contains the secretions of the prostate gland and seminal vesicle but no sperm so cannot fertilize an ovum. Sexual desire, erection, copulation and ejaculation are quite unaffected. The testis continues to produce sperm and testosterone. The sperm are removed by white cells as fast as they form. The testosterone ensures that there is no loss of masculinity. The sperm ducts can be rejoined by surgery but this is not always successful.

• Female sterilization– laparotomy

A woman may be sterilized by an operation in which her oviducts are tied, blocked or cut. The ovaries are unaffected. Sexual desire and menstruation continue as before, but sperm can no longer reach the ova. Ova are released, but break down in the upper part of the oviduct. The operation cannot usually be reversed. Both vasectomy and laparotomy are almost 100% guaranteed to prevent pregnancy and permanent control of fertility. Remove the problem of human error in contraception. For women in particular it involves a general an aesthetic. Not easily reversible. There a chance of 0.05 pregnancies per 100 woman years.

The different Contraceptive methods used by females and males

Sterilization is the permanent prevention of gamete production or release. For women, the most common method is tubal ligation, the sealing shut or tying off (ligating) of a section of each oviduct to prevent eggs from traveling into the uterus. Similarly, vasectomy in men is the cutting and tying off of each vas deferens to prevent sperm from entering the urethra. Sex hormone secretion and sexual function are unaffected by both procedures, with no change in menstrual cycles in females or ejaculate volume in males. Although tubal ligation and vasectomy are considered permanent, both procedures can in many cases be reversed by microsurgery.

4.11 Sexually transmitted infections (STIs): Transmission and prevention

Sexually transmitted infections are infections which spread through sexual contact. **trichomoniasis, syphilis, gonorrhea**, **chaceriod** and **HIV/AIDS** are the common STIs in Ethiopia.

Trichomoniasis

It is caused by the flagellated protozoan Trichomonas vaginalis. Many infected people do not have symptoms, but some infected women have a yellowish discharge, and a sore, itchy vagina. In both sexes, an untreated infection can cause infertility. Some epidemiological studies suggest that, in men, untreated trichomoniasis may increase the risk of benign prostate enlargement and aggressive prostate cancer. A single dose of an antiprotozoal drug can quickly cure the infection. Both partners should be treated.

Chlamydia

It is caused by Chlamydia trachomatis. Chlamydias are small bacteria. In women, an infection of the reproductive tract by bacteria most often goes undetected. Some women and most men

experience painful urination; most infected men have a clear or yellow discharge from the penis. Left untreated, a Chlamydia infection can scar the reproductive tract and lead to infertility in both sexes. An infection can be passed from a mother to child during birth, causing pneumonia and conjunctivitis in the newborn. Chlamydia can be cured with antibiotics.

Syphilis

Is caused by Treponema pallidum, a spiral shaped bacterium. During sex with an infected partner, these bacteria get onto the genitals or into the cervix, vagina, or oral cavity. They slip into the body through tiny cuts. If untreated, the infection can become systemic. Skin chancres appear and the liver, bones, and eventually the brain can be damaged. Like gonorrhea, syphilis is treated with antibiotics.

HIV/AIDS

The disease is now known as Human Immunodeficiency Virus, or HIV. HIV kills immune cells in the body. HIV leads to Acquired Immune Deficiency Syndrome, or AIDS. Once attached, the virus can penetrate the immune cell. The virus may remain inactive for months.

- **Control of the spread of STIs**

The best way to avoid sexually transmitted infections is to avoid having sexual intercourse with an infected person. However, the symptoms of the disease are often not obvious and it is difficult to recognize an infected individual. So the STI is avoided by not having sexual intercourse with a person who might have the infection. Such persons are:

- prostitutes who offer sexual intercourse for money
- people who are known to have had sexual relationships with many others
- Casual acquaintances whose background and past sexual activities are not known.

These are good reasons, among many others, for being faithful to one partner. The risk of catching a sexually transmitted infection can be greatly reduced if the man uses a condom or if a woman uses a female condom. These act as barriers to bacteria or viruses. If a person suspects that he or she has caught a sexually transmitted infection, treatment must be sought at once. Treatment is always confidential.

The patients must, however, ensure that anyone they have had sexual contact with also gets treatment. There is no point in one partner being cured if the other is still infected. STIs that are caused by a bacterium, such as syphilis and gonorrhea, can be treated with antibiotics if the symptoms are recognized early enough. However, HIV is viral so antibiotics are not effective.

Review Questions

Part One (Matching Items): Match items under column A with the appropriate item under column B.

	A		B
1	FSH and LH	A	Birth canal
2	Prostate gland	B	Secrete fructose rich fluid
3.	Testis	C	Produces estrogens and Progesterone
4	Epididymis	D	Thin inner folds
5	Labia majora	E	Pituitary gland
6	Endometrium	F	Secretes semen components
7	Seminal vesicles	G	Conveys sperm out of body
8	Ovary	H	Produces testosterone
9	Oviduct	I	Usual site of fertilization
10	Vagina	J	Lining of uterus
11	Urethra	K	Fat-padded skin folds
12	Labia minora	L	Stores sperm

Part Two (Multiple Choice Items): Choose the correct answer among the given alternative

1. Sexual reproduction.....
A. Requires formation of gametes by meiosis
B. Produces offspring identical in their traits
C. Occurs only in vertebrates
D. All of the above

2. The cervix is the entrance to the.....
A. Oviducts
B. Vagina
C. Uterus
D. Scrotum

3. Semen contains secretions from the.....
A. Adrenal gland
B. Prostate gland
C. Pituitary gland
D. Corpus luteum

4. Sperm in an epididymis passes next into the.....
A. Prostate gland
B. Urethra
C. Seminiferous tubules
D. Vas deferens

5. A male attains an erection when.....
A. The posterior pituitary releases oxytocin

B. Spongy tissue inside the penis fills with blood
C. Muscles running the length of the penis contract
D. Leydig cells release a surge of testosterone

6. Birth control pills deliver synthetic.
A. Estrogens and progesterone
B. Oxytocin and prostaglandins
C. LH and FSH
D. Testosterone

7. Which one of the following is not the disadvantage of asexual reproduction?
A. Little variation created
B. No mate is needed,
C. No gametes are needed,
D. All the good characteristics of the parent are passed on to the offspring

8. Morally, teenagers are adult after they have reached puberty, when they are capable of having children.
A. True B. False

Part Three: Critical thinking question

1. State exactly what happens at the moment of fertilization.
2. From the list of changes at puberty in girls, select those that are related to childbearing and say what part you think they play.
3. How do sperm differ from egg in their structure?
4. Define, and distinguish among, the terms fission, fragmentation, parthenogenesis, budding and vegetative propagation.
5. Explain the function of the corpus luteum in the menstrual cycle. If fertilization of the ovulated egg happens, what endocrine events occur to support pregnancy?
6. Explain how the female hormones FSH, LH, and estrogen interact during the menstrual cycle to induce ovulation and, subsequently, formation of the corpus luteum.
7. What are the male sex hormones and what are their functions?
8. One of the first signs of pregnancy is that the menstrual periods stop. Explain why you would expect this.
9. What are causes and effects of common STIs, and how are they treated?
10. Describe, and distinguish among, the birth control methods - vasectomy, diaphragm, contraceptive pill, spermicides and laparotomy.
11. Name the general location and give the function of the following reproductive structures: seminiferous tubules, vas deferens, urethra, seminal vesicles, prostate gland, bulbourethral glands, mature follicle, oviducts, uterus, vagina, endometrium.
12. Match each disease with the type of organism that causes it. The choices can be used more than once.
i Chlamydial infection A. Bacteria
ii AIDS B. Protozoa

iii Syphilis C. Virus
iv Gonorrhea
v Trichomoniasis

Answer

Part One (Matching Items): Match items under column A with the appropriate item under Column B.

1. E	2. F	3. H	4. L	5. K	6. J
7. B	8. C	9. I	10. A	11. G	12. D

Part Two (Multiple Choice): Choose the correct answer among the given alterative

1. A	2. C	3. B	4. D
5. B	6. C	7. A	8. B

Part Three: Critical thinking question

1. **Answer:** The sperm then enters the cytoplasm of the ovum and the male nucleus of the sperm Fuses with the female nucleus.

2. **Answer:** A follicle is a group of epithelial cells. These epithelial cells surround a developing egg cell. FSH also causes a hormone called estrogen to be released from the ovary. Estrogen is a steroid hormone responsible for the secondary sex characteristics of females. These characteristics include the growth and maintenance of female sex organs. As in males, secondary sex characteristics include an increase in growth rates of the long bones of the arms and legs. In females, however, and unlike males, the hips broaden, and more fat is deposited in the breasts, buttocks, and thighs. The menstrual cycle begins.

3. **Answer:** Sperms are smaller in size compared to the egg, as the egg contains reserved food for the developing embryo.

4. **Answer:**
i. Fission: In **binary fission** the body of the unicellular parent divides by mitosis into two approximately equal parts, each of which grows into an individual similar to the parent. Alternatively, the nucleus of the orgasms divide repeatedly and each daughter nucleus breaks away together with a small portion of the cytoplasm, resulting in the production of **many daughter cells.**
ii. Fragmentation: Fragmentation is one of the most common modes of asexual reproduction involving the breakdown of a parent organism into parts that develop into whole organism
iii. Parthenogenesis: a form of asexual reproduction in which an unfertilized egg develops into an adult organism.
iv. Budding: During the process a bulge forms on the side of the cell, the nucleus divides mitotically, and the bud ultimately detaches itself from the mother cell.

v. Vegetative propagation: Is a method of asexual reproduction in plants where structures with lateral meristems such as roots, stems, buds, and leaves give rise to new self-supporting individual. The following are types of vegetative reproduction.

5. **Answer:** Once an egg has been released during ovulation, the part of the follicle that remains in the ovary develops into the corpus luteum. The **corpus luteum** is a structure that secretes the two female hormones estrogen and progesterone. Progesterone causes changes to occur in the lining of the uterus. These changes prepare the uterus to receive a fertilized egg.

6. FSH stimulates maturation of an ovarian follicle. The interval of follicle maturation before ovulation is the follicular phase of the cycle. During this time, cells around the egg secrete estrogens that stimulate the endometrium to thicken. The rise in estrogens encourages the pituitary to release more LH. The flow of LH causes the follicle to swell and burst. LH trigger for ovulation. The luteal phase of the cycle begins after ovulation. LH stimulates formation of the corpus luteum, which secretes some estrogens and a lot of progesterone. These hormones cause the uterine lining to thicken and encourage blood vessels to grow through it. The uterus is now ready for pregnancy.

7. **Testosterone**: main hormone produced by testes; required for sperm production and Development of male secondary sexual traits.

8. The hormones cause the uterine lining to thicken and encourage blood vessels to grow through it. The uterus is now ready for pregnancy.

9. **Answer**

	STIs	Cause	Treatment
i.	Chlamydial infection	Bacteria	Antibiotics
ii.	AIDS	Virus	ART/vaccine
iii.	Syphilis	Bacteria	Antibiotics
iv.	Gonorrhea	Bacteria	Antibiotics
v.	Trichomoniasis	Protozoa	Antibiotics

10. Answer:

a. Vasectomy: This is a simple and safe surgical operation in which the man's sperm ducts are cut and the ends sealed. This means that his semen contains the secretions of the prostate gland and seminal vesicle but no sperm so cannot fertilize an ovum. Sexual desire, erection, copulation and ejaculation are quite unaffected. The testis continues to produce sperm and testosterone. The sperm are removed by white cells as fast as they form. The testosterone ensures that there is no loss of masculinity. The sperm ducts can be rejoined by surgery but this is not always successful.

b. Diaphragm: A thin rubber disc, placed in the vagina before intercourse, covers the cervix and stops sperm entering the uterus. Condoms and diaphragms, used in conjunction with chemicals that immobilize sperm, are about 95% effective. However, a diaphragm does not prevent the risk of transmission of STIs (Fig. 4.16). There are no side effects, offers some protection against cervical cancer. It must be initially fitted by a doctor. May be incorrectly positioned or damaged and allow sperm past. Gives better protection against pregnancy when combined with spermicide. There is a chance of 2.5 pregnancies per 100 woman years.

c. contraceptive pill: The pill contains chemicals, which have the same effect on the body as the hormones oestrogen and progesterone. When mixed in suitable proportions these hormones suppress ovulation and so prevent conception. The pills need to be taken each day for the 21 days between menstrual periods. There are many varieties of contraceptive pill in which the relative proportions of oestrogen- and progesterone-like chemicals vary. They are 99% effective, but long-term use of some types may increase the risk of cancer of the breast and cervix. The pill does not protect against STIs.

d. Spermicides: Spermicides are chemicals which, though harmless to the tissues, can kill or immobilize sperm. The spermicide, in the form of a cream, gel or foam, is placed in the vagina. On their own, spermicides are not very reliable but, in conjunction with condoms or diaphragms, they are effective.

e. Laparotomy: A woman may be sterilized by an operation in which her oviducts are tied, blocked or cut. The ovaries are unaffected. Sexual desire and menstruation continue as before, but sperm can no longer reach the ova. Ova are released, but break down in the upper part of the oviduct. The operation cannot usually be reversed. Both vasectomy and laparotomy are almost 100% guaranteed to prevent pregnancy and permanent control of fertility. Remove the problem of human error in contraception. For women in particular it involves a general an aesthetic. Not easily reversible. There a chance of 0.05 pregnancies per 100 woman years.

11. Answer:

Male Reproductive System		Female Reproductive System	
Structure	Role	Structure	Role
semen	the combination of sperm and the fluids produced in glands to either protect the sperm or move them through and out of the male body	oviduct	the tube down which the ova pass when released from the ovary
seminal vesicle	a gland located at the base of the urinary bladder that secretes a fructose rich the top portion of the urethra; secretes an alkaline fluid that helps the sperm move	follicle	a group of epithelial cells that surround a developing egg cell
prostate gland	a doughnut-shaped gland that lies below the urinary bladder and surrounds	cervix	the lower end of the uterus that leads into a narrow opening in the vagina
epididymis	a single, coiled tube in which sperm finish their maturation process fluid into the vas deferens	corpus luteum	a structure that secretes the hormones estrogen and progesterone; progesterone causes changes to occur in the lining of the uterus that prepares it to receive a fertilized egg
scrotum,	a sac that contains the testes; suspended directly behind the base of the penis	vagina	muscular tube that receives erect penis during sexual intercourse
vas deferens	a duct that carries sperm from the epididymis toward the ducts that will force the sperm out of the body; sperm can stay in the vas deferens for two or three months		
Bulbourethral gland	secrete a clear, sticky alkaline fluid		

12. **Answer:**

STIs	Cause
Chlamydial infection	Bacteria
AIDS	Virus
Syphilis	Bacteria
Gonorrhea	Bacteria
Trichomoniasis	Protozoa

Unit 5

Human Health, Nutrition, and Disease

5.1. What is food?

Food is any beneficial substance that is eaten, drunk, or otherwise taken into the body to sustain life, provide energy, promote growth, etc. It is consumed to provide nutritional support for an organism. Food is usually of plant, animal, or fungal origin, and contains essential nutrients, such as carbohydrates, fats, proteins, vitamins, or minerals.

The importance of food in living things:

Growth: Food is the source substances necessary for making new cells, tissues and organs.

Energy: living things undergo different biological and chemical reaction in their bodies. These reactions in living things produce at the same time require energy.
Food is the sources of energy that fuel all the biological activities. Running, jumping, moving, growing, reproducing, and all other activities require energy.

Replacement of damaged tissues: Food is required for making new cell and used to replace damaged cells of the body.

Protect from diseases: There are different types of diseases caused by the shortage of specific groups of foods. Our body requires these food groups to protect our body from deficiency diseases and to become healthy.

5.2 Nutrition

Nutrition is the process of taking in food and converting it into energy and other vital nutrients required for life. Energy obtained from food is important for different activities of the body. The food we eat keeps us alive and provides the nourishment for growth, repairs of our body cells and maintain good health.

5.3. Nutrients

Nutrients: are important chemical substances that are found in foods. In human body, we need nutrients for growth, source of energy and stay healthy. We obtain these nutrients from the foods we eat. The five important classes of nutrients are: carbohydrates, proteins, lipids (Fats and oil), vitamins, minerals and water.

Macronutrients and Micronutrients

The three nutrients, carbohydrate, protein and fats are required in large quantities. Such nutrients are called macronutrients. In contrast, minerals and vitamins are needed in very small quantities

and are called micronutrients.

Vitamins are organic compounds, whereas minerals are inorganic compounds. Vitamins and minerals do not supply energy but they play an important role in the regulation of the metabolic activity in the body and help in the utilization of proteins, fats and carbohydrates.
Minerals are also used for the formation of body structure and skeleton.

Carbohydrates

Carbohydrates are types of nutrients that provide energy for the human body. They are composed of three elements, carbon, oxygen and hydrogen. The human body gets carbohydrate from green plants. These green plants prepare carbohydrate in the form of starch by the process of Photosynthesis. They combine carbon dioxide and water using energy from the sun in order to produce carbohydrate. Such carbohydrates are the major sources of energy in our diet. Starch is abundant in potatoes, bread, maize, rice and other cereals. Sugar appears in our diet mainly as sucrose (table sugar) and is added to drinks and many prepared foods such as biscuits and cakes. Sugars also occur naturally in many fruits and some vegetables. One gram of carbohydrate can provide, on average, 16 kilojoules (kJ) of energy.

There are three types of carbohydrates

• Monosaccharide The simplest carbohydrate is simple sugar or monosaccharide which include glucose, fructose and galactose. These three monosaccharide each have six carbon atoms, so they are also known as hexose sugars. Their molecular formula is $C_6H_{12}O_6$.

• Disaccharide: Similar to other carbohydrates, disaccharides are comprised of hydrogen, carbon, and oxygen, and the ratio of hydrogen atoms to oxygen atoms is often 2:1. it is the combination of two simple sugars to form a complex sugar called disaccharide. These are maltose(Glucose+ Glucose), sucrose (Glucose+ Fructose and lactose (Glucose+ Galactose). The general chemical formula of disaccharides is $C_{12}H_{22}O_{11}$.

• Polysaccharide, which is formed when many simple sugar join together. They are substances whose molecules contain hundreds or thousands of monosaccharaides linked together into long chains. polysaccharides are found in plant cell as cellulose and starch. In addition it stored in animals as glycogen. Polysaccharide are not soluble in water. The general formula of $(C_6H_{10}O_5)n$.

Fats and Oils

Fats and oils are high-energy nutrients that provide 35 to 45% of caloric intake. One gram of lipid gives 37 kJ of energy. Like carbohydrates, fats and oils are composed of three elements, carbon, oxygen and hydrogen. Fats are obtained from animal source and are solid at room temperature while oils are from plant source and liquid at room temperature.

The major sources of fat are meat, milk, cheese, butter and egg-yolk. We obtain oils from fruits, seeds(e.g. sunflower seed). In human body, lipid is used to make fatty tissue, adipose tissue, under the skin forms a layer that can reduce heat losses from the body. Besides satisfying

metabolic energy needs, dietary fat, also serve as a vehicle for the absorption of the fat soluble vitamins (A, D, E and K).

Proteins

Proteins are nutrients, which provide growth of the body and build a new cell. It is made up of amino acid composed of carbon, hydrogen, oxygen and nitrogen. In all living things, the structural part of the cell is composed of protein.

The major sources of dietary proteins from animals are meat, fish, eggs, milk and cheese. Plants such as beans, chickpea, soy beans and nuts are also important protein sources.

Source and function carbohydrate, protein and fats.

Nutrient	Good food sources	Use in the body
Carbohydrate	Barley, wheat, potato, bread, sugary foods like honey	storage; source of energy, An unavailable or indigestible carbohydrate provides dietary fiber that does not serve as a source of energy.
Lipids (Fat/oil) oils are liquid at room temperature, but fats are solid	Butter, cheese, animal fat, groundnuts (peanuts)	source of energy (twice as much as carbo-hydrate); insulation against heat loss; some hormones; cell membranes; insulation of nerve fiber
Protein	Meat, fish, eggs, soya, groundnuts, milk	Growth; tissue repair; enzymes; some hor-mones; cell membranes; hair; nails; can be broken down to provide energy

Vitamins (Types)

Vitamins are nutrients, which are essential in small quantities for human body. They are organic substances needed for chemical reactions of human cells. Plants can make these vitamins in their leaves, but animals as well as human have to obtain many of them ready-made either from plants or from other animals. If any one of the vitamins is missing or deficient in the diet, the vitamin-deficiency disease may develop. Examples of vitamins: are vitamin A, vitamin E, thiamine (vitamin B1) and riboflavin (vitamin B2), and vitamin C.

Minerals

Minerals are inorganic substances, which are essential in small quantities for human body. The major minerals, which are necessary for human body, are Calcium, Iron, phosphorous and Iron.

Calcium

is used to build teeth and bones, it make muscles to contract and help for the transmission of nerve impulses. The important sources of calcium are milk, cheese etc.

Iron

is a mineral which synthesizes the hemoglobin of red blood cells. Hemoglobin is a molecule,

which carries oxygen in blood. The sources of iron in the diet are red meat, liver, kidney, eggs, groundnuts, Tikur teff etc.

Iodine; is a mineral, which makes thyroid gland to work properly. The source iodine is iodized salt and seafood.

Phosphorus; is a mineral required to build bones in animal as well as humans body.

Water

Body fluids such as blood, lymph and tissue fluid are mainly composed of water. The transportation of digested food into the body cell and excretion of excess salt and urea out of the body is possible because of water. Thus, water acts as a solvent and as a transport medium for substances throughout the body.

5.4. Balanced diets

Ethiopia has multicultural societies. These diverse societies have different types of cultural foods. All these foods are different in their preparation, flavor and ingredients. In addition, different people prefer different food types. Some may prefer to feed on vegetables; others may carbohydrate, animal protein etc. Different food or diet may contain important composition of the above important nutrients. In contrast, some diet may result in health problem because it may contain high amount of fat or high amount of animal protein etc.

Ethiopian cultural foods

The diet that contains all of the nutrients in the correct amount and proportion is termed as a balanced diet. A balanced diet must contain enough proportion of carbohydrates and fats to meet

our energy requirement. It should also contain enough protein of the right kind to provide the amino acids to make new cells and produce tissues growth. The diet must also contain vitamins and mineral salts, plant fiber and water for normal functioning of the body. Therefore, a balanced diet gives us all the essential substances that we need in the right quantities.

Balanced diet

Balanced diet depends on age, sex, activities and lifestyles

The feeding habit of people depends on where they live, their social issues, their age, their sex their personal activity and physiological conditions etc. For example, a pregnant woman should eat more food for the development and growth of her baby. She should get more minerals like calcium for the development of bone and teeth of her baby.

Children have a greater energy requirement than adults because they are still in the process of growth. Young children also need more protein than adult does because they are constantly developing and making new cells. Elderly people generally have lower energy and protein needs. However, they need to eat a balanced diet in order to stay healthy.

Naturally, female have a relatively higher fat content in their bodies than male. Fat in female body is stored in fat tissue, such as under the skin. These fatty tissues have a lower metabolic rate than muscular tissue, so women generally have a lower energy requirement than men. Therefore, men should eat relatively more energy food than women should. Some jobs that involve physical activity require more energy than less active jobs. People who are usually work physical exercise such as athletes also require high energy and high protein diets. The extra protein is required for

muscle development.

Energy requirement by the body depends on age, sex, activities and lifestyles

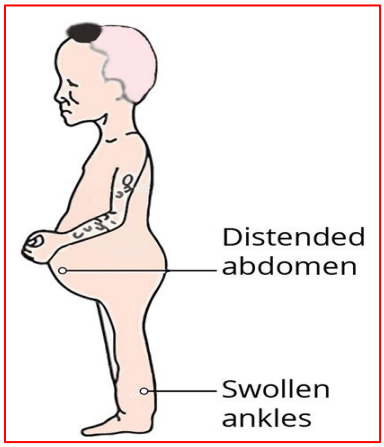
Different groups of human	Energy used in a day/kJ	
	Male	Female
8-year-old child	8 500	8 500
Teenager, aged 14	12500	9 700
Adult office worker	11 000	9 800
Adult manual worker	15 000	12500
Pregnant woman		10 000
Breast-feeding mother		11 500

5.5 Deficiency diseases

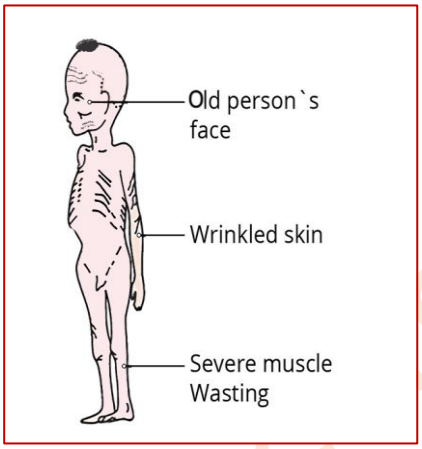
Human body requires a balanced diet for normal functioning of the body. If food intake in human body is inadequate in carbohydrate, proteins, minerals or vitamins, it causes deficiency diseases. A deficiency disease occurs when a person does not have enough amount of one particular nutrient and suffers health problems as a result. Examples of deficiency diseases are Kwashiorkor, Marasmus, Anemia, Rickets and Scurvy etc.

Kwashiorkor

Kwashiorkor is a deficiency disease caused by inadequate protein content in human body especially in children. Some symptoms of kwashiorkor are dry or flaky skin, swelling of leg and abdomen, and changes of the hair color, weakness and irritability. Protein deficiency can often be cured or prevented by an intake of protein.



Child suffering from kwashiorkor



child suffering from Marasmus

Marasmus

Marasmus is a deficiency disease caused by inadequate carbohydrate content in the human body. Like kwashiorkor, the incidence of marasmus increases in children. The symptoms of marasmus are thin arm and leg, little muscle, old-looking face. Peoples with this disease are extremely thin with reduced fat and muscle tissue. Their skin is thin and hangs in folds. Treatment involves delivery of an energy rich, balanced diet.

Diseases caused by deficiency of minerals and vitamins.

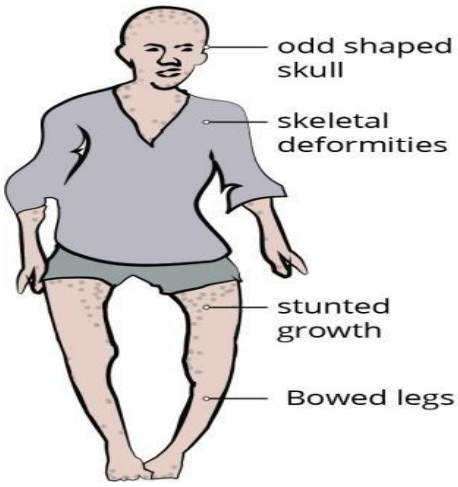
Anemia

Anemia is a deficiency disease caused by the lack of iron. A human adult should take enough amount of iron, which is important for the normal functioning of the body. A human body could not produce enough hemoglobin if the amount of iron in the blood is insufficient.

Less hemoglobin in the body results in less oxygen transportation. If the oxygen level of blood became less, it results in less respiration producing less energy. The symptom of anemia includes feeling weak, tired and irritable. It can treat or protect by using iron capsules and by consuming iron rich food.

Rickets

Deficiency disease caused by the shortage of vitamin D is called Rickets. It results in deformed bones in the legs of children. Vitamin D is the only vitamin that the human body can make upon exposure of the skin to sunlight. In addition, oily fish, butter, milk, cheese and egg-yolk are some foods that provide vitamin D. Vitamin D help in the absorption of calcium and phosphorus through the gut wall, which is important to build bone and teeth.



Child suffering from rickets

Scurvy

Scurvy is a deficiency disease caused by a lack of **vitamin C** (ascorbic acid). This deficiency disease occurs when fibers in the connective tissue of skin and blood vessels do not form properly. This disease causes bleeding under the skin, particularly at the joints, bleeding gums and poor healing of wounds. Vitamin C can't be stored in the body therefore, it is important to take it daily. The good sources of vitamin C are oranges, lemons, grapefruit, tomatoes, fresh green vegetables.

an individual suffering from scurvy

Summary of the major nutrients and their deficiency diseases.

Name	Rich food sources	Use in body	Deficiency disease
Protein	Meat, fish, eggs, soya, groundnuts, milk	To build cell structure, growth and repair.	Kwashiorkor
Carbohy-drate	Barley, wheat, potato, bread, sugary foods like honey	Provide energy	Marasmus
Vitamin C	oranges, lemons, other citrus fruits	tissue repair, resistance to disease	bleeding gums (scurvy)
Vitamin D	fish oil, milk, butter (also made by skin in the Sun)	strengthens bones and teeth	soft bones, legs bow out-wards (rickets)
Iron	liver, meat, cocoa, eggs	used in formation of hemo-globin in red blood cells for transport of oxygen	tiredness, lack of energy (anemia)
Calcium	milk, fish, green vegetables	strengthens bones and teeth	weak, brittle bones and teeth (rickets), muscle weakness and cramps

5.6 Malnutrition

Malnutrition is defined as the insufficient, excessive or imbalanced consumption of nutrients, which leads to health problems. The causes of malnutrition can be poverty, famine due to drought or flood, soil erosion, wars, too little land for too many people, ignorance of proper nutritional requirements.

The dual burden of malnutrition consists of both under nutrition and overweight and obesity, as well as diet-related non communicable diseases. Under nutrition the most common form of malnutrition is caused by under nutrition of protein and dietary energy (Carbohydrate, lipids). If the total intake of food is not sufficient to meet the body's need for energy, it leads to loss of weight, muscle wastage, weakness and ultimately starvation. Extreme reduction of diets, such as carbohydrate foods can result in the deficiency disease like marasmus. The victims of malnutrition due to food deficiencies have reduced resistance to different types of diseases. Under nutrition addresses the following four broad groups of conditions:

Wasting (low weight-for-height) is defined as low weight-for-height. It often indicates recent and severe weight loss, although it can also persist for a long time. It usually occurs when a person has not had food of adequate quality and quantity and/or they have had frequent or prolonged illnesses. Wasting in children is associated with a higher risk of death if not treated properly.

Stunting (low height-for-age), is defined as low height for age. It is the result of chronic or recurrent under nutrition, usually associated with poverty, poor maternal health and nutrition, frequent illness and/or inappropriate feeding and care in early life. Stunting prevents children from reaching their physical and cognitive potential.

Underweight (low weight-for-age) is defined as low weight-for-age.

Micronutrient deficiencies are a lack of vitamins and minerals that are essential for body functions such as producing enzymes, hormones and other substances needed for growth and development. In contrast, when the diet contains too much fat it causes diseases like coronary heart disease. If fatty substance builds up in the arteries, it reduces the diameter of these blood vessels which results in blood clots and leads to heart attack.

Obesity: If you eat more food than you want, your body stores the extra food as fat. Then the stored fat results in obesity (overweight). People with overweight may use diet contains fattening foods, such as high fat foods and foods with a lot of sugar.
Obesity is caused because of an imbalance between the energy store in human body and the energy released. An increase in consumption of high-energy foods, without an equal increase in physical activity leads to an unhealthy increase in weight. In other way, decreased levels of physical activity can also result in an energy imbalance and lead to weight gain.

Obesity can be controlled by

- Eating less high energy foods (lower energy intake)
- Taking more exercise (increase energy output).
- Eating a balanced diet with a lower intake of energy

5.7. Substance abuse

Drugs

A drug is any substance taken into the body that change and affects chemical reactions in the body. It can be taken legally to reduce a symptom such as a headache or to treat different types of infection, this is called medicinal drugs. There are also other drugs which could also be one taken illegally in order to provide stimulation or induce sleep or create hallucinations (recreational drugs).
Drugs are present in many food products such as: tea, coffee, energy drinks and alcoholic drinks. Though they have many useful medicinal properties their stimulant properties can produce caffeine's, a nasty condition that can readily addict.
Peoples are using drugs illegally to provide stimulation, induce sleep, or create hallucinations (recreational drugs) example of such drugs are: alcohol, tobacco, Khat, heroin etc. Peoples are also using alcohol, nicotine and caffeine for their pleasurable effects, to help them relax or concentrate. Some of the commonly practiced drugs in our country include:

1. Cigarettes smoking

Cigarette is made up of a plant called **tobacco** (Nicotiana tobacum) which originally cultivated and used in Central America. People use cigarette in order to stimulate their body or because they are addicted to it.
The chemical composition of cigarette leads to addiction and problem in human health. The main components of cigarette or tobacco are tar, carbon monoxide and Nicotine.

2. Drinking Alcohol

Alcohol is a socially acceptable drug in many countries including Ethiopia. In Ethiopia, there are different types of alcohol drinks such as Tella, Arekie (Katicala), Beer, Wine. When human body consumes alcohol, it is absorbed through the wall of the stomach and small intestine and it is absorbed into the blood. Alcohol gets distributed through- out the body by the help of blood circulation. It is absorbed by liver cells and broken down by liver enzymes; There- fore its concentration in the blood decreases gradually. Alcohol is a depressant. It affects the brain by slowing down the transmission of nerve impulses. Consuming larger quantities of alcohol leads to:

i. Loss of coordination,
ii. Loss of self-control.
iii. Loss of judgment and control of movements
iv. Slower reaction times (the interval between receiving a stimulus and making a response)loss of judgment and slower reaction times

3. Heroin

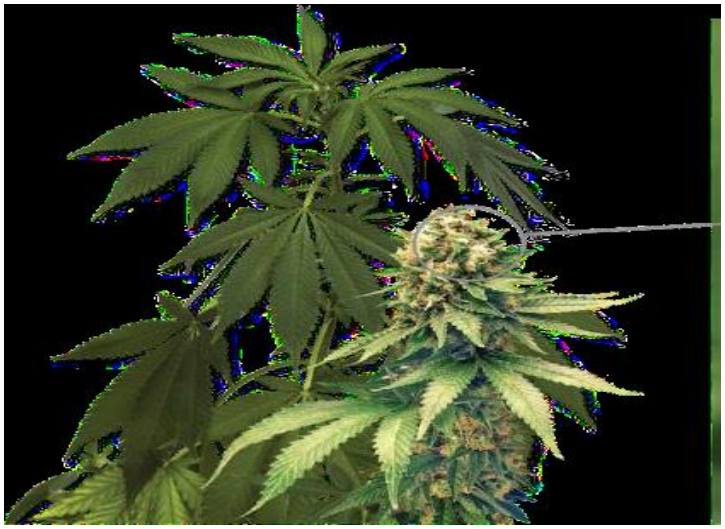
Heroin is a powerful depressant that slows down the nervous system. It has a chemical structure that is similar to endorphins, a group of chemicals that are found in the brain. Endorphins are made naturally in the brain and pro- vide relief when the body experiences pain or stress. Endorphins work on the synapses in the brain and preventing neurons from transmitting impulses from pain receptors, so they producing pain relief.

When a person takes heroin, the heroin molecules bind to the endorphin receptor sites, blocking nerve transmission. This mimics the function of natural endorphins. Therefore, by using heroin, the feeling of pain disappears and addiction produced. People practice to take heroin to reduce the pain. This is how the body develops a tolerance to the drug, and it has to be taken in ever-greater quantities in order to feel euphoria or just to reduce the pain.

4. Cannabis

Cannabis is the most commonly used illegal drug in the world. It is drug from Cannabis plant. Mostly it is the flower of cannabis plant, harvested, dried, and used as drug. Some people named this drug as weed, some call it pot, and others call it marijuana. This cannabis plant has been used as a drug for both recreational and traditional medicines for a long period. This drug contains a stimulant or psychoactive component called Tetra hydro cannabinol (THC). Peoples used this cannabis by smoking, vaporizing, together to food and as extract.

Cannabis causes: enjoyment, different states of mind and sense of time, difficulty concentrating, reduced short-term memory and body action relaxation and it results in an increase in appetite. The effect of cannabis in human body last for two to six hours, based on the quantity of the drug used. When cannabis is taken at high amount, it causes mental effects like: nervousness, panic, false beliefs, hallucinations, suspicion, and psychosis.



Cannabis

5. Chewing khat

Khat (*Catha edulis*) is bushy plant whose leaves are chewed for its stimulant effect. This plant is grown in southern Arabia and Eastern Africa including Ethiopia, Somalia, and Kenya. Khat is usually supplied as a bundle of leaves and fresh shoots wrapped in false banana leaves.

Khat contains a chemical compound known as cathinone, which affects central nervous system (CNS). This cathinone can be found only in fresh Khat leaves. Chewing khat releases Cathinone into the saliva that can be absorbed to the body easily. Only fresh leaves are chewed, because cathinone soon degrades into old in dry plant material.

Khat

6. Doping

The term “doping” refers to the use of prohibited medications, drugs, or treatments in competitive sports . It is practiced in athletes with the intention of improving athletic performance. Performance enhancing drugs (PEDs) is another term used to for drugs used by

athletes to improve their athletic performance. The World Anti-Doping Agency (WADA) uses a battery of blood and urine tests to determine if athletes are cheating. A key tool is the biological passport program, which tests all athletes for doping and performance enhancing drugs.

5.8. Infectious and noninfectious diseases

Disease is a condition in which the body does not function normally, and which produces symptoms such as: headache, increased body temperature, pain, distress or feeling weak. There are two types of diseases are called infectious and non-infectious diseases.

5.8. 1. Infectious diseases

Infectious diseases are diseases that are caused by disease causing organisms. These types of diseases can be transmitted from person to person such as HIV-AIDS, tuberculosis, malaria etc. Disease causing organisms are organisms, which cause diseases. Examples of disease causing organisms are bacteria, virus, protozoa, and fungi.

There are different types of infectious diseases that caused by different disease causing organisms. Their difference is based on:

• The type of host that they infect, some infect human, some infect only plant etc.
• Their mode of transmission, some are transmit by insects, some by contaminated water/food etc.
• type of disease causing organisms, some are caused by viruses, some by bacteria etc.
• the severity of the disease, such as the common cold, measles and influenza, only affect us for a short period of time. Others, such as tuberculosis (TB), human immune deficiency virus (HIV) infection may last a much longer time.

Transmission of infectious diseases

An understanding of the biology of the pathogen and its mode of transmission is essential to control and prevent the disease. Different infectious diseases have different mode of transmission.
• Some infectious diseases are transmitted from one per- son to another by direct contact with a patient.
• Other infectious diseases are transmit by drinking contaminated water or by eating contaminated food, (food or water contains disease-causing organisms like bacteria and virus). This is because the infectious organisms can survive in water, human food, faeces
• Some infectious diseases are transmitted by insect bite.
• Some infectious diseases are transmitted by sexual inter-course etc.

Preventing infections and control methods of infectious diseases

Control is an attempt to break transmission cycles by removing the conditions that favor the spread of the disease causing organisms.

1. Vaccination: is a major control measure for many infectious diseases; it works by making the body to defend against disease causing organisms.
2. Personal hygiene; people of all ages should wash their hands after using the toilet and before handling or eating food; this protects the entrance of disease causing organisms into our body.
3. Hygienic food preparation: food should be covered to keep flies away, kitchen surfaces should be cleaned to kill bacteria, and food should be cooked exhaustively to make sure any bacteria are killed.
4. Boiling cooking and/or drinking water to kill the pathogens

5. Proper waste disposal: household waste should be put
6. Into covered bins and collected at regular intervals.
7. Sewage treatment: toilet waste is a serious health threat if it is not disposed properly. Water pipe should be arranged far from toilet drainage. For example, the disease causing organism that cause giardia and cholera are transmitted through contamination of drinking water by faeces and sewage.

Human immune deficiency virus infection/ acquired immunodeficiency syndrome (HIV-AIDS)

Acquired immunodeficiency syndrome is caused by the human immunodeficiency virus (HIV).HIV infection rates are especially high sub-Saharan Africa including Ethiopia. Peoples who have HIV in their body are called HIV-positive or HIV carriers. Usually, these HIV positive people do not show any symptom of the disease for several years after infection. Infection of HIV starts when the virus infects and enters to T-lymphocytes. These are cells that defend our Body from diseases.

HIV replicates and survives in human T-lymphocyte cells. During its replication HIV, destroys these T-lymphocytes cells. As a result the number of T-lymphocytes gradually decrease which leads to declining of disease resistant mechanism of the body. When the body reduced in its dis-ease resistant mechanism, it causes acquired immunodeficiency syndrome (AIDS). AIDS is the result of opportunistic diseases like pneumonia, TB, cancers; weight loss, diarrhoea etc.

Tuberculosis (TB)
Tuberculosis is another example of infectious disease caused by the bacterium called *Mycobacterium tuberculosis* and rarely by*Mycobacterium bovis*. These bacteria live inside human cells, mainly in the lungs. TB has many symptoms like cough, chest pain, shortness
Of breath, fever, sweating, weight loss etc. After infection, some people develop TB quite quickly, while in others the bacteria remain inactive for many years. This difference is because of the difference in disease resistance ability between peoples.

TB transmission

TB bacteria can enter the lungs in airborne droplets. It spread when infected people with the active form of the illness cough or sneeze. The bacteria are carried in the air in tiny droplets of

liquid. Transmission occurs when people who are uninfected inhale (breath in) the droplets. These happen rapidly in places where many people are living in crowded conditions such as very crowded public transportation. The other transmission way is by consuming undercooked meat and unpasteurized milk. This type of transmission mainly occurs for the TB transmits from infected animals.

Prevention and control of TB

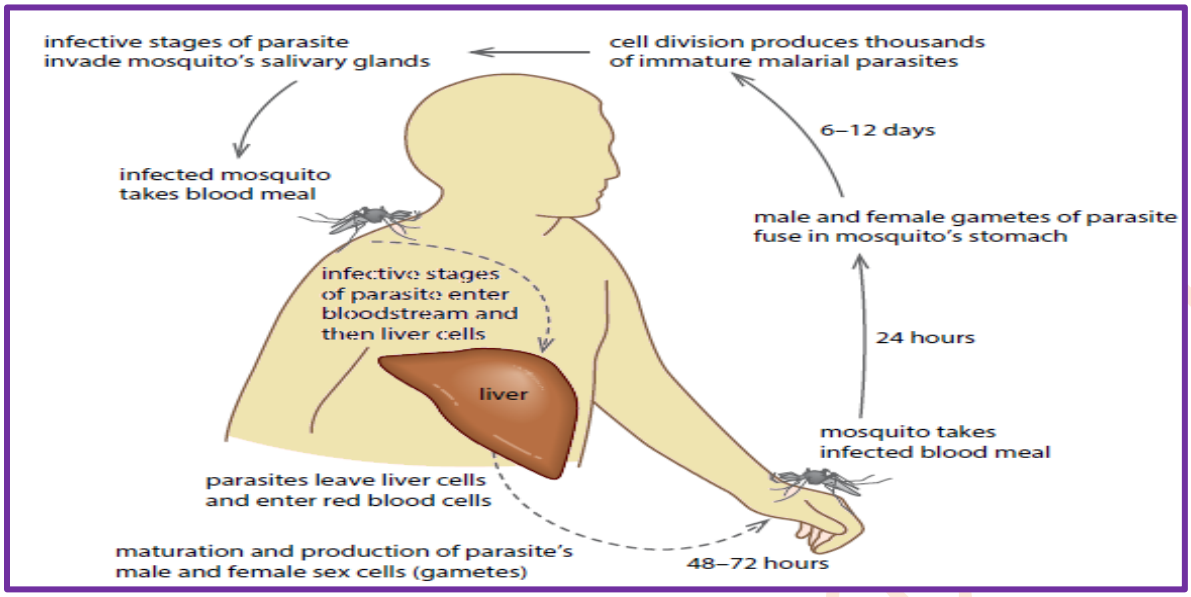
There are drugs and vaccines that are important to treat and prevent this disease

Treatment of TB: A person, who shows symptoms relating to TB, should his/her sputum sample tested for the presence of TB bacteria. If a person is positive for TB, then patients should be isolated while they are in the most infectious stage (which is at two to four weeks). The treatment involves using several drugs to ensure that all the bacteria are killed. The treatment also need about six to nine months. If the bacteria not killed by treatment, it may be because of drug resistance TB.

Vaccine: The only vaccine available for TB is the BCG vaccine, which is derived from animal TB bacteria and protects up to 70–80%of people who receive it. This vaccine is given during early child or infant stage. The effectiveness of the vaccine decreases with in old age. TB is relating to reduced immunity of the body, increasing standards of people who are living with HIV and treating HIV infected people help to reduce the incidence of TB.

Malaria

Malaria is caused by protozoa known as plasmodium Protozoa. Malaria is found in many parts of the world where *Anopheles* mosquito species that can act as vectors are found. It is very common in tropical and subtropical regions where humidity is high, a comfortable environment for mosquito breeding. Female Anopheles mosquitoes feed on human blood to obtain the protein they need to develop their eggs. If the person they bite is infected with Plasmodium, they will take up some of the plasmodium together the blood meal. When the mosquito feeds again another healthy person, she injects the plasmodium with her saliva. Then the parasites enter the red blood cells, where they multiply.



Life cycle of malaria

The life cycle of Plasmodium. Plasmodium has two hosts which are human and mosquito. The reproduction of plasmodium taken place in both hosts, sexual reproduction in mosquito and asexual preproduction in human.

Prevention and control of malaria

There are three main ways to control malaria:

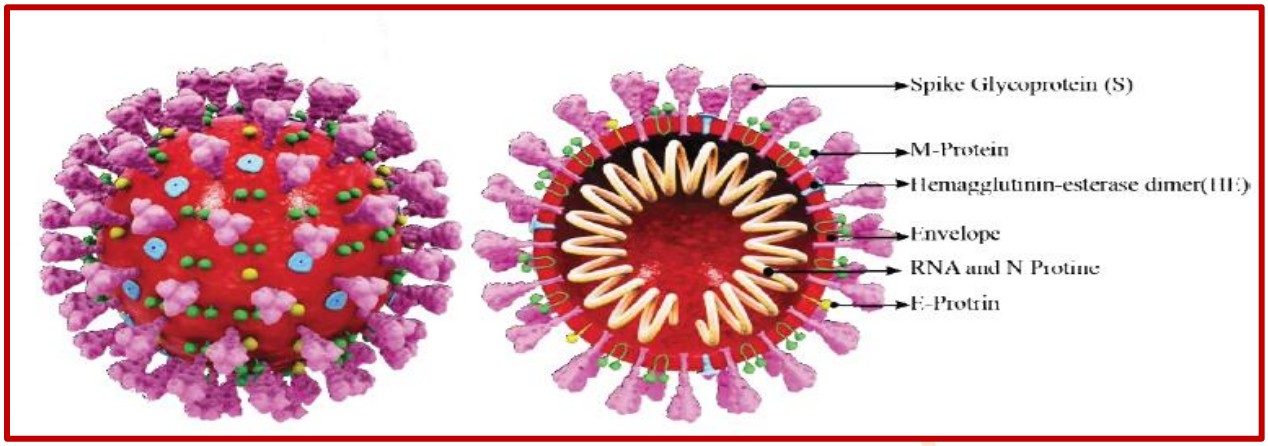
• Reducing the population of mosquitoes. This can be done by removing sources of water in which they can breed. Sometimes, it is possible to use Biological controls like fish which feeds on the larva of the mosquito. In addition using insecticide to kill mosquito is another way to reduce the number of mosquito.

• Avoiding mosquitoes bite: This can be done by sleeping under a mosquito net, or using insect repellant.

• Using anti-malarial drugs such as quinine and chloroquine to treat infected people. However, in many parts of the world Plasmodium has evolved resistance to some of these drugs. Chloroquine resistance is widespread in parts of South America, Africa; newer drugs such as mefloquine are used in these areas.

Coronavirus disease 2019 (COVID-19)

Corona virus large family of viruses belongs to family coronaviridae which cause diseases in mammals and birds. This virus has extracellular covering structure called lipid envelop. The virus also has club shaped spikes proteins on the outer surface of the virus. The viral envelope is made up of a lipid bilayer membrane (M), envelope (E) and spike proteins(S). The E and M protein are the structural proteins that combined with the lipid bilayer to shape the viral envelope and maintain its size. S proteins are needed for interaction with the host cells.



Structure of COVID-19

While SARS had occurred in 2003 in China, MERS occurred in Middle East countries in 2012. COVID-19 virus (previously called novel coronavirus) is a new strain of a coronavirus that first emerged in China in December1, 2019. The first case of pneumonia outbreak was reported in Wuhan, China. On 31 December 2019, the outbreak was traced to a novel strain of coronavirus that was given the name SARS-COV-2 by the international committee on Taxonomy of Viruses.SARS-CoV-2 may have originated in an animal and changed (mutated) so it could cause illness in humans. In March 2020, the World Health Organization (WHO) declared COVID-19 as a pandemic. The disease caused by SARS-COV-2 known as coronavirus disease 2019 (COVID-19).

How does the coronavirus spread?

The COVID-19 virus spreads primarily through the droplets and virus particles released into the air when an infected person breathes, talks, laughs, sings coughs or sneezes. When many people are gathered and if there is poor ventilation, these droplets can be inhaled or land in the mouth, nose or eyes of a person close. It can also spread, if a person touches a surface with the virus on it and then touches his or her mouth, nose or eyes.

What are the symptoms of COVID-19

COVID-19 symptoms can be very mild to severe. Even some people have no symptoms. The most common symptoms are fever, cough, and tiredness, shortness of breath, muscle aches, chills, sore throat, headache, chest pain, and loss of taste or smell. This list is not all inclusive. These symptoms may appear two to fourteen days after exposure.

How is COVID-19 diagnosed?

COVID-19 is diagnosed or tested by taking fluid sample from nose or mouth and testing it through a laboratory test. Laboratory testing is important because some people with the coronavirus do not have symptoms at all.

Prevention and control of COVID-19

There are many steps you can take to prevent yourselves from getting the COVID-19 virus and spreading it to others.

• Follow important precautions or instructions:
• keep at least 6 feet (2 meters) of distance between
• yourself and people outside your household.
• avoid crowds and indoor places that have poor ventilation.
• wash your hands often with soap and water for at least 20 seconds, or use an alcohol based hand sanitizer that contains at least
60% alcohol.
• wear a mask in public places, especially when social distancing is difficult.
• cover your mouth and nose with your elbow or a tissue when you cough or sneeze.
• Throw away the used tissue. Wash your hands rightaway.
• avoid touching your eyes, nose and mouth
• clean and disinfect surfaces you often touch on a daily basis.

Vaccine:

Currently there are different type's vaccines produced by different countries. Examples of these vaccines are AstraZeneca's AZD1222 BioNTech's BNT162 etc. Currently, large number of people in different country including Ethiopia receives these vaccines.

If you are suspect COVID-19 or if you are ill withCOVID-19 take the following precautions to avoid spreading the COVID-19 virus:
• stay home from school and public areas, except to get medical care.
• avoid public transportation, taxis and ride-sharing if possible.
• wear a face mask around other people.
• isolate yourself as much as possible from others in your home.
• use a separate bedroom and bathroom if possible.
• avoid sharing dishes, glasses, bedding and other household items.

5.8. 2 Non-infectious diseases

These are disease caused by malnutrition, chemical effect, inherited or genetic factor etc. These diseases are not caused by disease causing organisms. Some of the non-infectious diseases that you have learnt previously in this chapter are:

• diseases caused by malnutrition like Kwashiorkor, Scurvy, night blindness marasmus etc.,
• disease caused by cigarette smoke like lung cancer , Chronic bronchitis etc.
• In addition there are other examples of sickle cell anemia, cancer, allergies, kwashiorkor, marasmus, diabetes, podoconiosis, etc.

Review Questions

I. Choose the correct answer for the following questions.

1. Which of the following nutrient provide more energy?

a. Protein b. Carbohydrate c. Lipids d. Vitamins
2. Which of the following is not belong to deficiency diseases?
a. Kwashiorkor b. Diabetes c. Marasmus d. Scurv
3. Which of the following diet is composed of carbon, hydrogen, oxygen and nitrogen?
a. Carbohydrate b. Lipids c. Protein d. all
4. Which of the following minerals are used to synthesize the hemoglobin of red blood cells?
a. Iodine b. Calcium c. Iron d. Phosphorus
5. Which of the following group of people needs high amount of balanced diet?
a. Athletes b. pregnant women c. Children d. All
6. Which of the following is not the result of obesity?
a. heart disease b. high blood pressure c. diabetes d. Marasmus
7. Substance abuse is.....
a. using legal drugs in the wrong way b. using illegal drugs/ in the wrong way
c. using legal or illegal drugs for medical purpose d. a and b

8. What are the chemicals found in tobacco?
a. Carbon monoxide b. Nicotine c. Tar d. All
9. What type of drug is alcohol?
a. Depressant b. Stimulant c. Activator d. all
10. What is the stimulant or psychoactive component found in cannabis....
a. Tetrahydrocannabinol b. Cathinone c. Nicotein d. Tar

II. Fill in the blank space with appropriate words
1. Tuberculosis is caused by the bacterium called_____
2. Deficiency disease caused by the shortage of vitamin D is_____
III. Answer the following questions
1. Discuss the feeding habits that may lead to obesity
2. Examine the effects of smoking, alcohol use and chewing khat, on the health, social, economic, cultural, and psychological wellbeing
3. Explain the modes of transmission and prevention of infectious and non-infectious diseases
4. List the components of a balanced diet and give a good source of each one.

Answer for Review Questions.

I. Choose the correct answer for the following questions.

1. C 2. B 3.C 4. C 5. D 6. D 7. D 8. D 9. A 10. A

II. Fill in the blank space with appropriate words
1. Mycobacterium tuberculosis 2. Rickets

III. Answer the following questions

1. **Answer:** if you consume high amount of energy, particularly found in high fat and high sugar food, and do not use all of the energy through physical activity, much of the extra

energy will be stored in the body as fat.

2. High doses and chronic use of khat can cause more serious adverse neurological, psychiatric, cardiovascular, dental, gastrointestinal and genitourinary effect. And in general lack of basic essential commodities such as food,shelter,clothing and school fees
3. Infection diseases are transmitted from person to person through the transfer of a pathogen such as bacteria, viruses, fungi or parasites.
   A non-infectious disease cannot be transmitted through a pathogen and is caused by a variety of other circumstantial factors.
4. Protein, carbohydrates, lipids, vitamins, minerals and water.

Unit 6

Ecology

6.1 Ecology

6.1.1 Definitions

The branch of biology that developed from natural history is known as ecology**. Ecology** is the study of relationships of organisms to one another and to their environment. The scientist who studies ecology is known as ecologist.

Ecologists use both qualitative and quantitative research. They gather qualitative information by observing organisms and their environment. They gather quantitative data by making measurements and doing experiments. Ecologists study organisms both in the laboratory and in the field where they live.

6.1.2. Biotic and abiotic components

Abiotic Factors

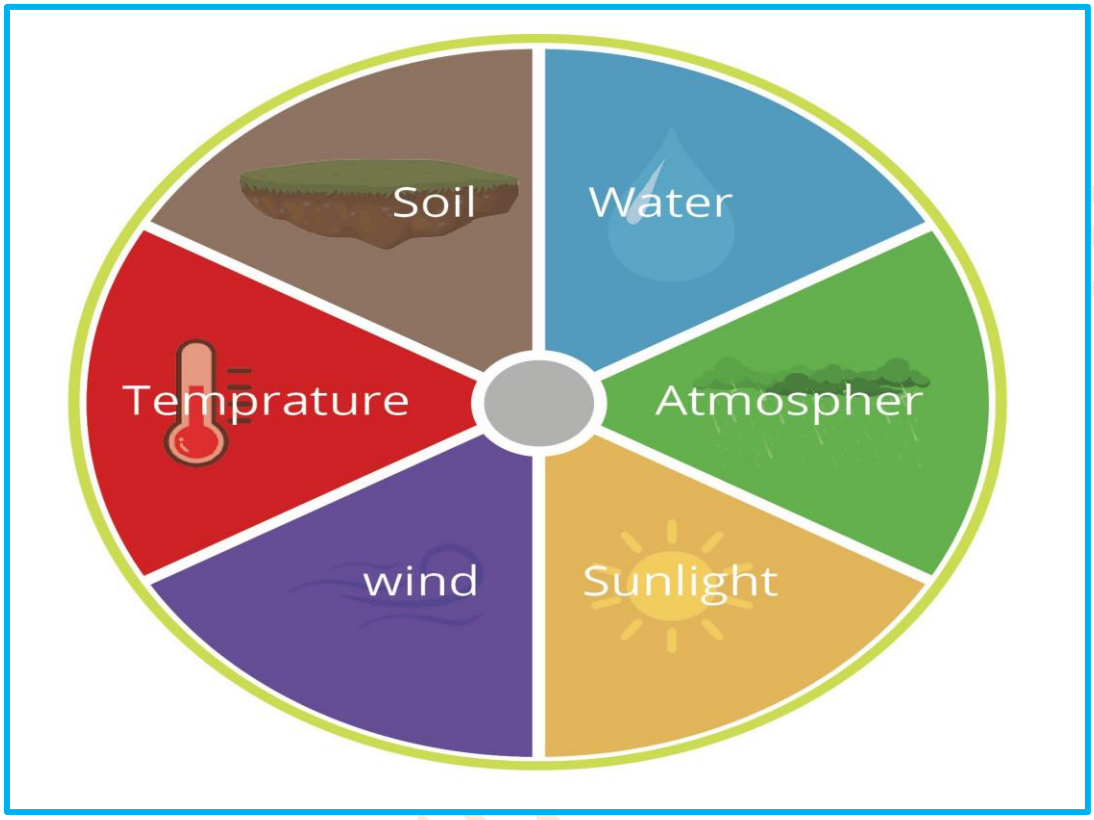
Abiotic factors are non-living components of the ecosystem that influence the distributions of organisms in their environment. Examples of abiotic factors include: energy, light, temperature, water, nutrients, salinity, etc.

Energy: All organisms require a usable source of energy to live. Solar energy from sunlight, captured by chlorophyll during the process of photosynthesis, powers most ecosystems. Lack of sunlight is rarely the most important factor limiting plant growth for terrestrial ecosystems, Although shading by trees does create intense competition for light among plants growing on forest floors. In many aquatic environments, however, light cannot penetrate beyond certain depths. As a result, most photosynthesis in a body of water occurs near the surface. Surprisingly, life also thrives in environments that are completely dark. These ecosystems are powered by bacteria that derive energy from the oxidation of inorganic chemicals such as hydrogen sulfide. Bacteria with similar metabolic talents support communities of caved dwelling organisms.

Temperature is an important abiotic factor because of its effect on metabolism. Few organisms can maintain a sufficiently active metabolism at temperatures close to 0°C (32°F), and temperatures above 45°C (113°F) destroy the enzymes of most organisms. Most organisms function best within a specific range of environmental temperatures.

Water is essential to all life. Aquatic organisms are surrounded by water, but they face problems of water balance if their own solute concentration does not match that of their surroundings. For terrestrial organisms, the primary threat is drying out in the air. Many land animals have

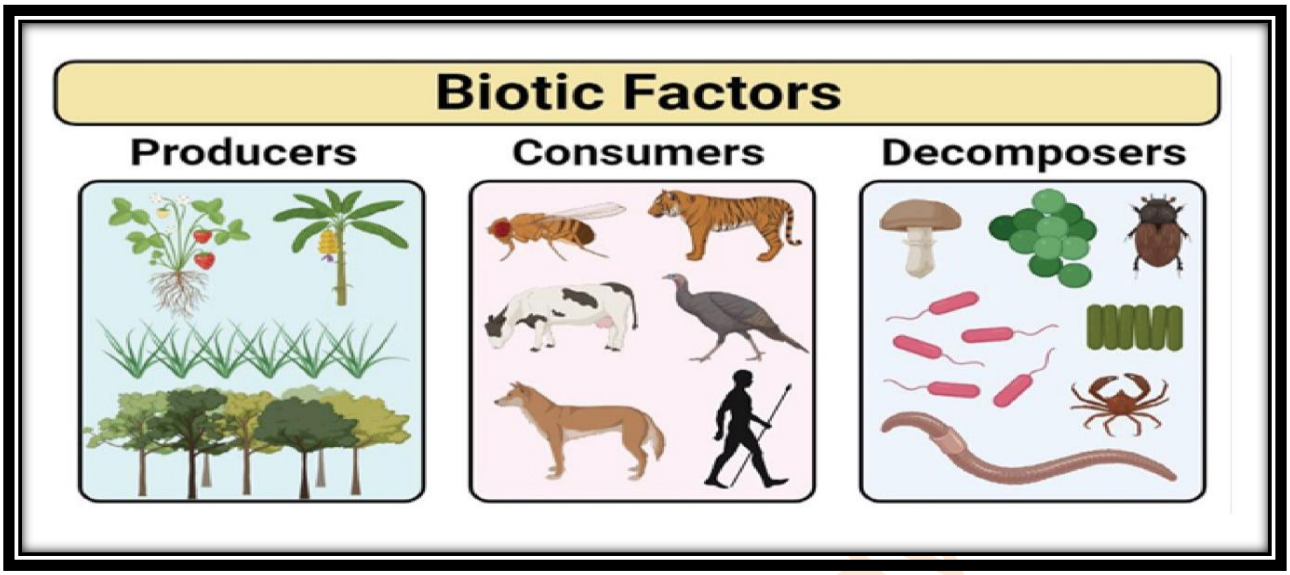
watertight coverings that reduce water loss, such as reptilian scales. Most plants have waxy coatings on their leaves and other aerial parts.



Common abiotic factors of territorial and aquatic biome

Biotic Factors

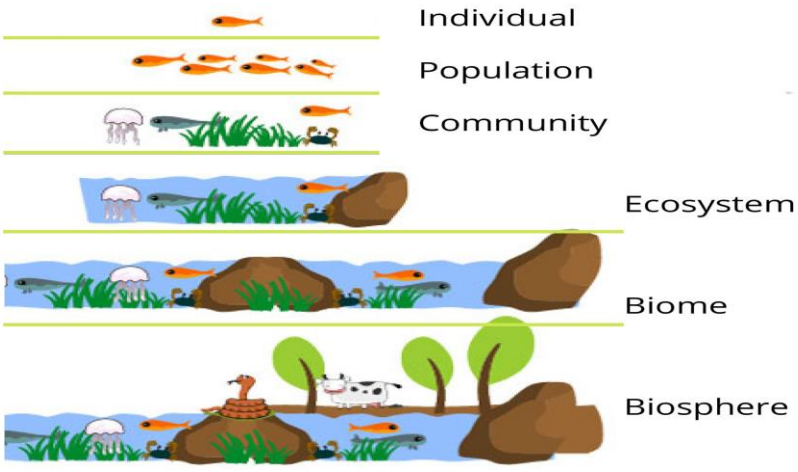
Biotic factors are the living components of the ecosystem that influence the distributions of organisms in their environment. Often, the ability of a species to survive and reproduce is reduced by its interactions with other species, such as predators (organisms that kill their prey) or herbivores (organisms that eat plants or algae). Herbivores could affect the distribution of a food species. In addition to predation and herbivory, the presence or absence of pollinators, food resources, parasites, pathogens, and competing organisms can act as a biotic limitation on species distribution. Such biotic limitations are common in nature.



Common biotic factors of territorial and aquatic biomes

6.1.3. Ecological levels

Ecologists study individual organisms. They study relationships among organisms of the same species and connections among organisms of different species. They also study the effects of abiotic factors on species that live together. To make it easier to examine all of these biotic and abiotic interactions, ecologists have organized the living world into levels. The levels are the organism by itself, populations, communities, ecosystems and biosphere. The traditional ecological investigation usually starts at the level of the individual.



Ecological levels

A population is a group of interbreeding organisms that are members of the same species living in the same area at the same time. Members of the same population may compete with each other for food, water, mates, or other resources. Some species have adaptations that reduce competition within a population. For instance, frogs have a life cycle in which the young tadpoles and adult frogs look very different and have different diets. Tadpoles eat algae and adult frogs eat insects; therefore, they are not competing with each other for food.

A biological community consists of the different species within an area, typically a three-dimensional space, and the interactions within and among these species. Examples of interactions include predation, parasitism, herbivory, competition, and pollination. In a biological Community, changes in one population may cause changes in other populations. For instance, if the number of mouse-eating birds (e.g., hawks) in a community increases slightly, the number of mice in that community will decrease slightly.

In a healthy forest community, there are many populations that depend on each other. These might include birds eating insects, mushrooms growing from decaying leaves or bark. While these populations are connected to each other, they are all affected by abiotic factors. These relationships between different populations and their surroundings create an ecosystem.

6.1.4. Ecosystems

The community of organisms in a habitat, plus the **non-living** part of the environment (e.g., air, water, soil, light, etc.) makes up an ecosystem. A lake is an ecosystem, which consists of the plant and animal communities mentioned above, and the water, minerals, dissolved oxygen, soil and sunlight on which they depend. An ecosystem is self-supporting. In a woodland ecosystem, the plants absorb light and rainwater for photosynthesis; the animals feed on the plants and on each other. The dead remains of animals and plants, acted upon by fungi and bacteria, return nutrients to the soil.

Lakes and ponds are clear examples of ecosystems. Sunlight, water and minerals allow the plants to grow and support animal life. The recycling of materials from the dead organisms maintains the supply of nutrients. So, a population of carp forms part of the animal community living in a habitat called **a lake**.

Types of ecosystems

An ecosystem is made of all of the different populations in a biological community and the community's abiotic factors. There are two major kinds of ecosystems—terrestrial and aquatic. Terrestrial ecosystems are those located on land. Examples include forests, fields, and a rotting log. Aquatic ecosystems are found in both freshwater and salt water. Freshwater ecosystems include ponds, lakes, and streams. Oceans are a type of saltwater, or marine, ecosystem.

6.1.5 Biomes

A biome is a major terrestrial or aquatic life zone characterized by vegetation type in terrestrial biomes and the physical environment in aquatic biomes. In this section, we will briefly survey the terrestrial biomes, followed by the aquatic biomes.

Terrestrial Biomes

Terrestrial biomes vary greatly. For example, at the North Pole, the weather is very cold and there are no plants. As you move south, the weather gets warmer and there is a change in the size, number, and kinds of plants that cover the ground.

As you continue south, the temperatures rise and you encounter forests. Still farther south are grasslands and deserts, with high summer temperatures and little rainfall. Near the equator, you find abundant growth and much rainfall.

What are the tropical rain forests?

Tropical rain forests of evergreen broad-leaf trees form between latitudes 10° north and south in equatorial Africa, the East Indies, Southeast Asia, South America, and Central America. Rain that falls throughout the year sums to an annual total of 130 to 200 centimeters. Regular rains, combined with an average temperature of 25°C (77°F) and little variation in day length, allow photosynthesis to continue year-round.

Broad-leaf evergreen trees are dominant in tropical rain forests. Tropical forests are home to millions of animal species. In fact, animal diversity is higher in tropical forests than in any other terrestrial biome. The animal species includes amphibians, birds and reptiles, mammals and arthropods. Deforestation is an ongoing threat to tropical rain forests. Tropical forests are located in developing countries with fast-growing human populations who look to the forest as a source of lumber, fuel, and potential agricultural land. Deforestation in any region leaves fewer trees to remove carbon dioxide from the atmosphere.

Picture Tropical forest

What is a desert?

Deserts receive an average of less than 10 centimeters of rain per year. Maximum air temperature in hot deserts may exceed 50°C while in cold deserts air temperature may fall below –30°C. They cover about one-fifth of Earth's land surface and many are located at about 30°north and south latitude.

Examples of desert biome include Chile's Atacama Desert and China's Gobi desert. Lack of rainfall keeps the humidity in deserts low. With little water vapor to block the sun's rays, intense sunlight reaches and heats the ground. At night, the lack of insulating water vapor in the air allows the temperature to fall fast.

Desert biome

What are Savannas?

The Savanna biome occurs in equatorial and sub-equatorial regions. Savannas lie between the tropical forests and hot deserts of Africa, India, and Australia. Africa's savannas are famous for their abundant wildlife. The precipitation averages 30–50 cm per year while the dry season can last up to eight or nine months. The temperature is warm year-round, averaging 24–29°C.

The biome is characterized by scattered trees found at different densities. Fires are common in the dry season, and the dominant plant species are fire-adapted and tolerant of seasonal drought. Grasses and small non-woody plants make are common. These plants grow rapidly in response to seasonal rains and are tolerant of grazing by large mammals and other herbivores. Herbivores include giraffes, zebras, elephants, a variety of antelopes, and immense herds of wildebeests. Lions and hyenas are carnivores that eat the grazers.

Savanna biome

What are temperate grasslands?

Temperate grasslands are warm in summer, but cold in winter. Annual rainfall is 25 to100 centimeters, with rains throughout the year. Grass roots extend profusely through the thick topsoil and help hold it in place, preventing erosion by the constant winds. North America's grasslands are shortgrass and tallgrass prairies. During the 1930s, much of the shortgrass prairie of the American Great Plains was plowed to grow wheat.

Tallgrass prairie has somewhat richer topsoil and slightly more frequent rainfall than shortgrass prairie. Nearly all tallgrass prairie has now been converted to cropland. The Tallgrass Prairie National Preserve was created in 1996 to protect the little that remains. North America's prairies once supported enormous herds of elk, pronghorn antelope, and bison that were prey to wolves. Today, these predators and prey are absent from most of their former range.

Grassland biome

What are Boreal Forests?

The boreal forest, also known as **taiga or coniferous forest**, is found south of the Arctic Circle and across most of Canada, Alaska, Russia, and northern Europe. This biome has cold, dry winters and short, cool, wet summers. The annual precipitation is from 40 cm to 100 cm and usually takes the form of snow. Little evaporation occurs because of the cold temperatures.

The long and cold winters in the boreal forest have led to the predominance of cold-tolerant cone-bearing (coniferous) plants. These are evergreen coniferous trees like pines and spruce which retain their needle-shaped leaves year-round. This benefits evergreen trees, which grow faster than deciduous trees in the boreal forest. In addition, soils in boreal forest regions tend to be acidic with little available nitrogen. Plant species diversity is less than that seen in temperate forests and tropical wet forests.

Northern Coniferous Forest biome

What is the temperate broad-leaf forest?

Temperate broad-leaf forest is found mainly at mid-latitudes in the Northern Hemisphere, with smaller areas in Chile, South Africa, Australia, and New Zealand. The precipitation can average from about 70 to over 200 cm annually. In winter temperatures average 0°C while in summers, with temperatures up to 35°C, are hot and humid.

The dominant plants are deciduous trees, which drop their leaves before winter, when low temperatures would reduce photosynthesis and make water uptake from frozen soil difficult. Many mammals hibernate in winter, while many bird species migrate to warmer climates.

Temperate broad-leaf forest has been heavily settled on all continents. Logging and land clearing for agriculture and urban development cleared virtually all the original deciduous forests in North America. However, owing to their capacity for recovery, these forests are returning over much of their former range.

Temperate Broad-leaf Forest biome

What are the tundra's?

Cover expansive areas of the Arctic, amounting to 20% of Earth's land surface. The precipitation averages from 20 to 60 cm annually in arctic tundra but may exceed 100 cm in alpine tundra. Winters are cold, with averages in some areas below –30°C while summer temperatures generally average less than 10°C. High winds and low temperatures produce similar plant

communities, called *alpine tundra*, on very high mountaintops at all latitudes, including the tropics.

The vegetation of tundra is mostly herbaceous, consisting of a mixture of mosses, grasses, and forbs, along with some dwarf shrubs and trees and lichens. A permanently frozen layer of soil called permafrost restricts the growth of plant roots .Large grazing musk oxen are resident, while caribou and reindeer are migratory. Predators include bears, wolves, and foxes. Many bird species migrate to the tundra for summer nesting. The major human impacts are mineral and oil extraction.

Tundra biome

Aquatic biomes

Aquatic biomes, which occupy roughly 75% of Earth's surface, are determined by their salinity and other physical factors. Freshwater biomes (lakes, streams and rivers, and wetlands) typically have salt concentrations of less than 1%. The salt concentrations of marine biomes (oceans, intertidal zones, and coral reefs) are generally around 3%.

What are the lakes?

Standing bodies of water range from ponds a few square meters in area to lakes covering thousands of square kilometers. The salinity, oxygen concentration, and nutrient content differ greatly among lakes and can vary with season.

Rooted and floating aquatic plants in lakes live close to shore. Here, sunlight penetrates all the way to the lake bottom; aquatic plants and algae that attach to the bottom are the primary producers. Also a variety of phytoplankton, including cyanobacteria and zooplankton live in the open water zone of a lake. Fishes live in all zones with sufficient oxygen. Runoff from fertilized land and dumping of wastes lead to nutrient enrichment, which can produce large numbers of algae (an algal "bloom") oxygen depletion, and fish kills.

Lakes biome

What are the wetlands?

Wetlands are environments in which the soil is either permanently or periodically saturated with water. Wetlands are different from lakes because wetlands are shallow bodies of water. There are several types of wetlands including marshes, swamps, bogs, mudflats, and salt marshes.

Because of high organic production by plants and decomposition by microbes and other organisms, both the water and the soils are periodic low in dissolved oxygen. Wetlands have a high capacity to filter dissolved nutrients and chemical pollutants. Wetlands are among the most productive biomes on Earth.

Wetlands biome

What are streams and rivers?

The most prominent physical characteristic of streams and rivers is them speed and volume of their flow. Headwater streams are generally cold, clear, swift, and turbulent. Farther downstream, where numerous tributaries may have joined, forming a river, the water is generally warmer and more turbid because of suspended sediment.

The salt and nutrient content of streams and rivers increases from the headwaters to the mouth. Headwaters are generally rich in oxygen. A great diversity of fishes and invertebrates inhabit unpolluted rivers and streams. Municipal, agricultural, and industrial pollution degrade water quality and kill aquatic organisms. Damming and flood control impair the natural functioning of stream and river ecosystems and threaten migratory species such as salmon.

Streams and Rivers biome

What are estuaries?

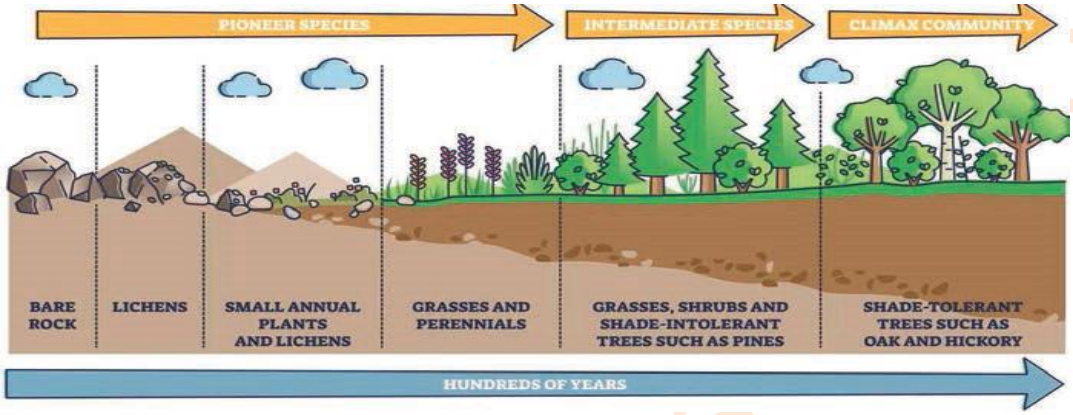
An estuary is a transition area between river and sea. Seawater flows up the estuary channel during a rising tide and flows back down during the falling tide. Often, higher-density seawater occupies the bottom of the channel and mixes little with the lower-density river water at
The surface.

Salinity varies spatially within estuaries, from nearly that of fresh water to that of seawater. Nutrients from the river make estuaries, like wetlands, among the most productive biomes.
Saltmarsh grasses and algae, including phytoplankton, are the major producers in estuaries. Estuaries support an abundance of worms, oysters, crabs, and many fish species that humans consume. Many marine invertebrates and fishes use estuaries as a breeding ground or migrate through them to freshwater habitats upstream. Estuaries are also crucial feeding areas for waterfowl and some marine mammals. Filling, dredging, and pollution from upstream have disrupted estuaries worldwide.

Estuaries biome

1.1.6 Ecological succession

Changes in the composition of terrestrial communities are most apparent after a severe disturbance, such as a volcanic eruption or a glacier, strips away all the existing vegetation. The disturbed area may be colonized by a variety of species, which are gradually replaced by other species, which are in turn replaced by still other species—a process called **ecological succession.** When this process begins in a virtually lifeless area, such as on a new volcanic island or on the rubble (moraine) left by a retreating glacier, it is called **primary succession.**

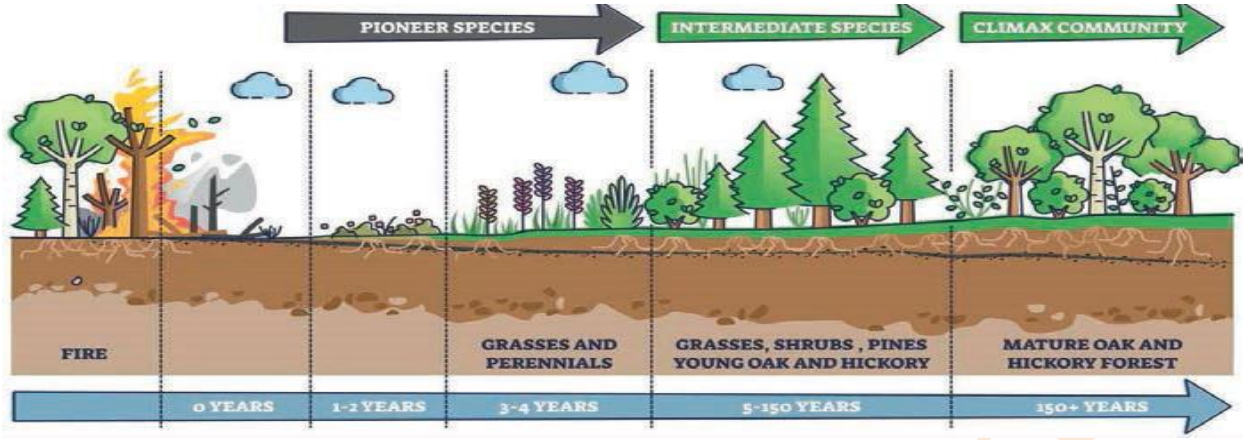


Primary successions

During primary succession, the only life-forms initially present are often prokaryotes and protists. **Lichens and mosses**, which grow from windblown spores, are commonly the first macroscopic photosynthesizes to colonize such areas. Soil develops gradually as rocks weather and organic matter accumulates from the decomposed remains of the early colonizers. Once soil is present, the lichens and mosses are usually overgrown by grasses, shrubs, and trees that sprout from seeds blown in from nearby areas or carried in by animals.

In contrast to primary succession**, secondary succession** involves the **re-colonization** of an area after a major disturbance has removed most but not all of the organisms in a community. Following the disturbance, the area may return to something like its original state.

For instance, in a forested area that has been cleared for farming and later abandoned, the earliest plants to recolonize are often herbaceous species that grow from windblown or animal-borne seeds. If the area has not been burned or heavily grazed, woody shrubs may in time replace most of the herbaceous species, and forest trees may eventually replace most of the shrubs.



Secondary succession

6.2. Ecological relationships

Some key relationships in the life of an organism are its interactions with individuals of other species in the community. These interspecific interactions include competition, predation, herbivory, parasitism, mutualism, and commensalism.

Competition (-/-)

Competition is interaction that occurs when individuals of different/same species each use a resource that limits the survival and reproduction of both individuals. Weeds growing in a garden compete with garden plants for soil nutrients and water. Predators compete for prey such as hares. In contrast, some resources, such as oxygen, are rarely in short supply on land; most terrestrial species use this resource but do not usually compete for it.

Predation (+/-)

Predation is interaction in which an individual of one species, the predator, kills and eats an individual of the other species, the prey. For example, a rotifer (a tiny aquatic animal that is smaller than many unicellular protists) that kills a protist by eating it can also be considered a predator. Because eating and avoiding being eaten are prerequisites to reproductive success, the adaptations of both predators and prey tend to be refined through natural selection.

Herbivory (+/-)

Herbivory is an exploitative interaction in which an organism— an herbivore—eats parts of a plant or alga, thereby harming it but usually not killing it. Examples of herbivores include cattle, sheep, giraffe and goat. However, most herbivores are invertebrates, such as grasshoppers, caterpillars, and beetles .

Herbivores have many specialized adaptations. Many herbivorous insects have sensors

on their feet that enable them to distinguish between plants based on their toxicity or nutritional value. Goats also use their sense of smell to examine plants, rejecting some and eating others. Other herbivores also have specialized teeth or digestive systems adapted for processing vegetation.

Parasitism (+/-)

Parasitism is exploitative interaction in which one organism, the parasite, derives its nourishment from another organism, its host, which is harmed in the process. Endoparasites such as parasitic roundworms live and feed inside their host.

An ectoparasite such as a tick feeds while attached to a host's external surface. Many parasites have complex life cycles involving multiple hosts. The blood fluke, which currently infects approximately 200 million people around the world, requires two hosts at different times in its development: humans and freshwater snails.

Mutualism (+/+)

Mutualism is interaction that benefits individuals of both of the interacting species. Mutualisms are common in nature, including cellulose digestion by microorganisms in the digestive systems of termites and ruminant mammals, animals that pollinate flowers or disperse seeds, nutrient exchange between fungi and plant roots in mycorrhizae, and photosynthesis by unicellular algae in corals.

In some mutualisms, such as the acacia-ant, each of the interacting individuals depends on the other for their survival and reproduction. Both partners in a mutualism incur costs as well as benefits. In mycorrhizae, for example, the plant often transfers carbohydrates to the fungus, while the fungus transfers limiting nutrients, such as phosphorus, to the plant.

Commensalism (+/0).

Commensalism is interaction that neither benefits the individuals of one of the interacting species but neither harms nor helps the individuals of the other species. For instance, cattle egrets feed on insects flushed out of the grass by grazing bison, cattle, horses, and other herbivores. Because the birds increase their feeding rates when following the herbivores, they clearly benefit from the association.

Much of the time, the herbivores are not affected by the birds. At times, however, the herbivores too may derive some benefit; for example, the birds may remove and eat ticks and other ectoparasites from the herbivores' skin, or they may warn the herbivores of a predator's approach.

Review Questions

Part One (Matching Items): Match items under column A with the appropriate item under column B.

Column 1	Column 2
1 abiotic factor	A. millipedes, centipedes, insects, slugs, and earthworms under a log
2 Parasitism	B. a tick on a cat
3 biological community	C. an owl eating a mouse
4 Habitats	D. Rain
5 predator-prey relationship	E. a rain forest
6 limiting factors	F. cold temperatures and high winds that prevent tree growth in mountain areas
7 secondary succession	G. the first organisms to grow on a new patch of cooled, Hardened lava
8 Tolerance	H . Ability of mosquitoes to survive in very different conditions all over the world
9 pioneer species	I. An old forest that has not had any fire damage in over 200 years
10 climax community	J. Weeds and wildflowers beginning to grow in a field after a corn crop is harvested

Part Two. Fill in the blanks below with the following words to make correct statements about the material you read in this section: desert, tundra, plankton, photic zone, rain forest.

1. The.....biome is a home to more types of life than any other biome.
2. The..... is so cold that very little life exists there.
3. The driest biome is..... The biome.
4. The part of the marine biome that is shallow enough for sunlight to penetrate is called the .....
5. The base of the entire marine biome food chain is formed by.....

Part Three. Critical thinking questions

1. Explain the difference between intra-specific competition ad inter specific competition.
2. What are common animal species in savanna biome?
3. Discuss the major human impact to the savanna biome and the solutions
4. Desert animals have various adaptive mechanisms to cope up with adverse ecological conditions. Describe some of the adaptive mechanisms.
5. Do we have tropical forests in Ethiopia? If we have indicate the locations/places in our country?

Answer

Part I: Matching

1.D	2.B	3.A	4.E	5.C
6.F	7.J	8.H	9.G	10.I

Part II: Fill in the blanks

1. Rain forest
2. Tundra 3. Desert 4. Photic zone 5. Plankton

IV. Critical thinking questions

1. Interspecific interactions include competition, predation, herbivory, parasitism, mutualism, and commensalism. Interactions ould have positive (+) or negative (-) effects on the survival and reproduction of individuals engaged in the interaction. For example, predation is a +/- interaction, with a positive effect on the survival and reproduction of members of the predator population and a negative effect on members of the prey population. Mutualism is a +/+ interaction in which the survival and reproduction of individuals of each species is increased in the presence of the other.

2. Wildebeests and zebras, and predators, including lions and hyenas, are common inhabitants

3. Cattle ranching and overhunting

4. Many species are nocturnal. Water conservation is a common adaptation, with some species surviving solely on water obtained from breaking down carbohydrates in seeds.
5. Yes, west of the country