# Biology

## Student Textbook

## Grade 9

Biology

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Federal Democratic Republic of Ethiopia
Ministry of Education

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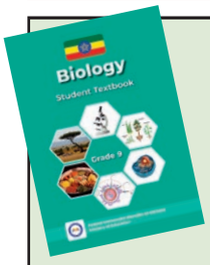


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# Biology

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## Grade 9


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# Unit 1: Introduction to Biology

| Sections | Learning competencies |
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| 1.1 Definition of Biology<br>1.2 Why do we study Biology?<br>1.3 The scientific method<br>1.4 Tools of a Biologist<br>1.4.1 Laboratory tools<br>1.4.2 Field tools<br>1.5. Handling and using of light Microscope<br>1.5.1 Parts and function of light microscope<br>1.5.2 Handling and using microscope<br>1.6. General Laboratory Safety Rules | • Define Biology<br>• Explain why Biology is studied?<br>• Plan a biological investigation using the scientific method<br>• Identify some common tools of a Biologist<br>• Utilize a microscope<br>• Execute general laboratory safety rules |

## 1.1 Definition of Biology

**Objectives**

At the end of this section, the student will be able to:

- *define Biology*
- *explain the relation of biology and other subjects*

**Key Terms**

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

Biology is the scientific study of life or living things.

*What does it mean to be "alive"?*

It seems very difficult to objectively define life in a simple sentence. But, we recognize life mainly by common characteristics shared by living systems.

**Activity 1.1: THINK-PAIR-SHARE**

Write down the common properties of living things that distinguish them from non-living things and compare your answer with other students.

Living things are composed of one or more cells, they can grow, reproduce, they transmit genetic information to their offspring, they need the energy to accomplish work, they can maintain relatively constant internal conditions (homeostasis) and they 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.

**Activity 1.2: Group work**

Make a group of students and discuss how the knowledge of biology can be applied in the fields of agriculture, medicine, food processing, food preparation, preparation of beverage etc. and present it to your class.

*What relationships does Biology have with other fields of natural sciences?*

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 Why do we study Biology?

**Objectives**

At the end of this section, the student will be able to:

- *explain why biology is studied*
- *give examples of biological application*

**Attention**

Application of Biology in our day to day life:

- Wine-making, the brewing, the baking of bread and the production of cheese all depend on fermentation processes brought about by yeasts, other fungi and bacteria, or enzymes from these organisms.
- Antibiotics, such as penicillin, are produced by mould fungi or bacteria.
- The production of industrial chemicals such as citric acid or lactic acid needs bacteria or fungi to bring about essential chemical changes.
- Sewage disposal depends on bacteria in the filter beds to form the basis of the food chain that purifies the effluent.
- Discovery of the structure of DNA and forensic analysis of DNA samples from crime scenes.

Human beings have an inborn curiosity about the natural world that leads them to study about living organisms and their habitats. Studying biology helps to understand how living things work, how they function and interact with the environment. Biology touches our everyday life in many ways. For example, biologists have discovered drugs that are used to treat different human diseases. Many biologists are working on problems that critically affect our lives, such as how our animals and plants body work, how ecosystems work, how advancements in genetics and cell biology are transforming to medicine and agriculture, as well as the use of forensics biology to investigate crime, Furthermore, studies how ecology is helping societies evaluate environmental issues, such as global warming, how fermentation is used to produce alcoholic drinks such as beer and wine. In addition, biological studies are used in treating patients suffering from AIDS, tuberculosis, and some types of cancer.

## 1.3. The Scientific Method

**Objectives**

At the end of this section, the student will be able to:

- *explain about scientific method*
- *explain about the meaning of hypothesis*
- *practice about formulating hypothesis*
- *practice doing scientific experiment and drawing a bar graph*

Biology is a science of inquiry.

*What comes to your mind when you hear the word science?*

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 leads 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

**Key Terms**

**Hypothesis**: a proposed scientific explanation

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.

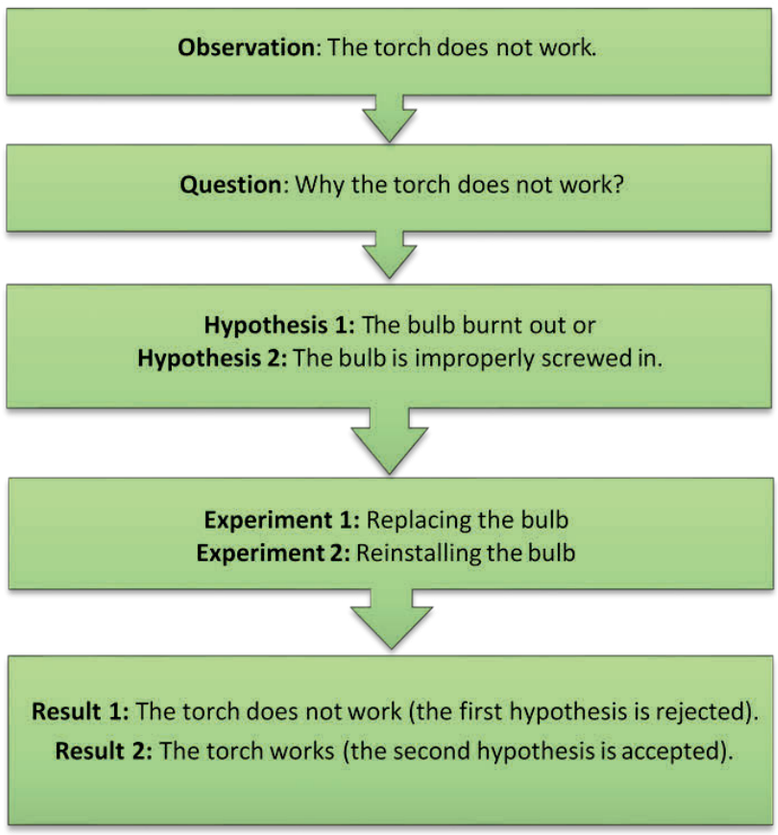



Figure 1.1. Application of the scientific method to common problems in our surroundings

## Activity 1.3: Application of Scientific Method

**Objective**: To determine the importance of temperature for seed germination,

1. Form a group
2. Germinate bean seeds at different temperatures like:
   - Group one in room temperature;
   - Group two in colder place like outside your room or in refrigerator;
   - Group three in hotter place like inside the kitchen; and
3. Then give your possible hypothesis for the differences in germination.
4. Measure the times of germination and length of the seedlings for the different groups
5. Draw a bar graph based on the result of your experiment using X axis for measurement of time /hour of germination (1st day of germination, 2nd day of germination, 3rd day of germination etc.) and at Y axis indicate the length of the germinated plants. (You can measure the length of your germinating plants using ruler).
6. Interpret the results and conclude the result.
7. Report your result to your friend in your class.

## 1.4 . Tools of a Biologist

**Objectives**

At the end of this section, the student will be able to:

- *identify the major tools of biologists*
- *describe the functions of the identified biologist tools*

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 micro-organisms.

**Activity 1.4. Class work**

Recall what you learn in your grade seven general science lesson and write down the names of the tools used by biologists and compare your answer with your partners.

### 1.4.1. 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.

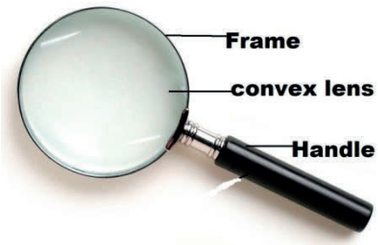



Figure 1.2 Hand lens

**Activity 1.5: Laboratory Activity**

**Objective**: To study the magnification and focusing of radiation using hand lens

**Materials** hand lens, Pieces of paper

1. Draw a dot on the piece of the paper.
2. Observe the dot using a hand lens.
3. What happened? Did the dot get bigger than the original size? Why?
4. Bring the hand lens to where the sun light is available.
5. Put the piece of paper under the hand lens and stay for some minute.
6. What happened to the paper? Why?

**Attention**

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.

Figure 1.3. Light microscope

**Key Terms**

**Microscope**: an instrument used to observe and study objects that are too small to be seen by the naked eye. It magnifies the image of small objects

**Light microscope:** the microscope uses a beam of light to view specimens

**Electron microscopes:** the microscope uses a beam of electrons (instead of a beam of light) and electromagnets (instead of glass lenses) to enlarge the image of an object

Figure 1.4. Glass slide and cover slides

**The Microscope**

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.

**Activity 1.6 Classwork**

How many lens does hand lens have?

Discuss with your friend next to you.

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 eye-piece is called monocular; one with two eye-pieces is said to be binocular.

**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 micro-organisms 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.

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

Figure 1.5. Autoclave

**Attention**

Culturing is the procedure used to grow microorganisms in a controlled environment. Many microorganisms reproduce very quickly. Culturing of micro-organisms also have important function like in medicine (Penicillin) and for food (beverage) preparation. Wine and beer making uses culturing on a large scale, as it does in cheese making, bio-fuel production, and many other endeavors.

There are many ways of killing microorganisms, including chemical disinfectants, flame, dry or wet heat, ultraviolet light, and ionizing radiation such as X-rays or gamma rays. The problem is, some bacteria form spores, which are resistant to chemical disinfectants, including bleach. In these situations, it is very important to use autoclaving which kill microorganisms as well as their spores.

Figure 1.6. A Bacteriological incubator

**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 micro-organisms.

**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.

Figure 1.7. Petri dishes

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

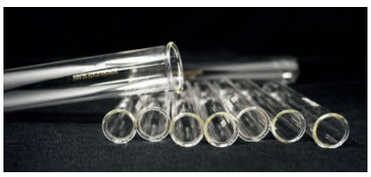


Figure 1.8. Test tubes

**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 micro-organisms. They are available in a variety of shapes and sizes.

Figure 1.9. flasks

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

Figure 10. Balance

Figure 1.11. Dropper

**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.

**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.

Figure 1.12. Tongs

Figure 1.13 dissecting kit

**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 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.

Figure 1.14 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.

Figure 1.15. Crucible

**Beaker**

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

Figure 1.16. Beakers

Figure 1.17 Hot plate

**Hotplate**

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

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

Figure 1.18. pH mete

**Thermometer** is an instrument that measures the temperature of substances.

Figure 1.19. Thermometer

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

Figure 1.20. Forceps

Figure 1.21. Spatula

**Spatula**

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

**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.

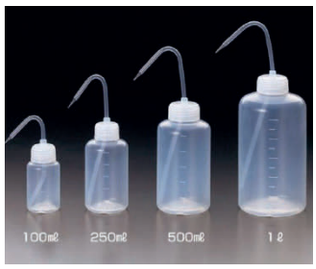


Figure 1.22. Wash bottles

**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.

Figure 1.23. Bunsen burner

Figure 1.24. Insect net

Figure 1.25. Fish net

## 1.4.2. 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.

**Fishing net** is a net used for fishing. Nets are devices made from fibres 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.

# 1.5. The Light Microscope

**Objectives**

At the end of this section, the student will be able to:

- *handling the microscope*
- *use the microscope*

Most microscopes have several different powerful lenses attached to them, allowing the viewer to inspect the content at more than 100 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.

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.

## Activity 1.7: Classwork

Fill the following table by calculating the exact magnification.

| Eye lens magnification | Objective lens magnification | Total lens magnification |
|---|---|---|
| X5 | | X500 |
| X10 | X40 | |
| | X100 | X1000 |

## Activity 1.8: Practical Activities

In this section, you will learn how light microscope magnifies objects by eyepiece and objective microscope.

**Objective:** To study focusing of a light microscope

**Materials needed** for this activity: a microscope, microscope slides, cover slips

A. Take a piece of paper and make sure it is transparent
B. Write letter C or P on the paper
C. Put the paper on the stage of microscope
D. Use low power objective move the paper from side to side till you get a clear focus/image
E. Draw the letter that you observe. What difference have you seen between the letter on the paper and the image under the microscope? Why?
F. Replace/move the low power objective with middle power objective
G. What do you see? What makes this difference?

### 1.5.1. 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.

**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.

**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.

**Activity 1.9: Group work**

Look at the picture on the figure 1.26.

Write the parts of the microscope parallel to the number and discuss in groups about the function of each parts.

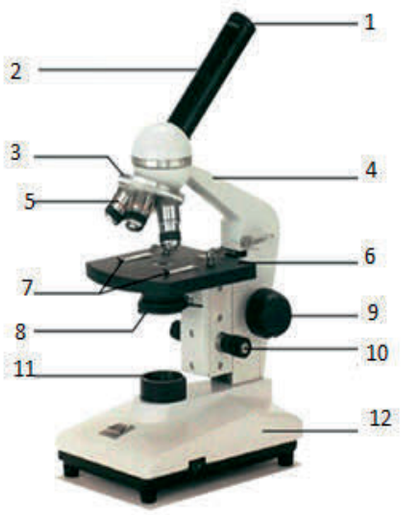



Figure 1.26. The parts of the light microscope

**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 4X-100X.

**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.

**Body tube**

Body tube connects the eyepiece to the objective lenses.

**Nose piece**

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

**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.

**Stage**

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

**Stage clip**

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

**Aperture**

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

**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.

**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.

**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.

**Base**

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

## 1.5.2 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.

## 1.6. General Laboratory Safety Rules

**Objectives**

At the end of this section, the student will be able to:

- *explain about laboratory safety rules*
- *identify the major laboratory safety rules*

Safety is the condition of being protected from harm or other danger. 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.

Figure 1.27. Dress and safety for the laboratory

**Activity 1.10**

Look at the picture on the figure 1.27 and recall what you learned in your grade seven general science subject to answer the following questions. Discuss in groups.

1. Why goggles and laboratory coats used?
2. Why is hair tied back?
3. List some 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. Knowing 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. Unlabelled chemicals should never be used.


Figure 1.28. Signs for general laboratory safety rules

## Unit Summary

- Biology is the scientific study of living things.
- Living organisms interact with themselves and the environment at all levels of biological organizations.
- Biological inquiry depends on a *scientific method. Scientists follow a method* while performing scientific experiments and writing up the results.
- By following the scientific method carefully, scientists make sure that their conclusions are based on observations and that other scientists can repeat their experiments.
- The steps for scientific method includes: observations, questions, hypothesis, experiment, conclusion (result) and communication with other Scientists.
- Biologists use different types of tools in the laboratory and field. Some of the tools are used for measuring, some are used for observation and some are used for culturing micro-organisms. Of all the tools, the most important scientific tools of the biologist is a microscope. A microscope is an instrument that is used to see very small objects by a process called magnification.
- Laboratory safety is mainly important before we do any activities of the laboratory. Working carefully in the laboratory, dealing with minor problems before they become major problems, keep safety constantly in mind, and chances of any problems you have will be very minor ones.

## 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.

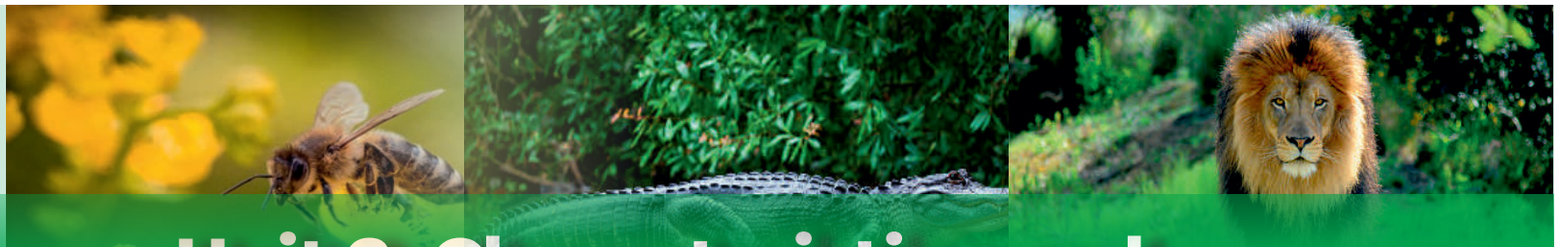
8. Why does a microscope have several objective lenses?

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 specimen?

11. Explain the importance of adding oil immersion when using high power objective? How?

12. List at least three field tools used by biologists.



# Unit 2: Characteristics and Classification of Organisms

| Content | Learning competencies |
|---|---|
| 2.1. Characteristics of living things<br>2.2. Taxonomy of living things<br>2.2.1. Principles of classification<br>2.2.2. Taxonomic hierarchies in biological classification<br>2.3. Relevance of classification<br>2.4. Linnaean system of nomenclature<br>2.5. Common Ethiopian animals and plants<br>2.6. The five-kingdom system of classification<br>2.6.1. Kingdom Monera<br>2.6.2. Kingdom Protista<br>2.6.3. Kingdom Fungi<br>2.6.4. Kingdom Plantae<br>2.6.5 Kingdom Animalia<br>2.7. Renowned taxonomists in Ethiopia | • State the characteristics of living things<br>• Classify living things based on taxonomic principles<br>• Argue for or against the importance of classification<br>• Describe the system of Linnaean nomenclature<br>• Classify common Ethiopian animals and plants based on the taxonomic categories.<br>• List the characteristic features of the five kingdoms<br>• Appreciate the works of renowned taxonomists in Ethiopia |

## 2.1 Characteristics of living things

**Objectives**

At the end of this section, the student will be able to:

- *state the 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. For example, they count how many times a hummingbird's wings beat per second. What makes something "alive"? Anyone could deduce that a galloping horse is alive and a car is not, but why? We cannot say, "If it moves, it's alive" because a car can move, and gelatin can wiggle in a bowl. They certainly are not alive. Although we cannot define life with a single sentence, we can come up with a series of characteristics shared by living systems.

**Activity 2.1: Reflective Discussion**

If somebody places an object in front of you and asks you whether it is alive, what would you do?

Would you poke it to see if it reacts?

Would you watch it closely to see if it moves or breathes?

Would you dissect it to look at its parts?

**Activity 2.2: Field Observation**

Discuss what makes living things different from non-living. Go outside your village or your school compound and sort the things you observe into living and non-living. Based on your observations, write a short report and present to your classmates.

*What are the characteristics of living things?*

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 non-living 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 (Fig.2.1).


Figure 2.1. Characteristics of life

**Self Assessment 2.1**

1. Is it possible to define life in a simple sentence? If your answer is no, why not? Give a short explanation.
2. How are living things different from the non-living things?

## 2.2 Taxonomy of living things

### 2.2.1 Principles of classification

**Objectives**

At the end of this section, the student will be able to:

- *classify living things based on taxonomic principles,*

*Why do biologists classify living things?*

Organizing items not only makes them easier to find but can also make them easier to understand. 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, behavioural, and/or ecological characters).

**Activity 2.3: Reflective Discussion**

This section explains how biologists have organized the study of living things. This organization makes it easy to tell which organisms share characteristics and which are related to each other.

1. How organized are you?
2. Do you organize your clothes or books in some way?
3. Discuss the advantages of being organized.

**Key Terms**

**Identification**: identifying organisms using characteristic feature

**Nomenclature**: Aspect of taxonomy that deals specifically with the naming of organisms

**Taxonomy**: The science of naming and classifying species.

## 2.2.2. Taxonomic hierarchies in biological classification

**Activity 2.4: Problem solving**

Read a book or search in the Internet on biological classification. Why do biologists need to organize living things in hierarchies?

**Objectives**

At the end of this section, the student will be able to:

- *describe taxonomic hierarchies*

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 (Fig. 2.2). 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.

At the broadest level, biologists divide the diversity of life into three domains: Bacteria, Archaea, and Eukarya. Domain is the rank above kingdom. 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. Archaea are prokaryotic as their cells have no nucleus and membrane bounded organelles. Their range of size is similar to that of bacteria. Many Archaea inhabit extreme environments. Bacteria are prokaryotic as their cells have no nucleus. They are all small organisms that vary in size between that of the largest virus and the smallest single-celled eukaryote. The major differences

of bacteria and archaea includes the chemical composition of the cell wall and cell membrane; the use chlorophyll for photosynthesis by bacteria but not by archaea, methane generation, and sensitivity to some antibiotics. 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 as protists, fungi, plants and animals. Have a great diversity of forms: there are unicellular, colonial and multicellular organisms.

**Attention**

| Archaea | Bacteria | Eukarya |
|---|---|---|
| • Cells with no membrane-bound organelles.<br>• DNA exists as a circular 'chromosome'<br>• Ribosomes are similar to bacteria.<br>• Cell wall does not contain peptidoglycans<br>• Cells divide by binary fission<br>• Are unicellular/ colonial | • Cells with no nucleus<br>• DNA exists as a circular 'chromosome'.<br>• No membrane-bound organelles are present<br>• Ribosomes are similar to archaea<br>• Cell wall contains peptidoglycans<br>• Cells divide by binary fission,<br>• Are unicellular/ colonial | • Cells with a nucleus and membrane-bound organelles.<br>• DNA in the nucleus arranged as linear chromosomes with histone proteins<br>• Ribosomes are different from both bacteria and archaea<br>• There are unicellular , colonial and multicellular organisms<br>• Cell division is by mitosis<br>• Many different ways of reproducing – asexually and sexually. |

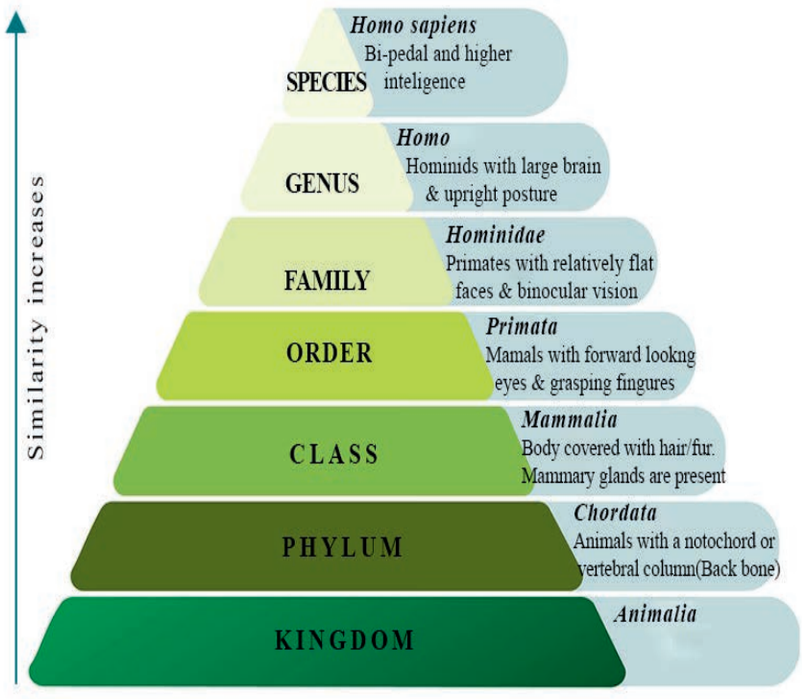



Figure 2.2. Taxonomic hierarchy

**Key Terms**

**Bacteria**: is the most diverse and well-known group of single-celled organisms that lack a nucleus.

**Classes**: is a taxon of similar orders.

**Eukaryotic** cells: cells with a nucleus and membrane-bound organelles.

**Family**: is a taxon of similar genera.

**Genera**: is a taxon of similar species.

**Kingdoms**: is a taxon of similar phyla (plural for phylum).

**Orders**: is a taxon of similar families.

**Phylum**: is a taxon of similar classes. (Plant taxonomists use the taxon division instead of phylum).

**Prokaryotic cells:** are unicellular organisms without a separate nucleus.

**Species:** unique type of organism

**Taxon**: is a group of organisms that share a unique set of traits.

**Self Assessment 2.2**

1. What is taxonomic hierarchy?
2. List some of the taxonomic hierarchies that you know.

**Attention**

Have you ever asked yourself what a species is? What are the characteristic features of a species? The smallest natural group of organisms is the species. A species can be defined as a group of organisms that can reproduce to produce fertile offspring. Members of a species also often resemble each other very closely in appearance, unless humans have taken a hand in the breeding programs. All cats belong to the same species but there are wide variations in the appearance of different breeds. There are many other definitions of species; for example, phylogenetic species, morphological species, evolutionary species, systematic species, recognition species etc. However, for a biological species, members could reproduce to produce fertile offspring. Members of a species also often resemble each other very closely in appearance.

## 2.3 Relevance of classification

**Objectives**

At the end of this section, the student will be able to:

- *describe the relevance of classification*

**Activity 2.5: Investigating**

1. Why and how do human beings classify organisms?
2. Visit a library in your school or public library in your village, and write on the importance of biological classification and present your results to your classmates.

*What are the relevancies of biological classification?*

The applications of classification are manifold: identification of harmful and beneficial organisms, reduce energy and time to study organisms, and help us understand the relationship between organisms, etc. Classification gives biologists a framework that allows them to study the relationships between 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 also 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. For example, a taxonomist might know that a certain species of tree contains chemicals that make good disinfectants (e.g., Shiferaw/ Moringa- *Moringa stenopetala*). It is possible that a closely related plant species could have the same useful substances. So instead of having one source of chemicals, there may be two or more sources.

**Self Assessment 2.3**

1. For which of the following purposes could taxonomy be used?
   a. to determine whether a plant is safe to be planted in a schoolyard
   b. to find a new source for medicine that comes from plants
   c. to determine how closely related two species animals
   d. all of the above

## 2.4 Linnaean system of nomenclature

**Objectives**

At the end of this section, the student will be able to:

- *describe the system of Linnaean nomenclature*
- *explain how organisms are given scientific names.*
- *write scientific names properly and give examples.*

*How did Carl Linnaeus classify living organisms?*

Linnaeus was a Swedish naturalist who initially graduated in medicine but became interested in plants. He travelled in Scandinavia, England and Eastern Europe, discovering and naming new plant species. In 1735 he published his *Systema Naturae*, in which he accurately described 7700 plant species and classified them. He further grouped species into genera, genera into classes, and classes into orders. He also classified over 4000 animals, but rather less successfully into mammals, birds, insects and worms.

Linnaeus refined and popularized the **binomial system** of naming organisms, in which the first name represents the genus and the second name the specific epithet. This system is still the official starting point for naming or revising the names of organisms.

**Binomial nomenclature**

Species must be named in such a way that the name is recognized all over the world. For example, maize is named *Bekolo* in Amharic, *Boqqollo (Badallaa)* in Afan Oromo and *Baddela* in Sidaamu Afoo and corn in American English etc. If you are not aware of these names, it could lead to confusion. If the botanical name, *Zea mays*, is used, however, there is no chance of error. As you all might know our country is endowed with cultural and linguistic diversities and each would have different names for the same species. As a result, it would be difficult for a person to know the names given by the 80 plus ethnolinguistic groups in Ethiopia. Similarly, there are over thousands of languages in the African continent and beyond.

Therefore, the Latin form of the name allows it to be used in all over the world irrespective of language barriers. The similarity in size, shape, behaviour and colour makes it difficult to differentiate one species from the other. Again, the use of the scientific name avoids such confusion.

The **binomial system of** naming species **(**introduced by Linnaeus**)** is an internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and the species.

**Activity 2.6: Inquiring and researching**

Did you know Carl Linnaeus?

List the major contributions of Carl Linnaeus to the Science of taxonomy.

**Self Assessment 2.4**

1. What is a binomial nomenclature?
2. Write the scientific names of the following organisms: house fly, mouse, dog, cat & goat.

Binomial means 'two names'; the first name gives the **genus** and the second gives the specific epithet. A genus (plural, genera) consists of a group of similar species. The specific epithet sometimes describes a characteristic of the organism. For example, Enset, false banana, Ensete *ventricosum* and Banana, *Musa acuminate*, belong to the same family (Musaceae).In writing a scientific name, the first letter of name of the genus is a capitalized letter and the specific epithet always starts with a small letter, for example, the scientific name of human beings is *Homo sapiens.* The scientific names are underlined when handwritten or italicized when printed.

## 2.5 Common Ethiopian animals and plants

**Objectives**

At the end of this section, the student will be able to:

- *classify common Ethiopian animals and plants based on the taxonomic categories.*
- *write the scientific names of common Ethiopian plant and animals species*
- *use dichotomous keys to identify unknown organism*

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. Also Ethiopia has served as a gateway to domestic animals from Asia to Africa and its diverse ecology favoured diversification of these resources. The scientific and common names of some plants and animals in Ethiopia are presented in table 1.

**Activity 2.7:Inquiring and Researching**

Read books and/or search in the Internet for the scientific and the local names common Ethiopian plants and animals species. Present your report to your classmates.

**Table 1: Scientific names of some common plants and animals in Ethiopia**

| Common name | Taxon | | | | | | |
|---|---|---|---|---|---|---|---|
| | Kingdom | Phylum/ Division | Class | Order | Family | Genus | Scientific Name |
| Elephant | Animalia | Chordate | Mammalia | Proboscidea | Elephantidae | Loxodonta | *Loxodonta africana* |
| Ethiopian Wolf | Animalia | Chordate | Mammalia | Carivora | Canidae | Canis | *Canissimensis* |
| Gelada | Animalia | Chordate | Mammalia | Primate | Cercopithecidae | Theropithecus | *Theropithecus gelada* |
| Lion | Animalia | Chordate | Mammalia | Carivora | Felidae | Panthera | *Panthera leo* |
| Walia | Animalia | Chordate | Mammalia | Artiodactyla | Bovida | Capra | *Capra walie* |
| Ostrich | Animalia | Chordate | Ave | Struthioniformes | Struthionidae | Struthio | *Struthio camelus* |
| Watled Ibis | Animalia | Chordate | Ave | Pelecaniformes | Threskiornithidae | Bostrychia | *Bostrychia carunculata* |
| Enset | Plantae | Angiospermata | Monocylodoneae | Zingiberales | Mussaseae | Ensete | *Ensete ventricosum* |
| Maize | Plantae | Angiospermata | Lilospida | Cyperales | Poacea | Zea | *Zea mays* |
| Noug | Plantae | Angiospermata | Eudicots | Asterales | Asteraceae | Guizotia | *Guizotia abyssinica* |
| Tef | Plantae | Angiospermata | Lilospida | Cyperales | Poacea | Eragrotes | *Eragrstos tef* |
| Wheat | Plantae | Angiospermata | Lilospida | Cyperales | Poacea | Triticum | *Triticum aestivum* |

### Dichotomous keys

*How do biologists use dichotomous keys?*

Dichotomous keys are 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. Figure 2.3 shows an example of a dichotomous key that could be used to place an unknown vertebrate and unknown invertebrate in the correct class. Item 1 gives you a choice between two alternatives. If the animal is **poikilothermic (cold-blooded),** you move to item 2 and make a further choice. If it is a **homoiothermic (warm-blooded),** you move to item 4 for your next choice. The same technique may be used for assigning an organism to its class, genus or species. However, the important features may not always be easy to see and you have to make use of less fundamental characteristics.

**Activity 2.8: Inquiring and Researching**

You may have come across organisms that you did not recognize and could not classify. How do you solve this problem?

**Self Assessment 2.5**

1. Make a field visit in your village and or your school compound and ask the names of twenty common Ethiopian animals and plants. Write their scientific names (species names) along with their local names.

| | | |
|---|---|---|
| 1 | Poikilothermic | 2 |
| | Homoiothermic | 4 |
| 2 | Has fins but no limbs | Fish |
| | Has four limbs | 3 |
| 3 | Has no scales on body | Amphibian |
| | Has four limbs | Reptile |
| 4 | Has feathers | Bird |
| | Has fur | Mammal |

| | | |
|---|---|---|
| 1 | Has Legs | 2 |
| | No les | 5 |
| 2 | More than six legs | 3 |
| | Six legs | 4 |
| 3 | Short, flattened gray body | Woodlouse |
| | Long brown/yellow body | Reptile |
| 4 | Pincers on last segment | Earwig |
| | Hard wing covers | Beetle |
| 5 | Body segmented | Earthworm |
| | Body not segmented | 6 |
| 6 | Has a shell | Snail |
| | No shell | Slug |

Figure 2.3. Vertebrate (left) and invertebrate(right) keys

## 2.6 The five-kingdom system of classification

**Objectives**

At the end of this section, the student will be able to:

- *list the characteristic feature of the five kingdoms,*
- *describe the kingdoms of the Monera, Protista and Fungi and give examples of organisms from each one.*
- *describe the kingdom Plantae and explain its major taxa, giving examples.*
- *discuss features the kingdom Animalia and explain its major taxa, giving examples .*
- *group animals into vertebrates and invertebrates and explain the differences between them.*

*Why did we come up with the five kingdoms?*

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 long time 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(Fig.2.4). It is still not easy to fit all

**Activity 2.9: Cooperative Learning**

What is the largest group of organisms recognized by biologists? How many such groups should there be? Most biologists used to favor the adoption of two groups. What are these two groups?

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.

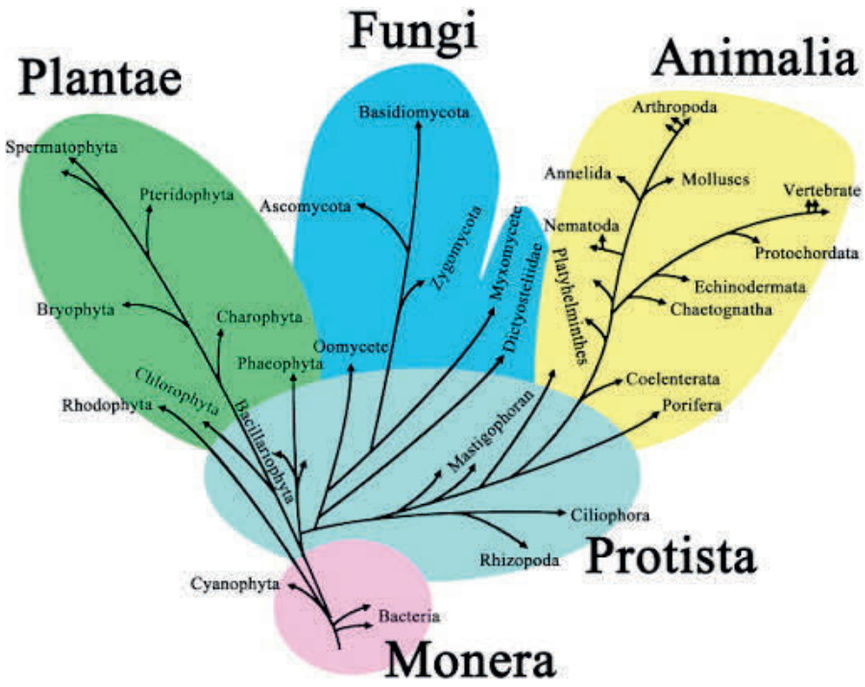



Figure 2. 4. The five kingdoms of life

**Attention**

Viruses are not included in any kingdom – they are not considered to be living organisms because they lack key characteristics of living things. Viruses are particles that are not alive. They cause diseases and infections. Viruses are made up of nucleic acids, either DNA or RNA, surrounded by a protein coat. They are smaller than the tiniest bacterium. Most biologists agree that viruses are not alive because they don't grow, develop, or carry out respiration. All viruses replicate, or make copies of themselves. However, viruses need the help of living cells to copy themselves. In order to copy itself, a virus must enter a living cell. The cell in which a virus replicates is called the host cell.

**Self Assessment 2.6**

1. Do you agree or disagree with the classification of algae as a plant? Explain.
2. Do you suggest an alternative category or group for organisms' such as algae and the likes?

**Activity 2.10: Debate**

Debate on why it is difficult for biologists to develop a rigid classification scheme? Do you think the Whittaker's five-kingdom scheme has solved the classification problems biologists are trying to answer for generations?

Procedure:

1. Divide members of your classmates into three groups.
2. Members of group 1 support the idea that Whittaker's five-kingdom scheme has solved the classification problems.
3. Members of group 2 are against the idea that Whittaker's five-kingdom scheme has solved the classification problems.
4. The third group will be the audience.
5. Let members of group 1 and 2 present their position each in five minutes, and
6. Let students from group three ask questions both groups.

**Activity 2.11: Collaborative Learning**

What do you think about when you hear the word bacteria? You probably think about germs or something that is bad for you. Did you know that some bacteria are actually helpful? For example, some bacteria help with human digestion, while other bacteria help produce cheese, yogurt, and sourdough bread. However, other bacteria cause diseases in humans, for example Mycobacterium tuberculosis, causes tuberculosis, and Haemophilus ducreyi, chancroid. Discuss the major distinguishing features of kingdom Monera

**Key Terms**

**Archaebacteria**: a group of microorganisms considered to be an ancient form of life that evolved separately from the bacteria

**Chemosynthetic**: synthesis food using chemical reaction.

**Eubacteria**: true bacteria

## 2.6.1. Kingdom Monera

**Objectives**

At the end of this section, the student will be able to:

- *describe the kingdom Monera and give example of organisms*
- *describe importance of Monera*

*What are Monera?*

Monera includes eubacteria and archaebacteria. Eubacteria (true bacteria) have strong cell walls. They exist in various shapes and forms (Figs 2.5 and2.6). Some eubacteria are heterotrophs; otherscan make their food (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.


Figure 2.5. Examples major groups of Monera

Archaebacteria (Archaea) have very different cell walls than bacteria, but 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 hot-water vents and seawater evaporating ponds. The environments in which the archaebacteria live often have no oxygen (Fig 2.5).

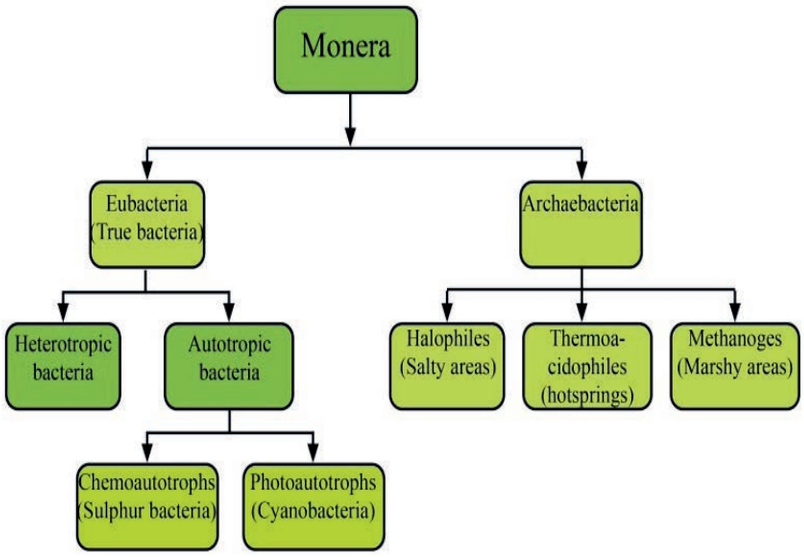



Figure 2.6. Some representative of taxa of kingdom monera

**Attention**

Most people tend to think of bacteria in terms of illness and disease. However, there are actually only a few disease-causing bacteria compared to the number of harmless and beneficial bacteria. In fact, we could not survive without bacteria. Bacteria cause diseases in plants, animals, and humans. Disease causing bacteria enter the human body through openings such as the mouth. Bacteria are carried in air, food, and water. Sometimes bacteria enter the body through skin wounds. There are two ways bacterial diseases harm people. First, the growth of bacteria can interfere with the normal function of body tissues. Second, the bacteria can release a toxin that directly attacks the host.

**Activity 2.12: Collaborative Learning**

Classify the following statements into useful versus harmful relating to the importance of bacteria: endospores germinate in human lungs, cause infection in humans, provide nitrogen in a usable form for plants, flavor food, oxygen is a byproduct of making food and Create toxins.

Important characteristics of monera:

- Simple prokaryotic unicellular organisms
- Lack a well-defined nucleus or any membrane bound organelles
- Most have a rigid cell wall
- Have various modes of nutrition. Could autotrophs or heterotrophs
- Known as decomposers and mineralizers in the biosphere

**Self Assessment 2.7**

If someone tells you that bacteria are bad, how would you respond?

## 2.6.2. Kingdom Protista

**Objectives**

At the end of this section, the student will be able to:

- *describe the kingdom Protista and give examples of organisms*
- *describe importance of Protista*

**Activity 2.13: Collaborative Learning**

You have learned that all life is organized into five kingdoms. Without using your notes, name all five kingdoms. Some of the organisms you will learn about in this section are plantlike, and some are animal-like. Still others have characteristics like fungi. Some of them were placed in different kingdoms before they were finally classified as Kingdom Protista. As you read this sub-section keep in mind how much variety there is in the world of Protista.

*What are protists?*

There is no such thing as a typical protist. Kingdom protista contains the most diverse organisms of all the kingdoms (Figs. 2.7 and 2.8). 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.

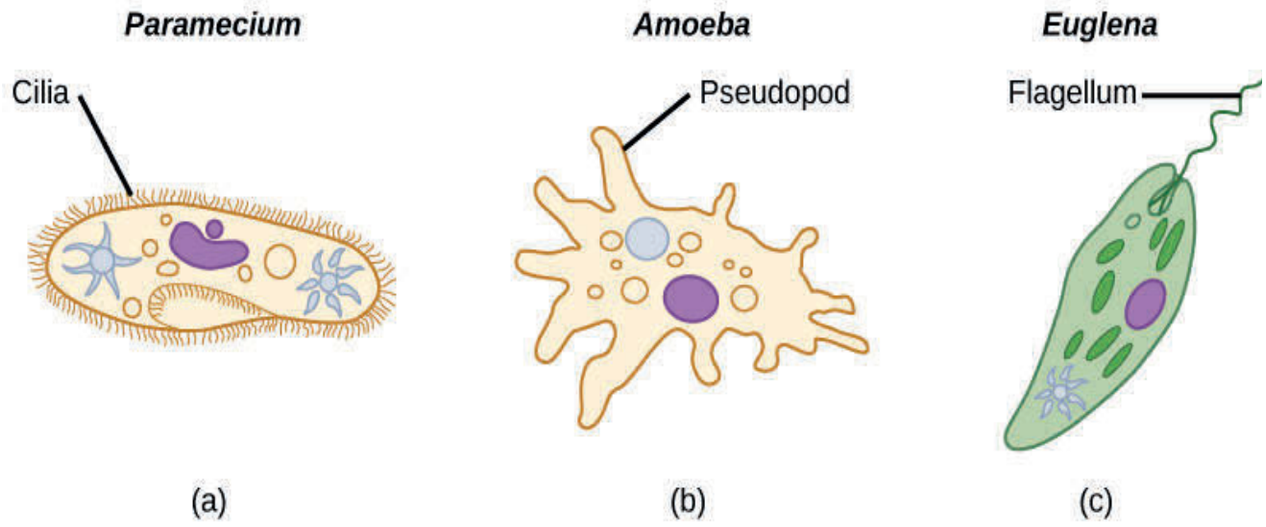



Figure 2.7. Examples major groups of protists

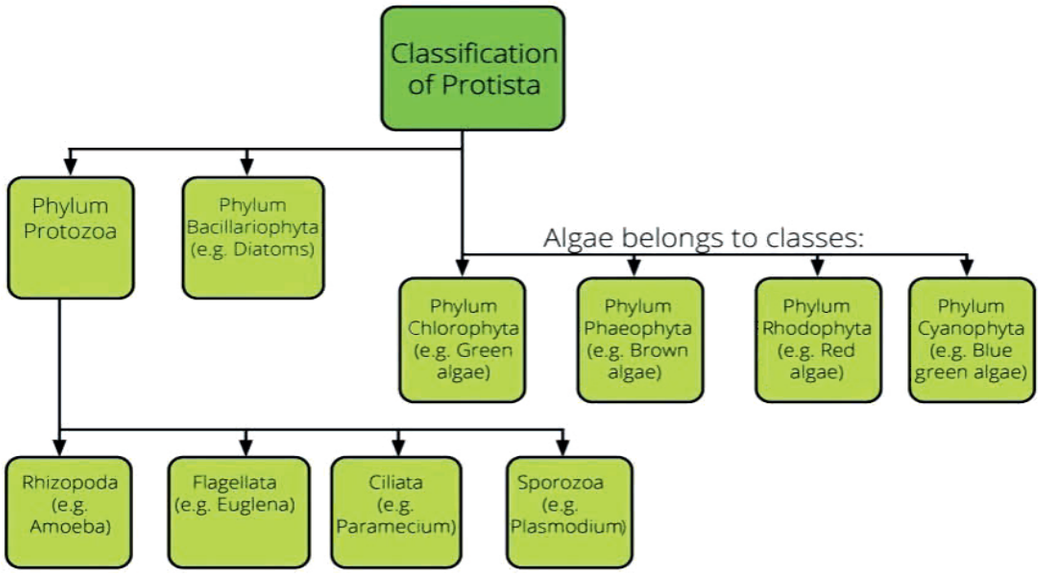



Figure 2.8. Some representative taxa of kingdom Protista

**Self Assessment 2.8**

1. What are the characteristic features of protists?
2. Write the single common feature to all protists.

**Activity 2.14: Reflective discussion**

You probably come into contact with algae every day. Diatoms are a type of algae whose remains become a powdery, porous rock called diatomite. Diatomite is highly absorbent. It is used in pet litter and to clean up chemical spills. It also is used as an abrasive in household cleaners. It is even added to paint to add sparkle. Now that you know that diatomite is absorbent, sparkling, and abrasive, see if you can imagine some additional uses for it. Discuss the additional application and present to your classmate.

## 2.6.3. Kingdom Fungi

**Objectives**

At the end of this section, the student will be able to:

- *describe the kingdom fungi and give example of organisms*
- *describe the importance of fungi*

**Activity 2.15: Peer conferencing**

So far, you have studied bacteria, and protists. In this section, you will learn about the kingdom Fungi. Fungus is the singular of fungi. Mushrooms are types of fungi. Think about places you have seen mushrooms growing. What do those places have in common? Were they hot, dry, cool, or damp? Did the mushrooms appear suddenly or grow slowly over time?

*What are fungi?*

Fungi are eukaryotic organisms that include micro-organisms such as yeasts, 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 (Figs 2.9 and 2.10).

Figure 2.9. 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 non-living organic material, such as fallen logs, animal corpses, and the wastes of living organisms.

**Key Terms**

**Mutualism**: symbiotic relationship in which both species benefit.

**Parasitism:** symbiotic relationship in which one organism benefits at the expense of another.

**Symbiosis**: permanent, close association between two or more organisms of different species.

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 also live with different living as parasites or mutualists. Parasitic fungi absorb nutrients from the cells of living hosts. Some parasitic fungi are pathogenic, causing diseases in humans (Example: *Candida albicans* cause rush and *Tinea pedis* cause athlete's foot), animals and plants. Mutualistic fungi also absorb nutrients from a host organism, but they reciprocate with actions that benefit the host. For example, mutualistic fungi that live inside certain termite species use their enzymes to break down wood, making food available for termites. Fungi can also live as symbionts in association with algae as lichens and with roots of higher plants as mycorrhiza.

**Attention**

Some fungi cause food to spoil, others cause diseases, and some are even poisonous. However, fungi are important and beneficial. Without fungi, the world would be overrun with huge amounts of waste, dead organisms, and dead plants. Thanks to many fungi, some bacteria, and protists, the organic material is broken down and recycled into the raw materials that other living organisms need.

Fungi can reproduce either asexually 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.).

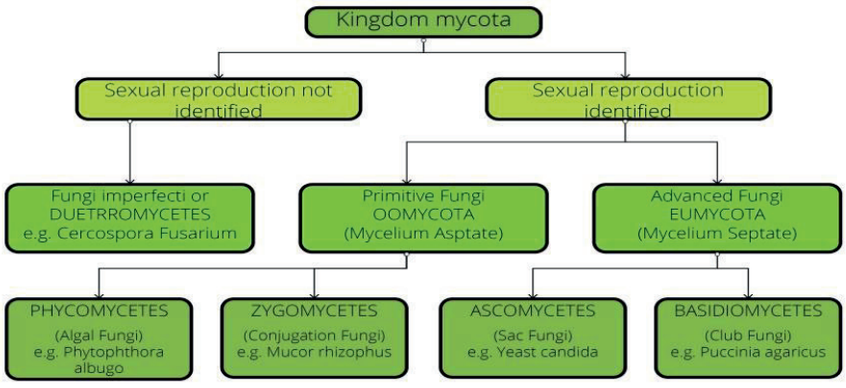



Figure 2.10. Some repressive taxa of kingdom fungi

**Self Assessment 2.9**

1. What are the characteristic features of fungi?

## 2.6.4. Kingdom Plantae

**Objectives**

At the end of this section, the student will be able to:

- *describe the kingdom Plantae and give example of organisms*
- *describe characteristic features of major divisions of plants*
- *give examples of flowering plants*

*What are plants?*

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.

- Some parasitic.
- Nearly all live on land.
- Sexual reproduction predominates.
- 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.
- There are over 250 000 species of plants. These include flowering plants, mosses, ferns, and coniferous plants (see figs 2.11 and 2.12).

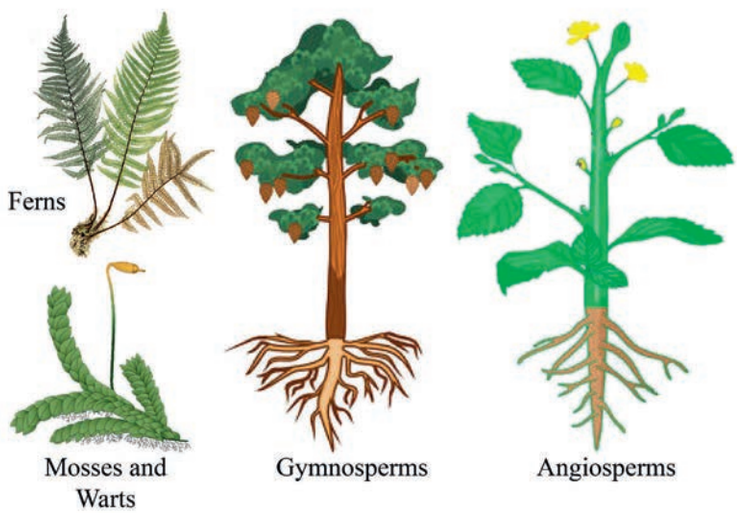



Figure2.11. Examples of major groups of plants

**Self Assessment 2.10**

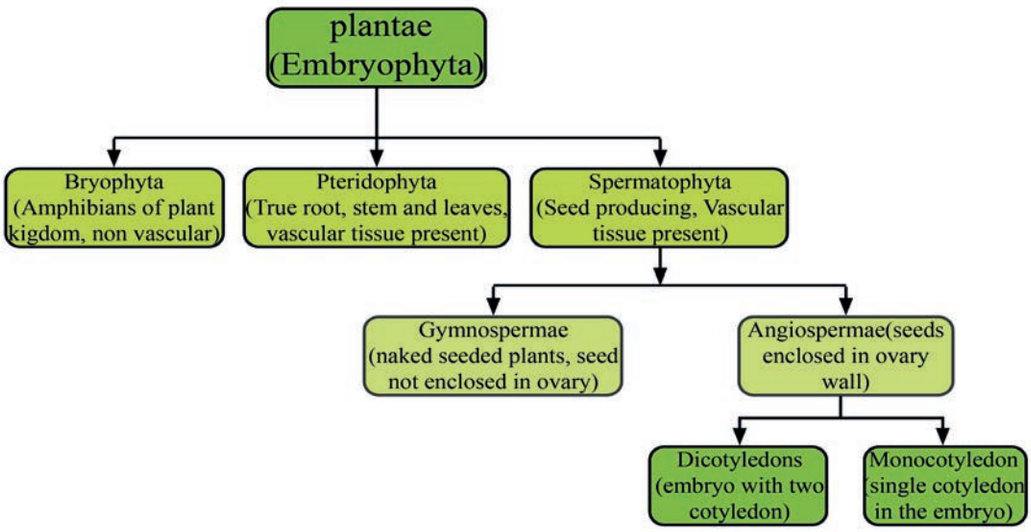
1. What are the characteristic features of plants?

**Activity 2.16: Reflective Discussion**

Think of all the things that plants provide for us. They are an important source of food. They also provide oxygen through photosynthesis. Some plants are valuable sources of medicine. What are some other things that plants provide?

**Activity 2.17: Inquiring and Researching**

Name or think of at least five different plants. You might think of flowers, bushes, shrubs, ferns, trees, and grasses to name a few. They are all plants, yet they look different from each other. As in the other kingdoms you have studied, the plant kingdom has divisions based on shared characteristics. If you were to place plants in divisions, what characteristics would you use? Hint: Look at figure 2.12 to find useful features to classify plants.




**Activity 2.18: Interviewing**

Ask a botanist about the economic, medicinal and ecological uses of plants (e.g., food, medicinal, ornamental, horticultural, cultural, spiritual, aesthetic, music and arts etc.).

**Key Terms**

**Angiosperms**: Most diverse seed plant group. Only group that makes flowers and fruits.

**Bryophyte**: is the common name for three lineages of plants: mosses, liverworts, and horn-worts.

**Dicots**: Most diverse groups of angiosperms; members have two seed leaves, branching leaf veins.

**Embryophyta**: land plants; photosynthetic species that protect and nourish the embryo on the parental body

**Gymnosperm**: Seed plant that does not make flowers or fruits; for example, a conifer.

**Monocots:** Highly diverse angiosperm group; includes plants such as grasses that have one seed leaf and parallel veins.

**Seed plant (spermatophyte):** Plant that produces seeds and pollen; an angiosperm or gymnosperm.

**Vascular plant:** Plant having specialized tissues (xylem and phloem) that transport water and sugar within the plant body.

## 2.6.5 Kingdom Animalia

**Activity 2.19: Investigating**

Think about all the animals you are familiar with. They may be pets, animals in nature, or captive animals such as in a circus or zoo. This section explains what all animals have in common. List the characteristics you know about that all animals share.

**Objectives**

At the end of this section, the student will be able to:

- *list the characteristic feature of the animal kingdom,*
- *describe characteristic features of invertebrates and vertebrates*
- *list the common class of animals*

*What is an Animal?*

Kingdom Animalia includes all multicellular, heterotrophic, eukaryotic organisms. 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.

The ability to move and conduct nerve impulses underlies many of the adaptations that differentiate animals from plants and fungi, making muscle and nerve cells central to what it means to be an animal.

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(Fig. 2.13 -2.15).

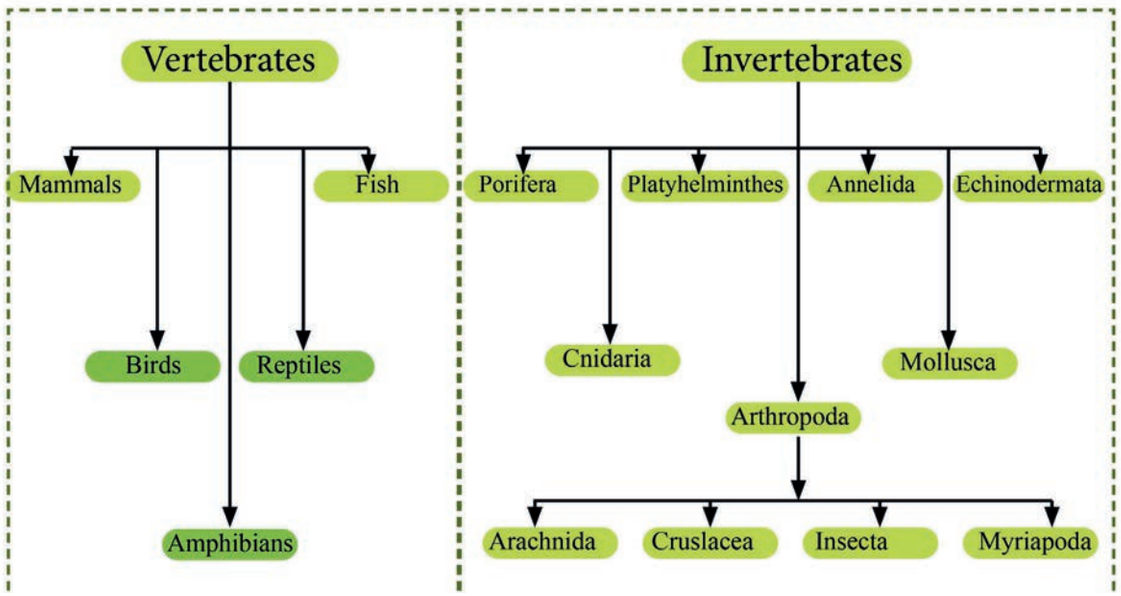



Figure 2.13. Major groups of animals

**Activity 2.20: Collaborative Learning Groups**

What are the two largest groups of animals recognized by biologists/ zoologists? Make a field visit in your school compound or village and try to classify the animals you see/know into invertebrates or vertebrates. (Hint: you could use a dichotomous key)

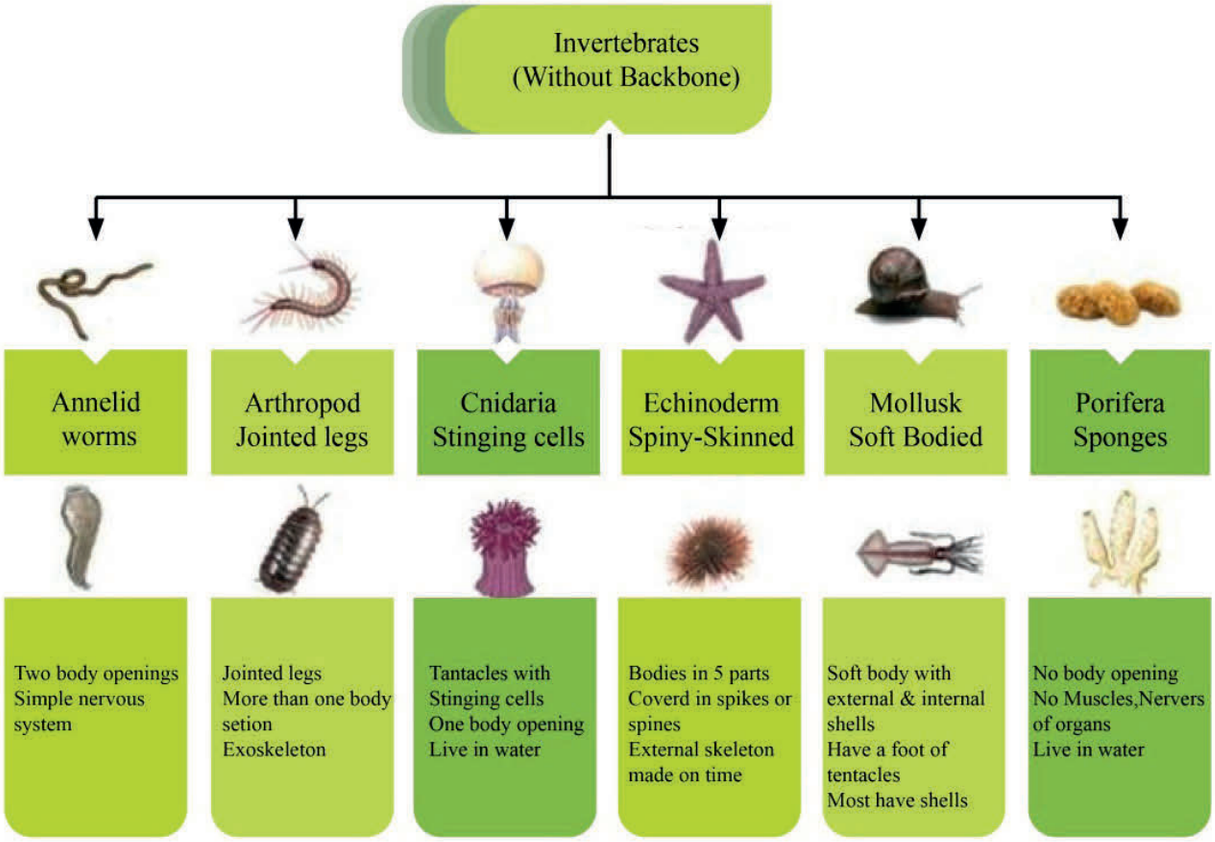



Figure 2.14. Major groups of invertebrates

**Key Terms**

**Anatomy**: the study of internal structure, as revealed by dissection.

**Invertebrates**: are animals without a backbone.

**Morphology**: is the study of the form or outward appearance of organisms.

**Vertebrates**: are animals with a backbone.

**Self Assessment 2.11**

1. What are the characteristic features of animals?
2. What are the differences between invertebrates and vertebrates?

**Activity 2.21: Interviewing**

Make internet search or ask a biologist about medically or agriculturally important insects (e.g., grasshopper, tsetse fly, mosquito, honey bee, etc.) and list their importance (Hint: economic, pollination, pest, aesthetic, music and arts, cultural, spiritual, vector, etc.).

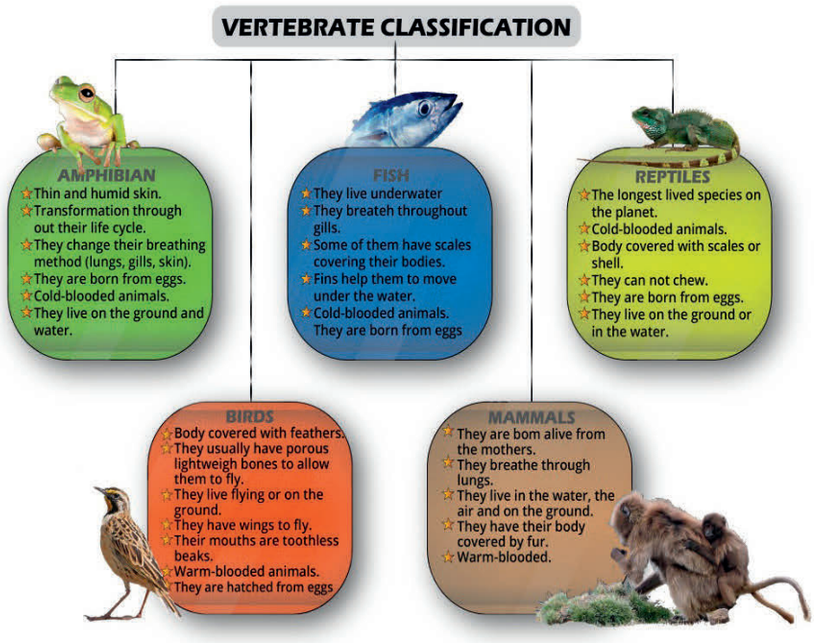



Figure 2.15. Major groups of vertebrates

**Activity 2.22: Collaborative Learning**

Read a book or search on Internet about important fish species, mammals, and birds. Then list their economic, medicinal, aesthetic, cultural, spiritual, and/or ecological importance.

## 2.7 Renowned Taxonomists in Ethiopia

**Objectives**

At the end of this section, the student will be able to:

- *Appreciate the works of renowned taxonomists in Ethiopia.*

**Activity 2.23: Collaborative Learning**

Do you know any renowned Ethiopian taxonomist? If you know one, please write the name and the contribution of the renowned Ethiopian taxonomist.

As stated in section 2.5 of this textbook, Ethiopia is known for high degree speciesdiversity 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. Below, we will discuss briefly the contributions made by some distinguished Ethiopian taxonomists to the scientific community in general and Ethiopian society in particular.

### Professor Sebsebe Demissew

Professor Sebsebe Demissew has participated in several successful research projects universities in Europe and Africa. He has published books and articles on the vegetation and plants of Ethiopia and Africa. He is a member of national and international professional organizations and has served as Chair of the Biological Society of Ethiopia, Secretary-General of the Association for the Taxonomic Study of the Flora Tropical Africa (AETFAT) in addition to being a Council member of the International Association for Plant Taxonomy. He has also served as a director of Flora of Ethiopia and Gulelle botanical Garden.

## Unit review

- The characteristics of living things are movement, respiration, sensitivity, growth, reproduction, excretion, nutrition, etc.
- Classification is a way of sorting organisms into a meaningful order, traditionally using morphology and anatomy, but recently also using DNA (molecular).
- The science of naming, identifying and classifying organisms is known as **taxonomy**.
- **Carolus Linnaeus** (1707–1778), who is also known as the father of taxonomy, introduced a taxonomic hierarchy of classification.
- The taxonomic hierarchies are domains, kingdom, Phylum (division), class, order, family, genus, and species
- The three domains are archaea, bacteria and eukarya (i.e. protists, fungi, plants and animals)
- Classification gives biologists a framework that allows them to study the relationships between living and extinct organisms.
- Taxonomy can be a useful tool for scientists who work in such areas as agriculture, forestry, and medicine.
- The binomial system is an internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and the specific epithet.
- In writing a scientific name, the first letter of name of the genus is a capitalized letter and the specific name always starts with a small letter, for example, the scientific name of human beings is *Homo sapiens*. The scientific names are underlined when handwritten or italicized when printed.

- 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
- Dichotomous keys are used to identifying unfamiliar organisms. Dichotomous means two branches, so the user is given a choice of two possibilities at each stage.
- Whittaker's five-kingdom scheme consists of animals, plants, fungi, monera and protoctista
- Monera (bacteria and archaea): do not typically have a nucleus or endomembrane system,and they do not reproduce sexually. Members of both groups typically have cell walls.
- Protists do not have a specific defining trait; they are a collection of many eukaryotic groups. Most protists are single-celled, but there are multi-celled and colonial species. Life cycles vary like nutrition; some species are autotrophs, others are heterotrophs.
- Fungi are heterotrophs that secrete digestive enzymesto break down organic material, then absorb the released nutrients. Some live as single cells; others grow as a multi celled mycelium. All have cell walls with chitin.
- Bryophytes: have no vascular tissues, seedless,
- Gymnosperms: Vascular tissue present, "naked" seeds
- Angiosperms: Vascular tissue present, Seeds form in a floral ovary that becomes a fruit and monocots, dicots, and relatives
- 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).
- The invertebrates includes: sponges, flat worms, round worms, annelida, Mollusca, Arthropoda (e.g., Insects, Arachnids, Crustacea & Myriapods).
- The vertebrates includes: fish, amphibians, reptiles, birds, & mammals.
- Dr. Mesfin Taddese, Professor Sebsebe Demissew, Professor Ensermu Kelbessa, Professor Abebe Getahun and Professor Silesh Nemomissa are few of the renowned Ethiopia taxonomists.

## Review Questions

**Part One:** Say true if the statement is correct or 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 centre 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:** Choose the best answer among the given 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. mammals 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**: Think critically and answer the following 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?

# Unit 3: Cells

| Contents | Learning Competencies |
|---|---|
| 3.1. What is a cell?<br>3.2. Cell theory<br>3.3. Cell structure and function<br>3.4. Types of cells<br>3.5. Animal and plant cells<br>3.6. Observing cells under a microscope<br>3.7. The cell and its environment<br>3.7.1. Passive transport<br>3.7.2. Active transport<br>3.8. Levels of Biological Organization | • Define a cell<br>• Outline the contributions of Theodor Schwann and Matthias Schleiden to the development of the cell theory<br>• Compare and contrast the structures of plant and animal cells<br>• Differentiate between eukaryotic and prokaryotic cells<br>• Make temporary slides of plant and animal cells<br>• Observe and draw animal and plant cell parts under the microscope<br>• Conduct substances across animal and plant cells experiments about the movement of substances across animal and plant cells (osmosis, diffusion)<br>• Construct with examples the different levels of biological organization |

## 3.1. What is a cell?

**Recall**

**Recall grade seven general science lesson:**

**Unit 4: cell as the basis of life**

**Objectives**

At the end of this section, the student will be able to:

- *explain how living things are composed of cells*
- *identify unicellular organisms from multicellular organism.*

**Activity 3.1: Group work**

1. Why do we study about cell?
2. List some important biological activities take place in the cell
3. Discuss in groups about the unicellular and multicellular organisms

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.

**Attention**

Most cells are very small and are, therefore, visible only with a microscope but an ostrich egg is a single cell with about 6 inches in diameter and weighing about 1.36 kg; nerve cells in your body can stretch several feet long, and nerve cells in giant squid can be more than 30 feet long!

**Key Terms**

**Cell**: is the smallest and the basic unit of living things. All living things are composed of cells. Unicellular organisms: living things consist of a single cell

**Multicellular organisms:** groups of living things composed of many cells

## 3.2. Cell theory

**Objectives**

At the end of this section, the student will be able to:

- *describe cell theory,*
- *name scientists who played a role in the discovery of the cell theory.*

**Activity 3.2 : Group work**

Discuss in group about the 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 is '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.

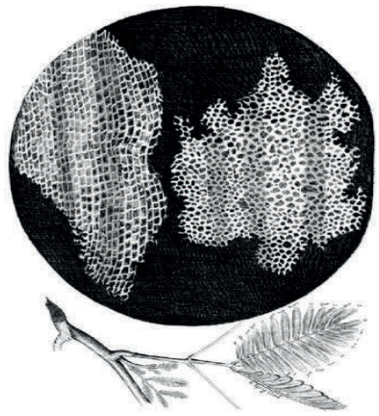


Figure 3.1. Drawing of cork cells published by Hooke

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 micro-organisms 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

**Attention**

English natural philosopher Robert Hooke was the first to observe cells in 1665, naming the shapes he saw in cork cellulae (Latin, "small rooms").They are known to us as cells.

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, catalysed 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

**Objectives**

At the end of this section, the student will be able to:

- *identify the main structure of a cell,*
- *state that the cytoplasm of all cells contains most organelles like the nucleus, ribosomes, and rough endoplasmic reticulum,*
- *describe the function of the structure of a cell, and*
- *list the main structure of a cell.*

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.

## Activity 3.3: Self-test

1. Read books and/or search the Internet for the function of the structure of a cell. Present your report to your classmates.
2. Complete the following table based on your search

| Function | Cell Structure |
|---|---|
| Control all activity of the cell | |
| Control the transport of material into and out of a cell | |
| The place where protein is synthesized | |
| Packaging of the materials in a cell | |
| Produce energy | |

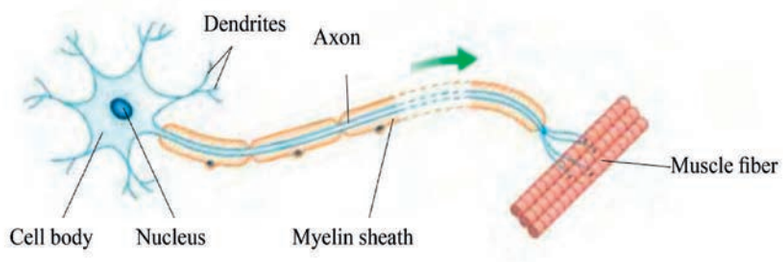



Figure 3.2 Nerve cell

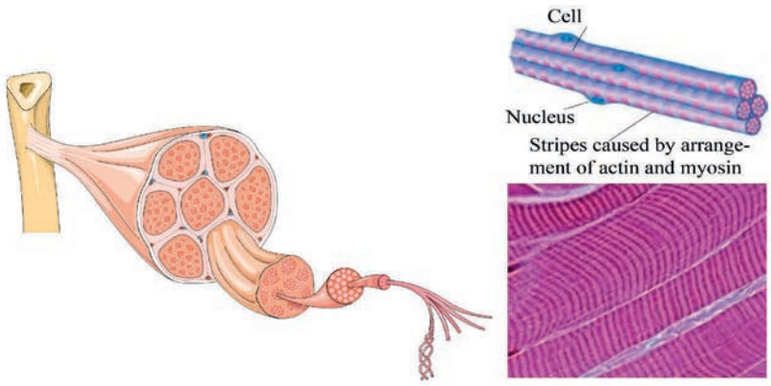



Figure 3.3 Muscle cells

## Activity 3.4: Group work

Make a group of five students, examine Fig 3.2 and 3.3 carefully and discuss the structures and functions of the cell.

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.

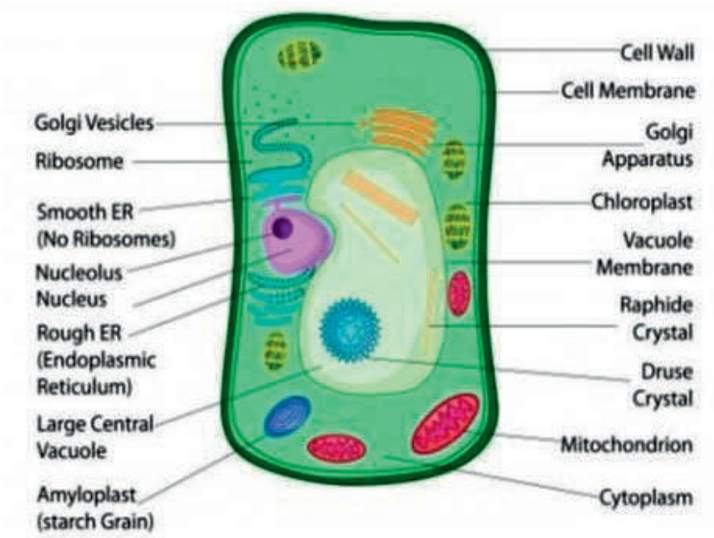



Fig. 3.4 Structure of typical plant cell

**Activity 3.5: Think-pair-share**

What is the difference between the cell wall and cell membrane? Answer the question in relation to their function, discuss in pair and share your answer with the other classmate.

### 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.

**Attention**

Cell membrane is semi-permeable (selectively permeable) because it chooses what can go in and out of the cell

### 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.

**Activity 3.6: Homework / Individual assignment**

Using the Internet or books as a source of information, study the relationship between chromosomes, chromatin, and DNA.

### 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.

**Attention**

Most cells contain one nucleus but there are interesting exceptions. For example, both the mature red blood cells of mammals and the sieve tube elements of the phloem of flowering plants are without a nucleus. Both lose their nucleus as they mature. The individual cylindrical fibers of voluntary muscle consist of a multinucleate sack. Fungal mycelia also contain multinucleate cytoplasm.

### 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.

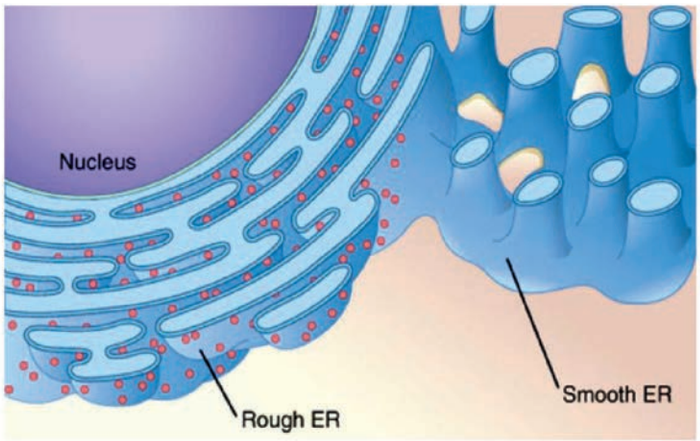



Figure 3.5. The Rough and Smooth Endoplasmic Reticulum

**Activity 3.7: Group work**

What makes rough endoplasmic reticulum rough?

**Attention**

Golgi apparatus is an organelle named by its discoverer (Italian scientist Camillo Golgi),who first described this structure in 1898.

You can think of the Golgi apparatus as a detailing facility that receives ship newly manufactured cars (proteins), puts on the finishing touches, stores the completed cars, and then ships them out when needed. Products made in the ER reach the Golgi apparatus in transport vesicles.

**Activity 3.8: Group work**

Why do you think some metabolically active cells such as muscle cells contain thousands of mitochondria? Discuss in groups of three to five students and present what you have discussed to your classmates.

### 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.

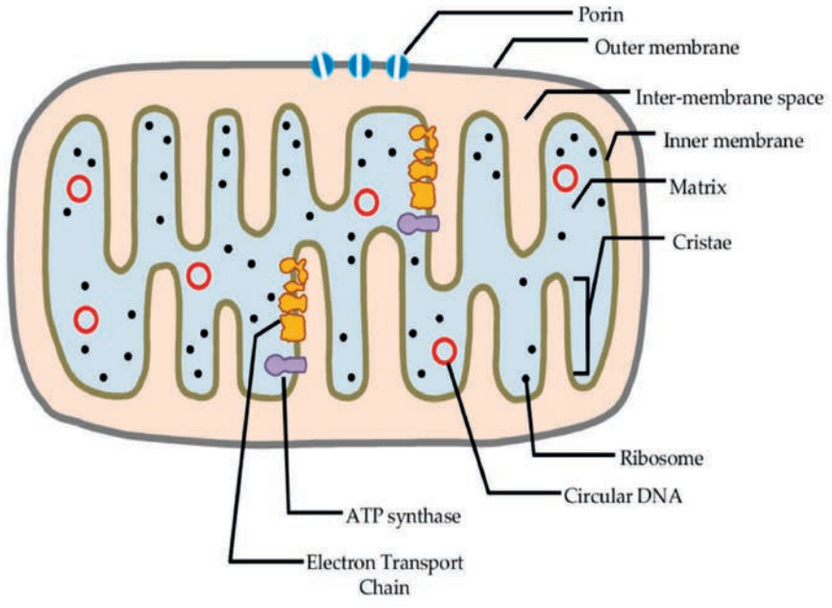



Figure 3.6: Mitochondria

### 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.

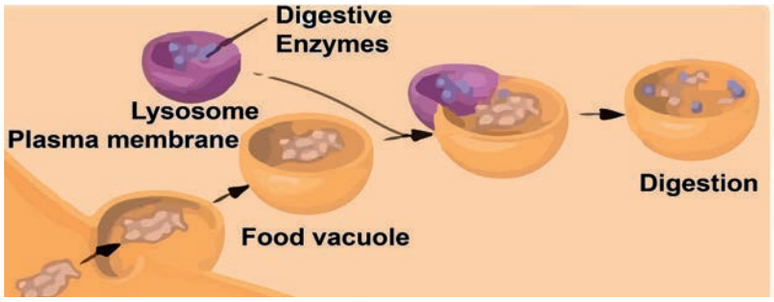



Figure 3.7: Lysosome

### 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.

**Attention**

Lysosomes are involved in the breakdown of the contents of 'food' vacuoles. For example, harmful bacteria. Any foreign matter or food particles are taken up into these vacuoles is then broken down by the digestive enzymes. This occurs when lysosomes fuse with the vacuole.

Lysosomes also destroy damaged organelles in this way.

Phagocytosis came from two Greek words phagein which means to eat, and kytos is vessel referring here to 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 the synthesis of carbohydrates.

**Activity 3.9: Individual assignment**

Make Internet search or refer books and list some unicellular eukaryotes which have food vacuole and contractile vacuole.

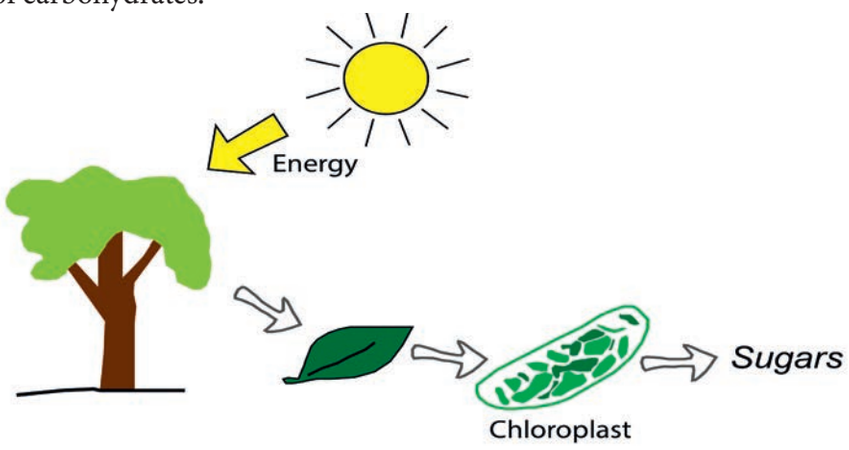



Figure 3.8: Chloroplast trapping sunlight energy to synthesize sugar

**Centrioles and microtubules**

The cytoplasm of cells consists of small cylindrical fibres 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 micro-tubules 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.


Figure 3.9. Cilia and Flagella

**Key Terms**

**Organelles:** small structures found in plant and animal cells. Some examples of organelles are: nucleus, mitochondria, vesicles, and Endoplasmic reticulum.

**Cytoplasm:** is a thick fluid-filled region in the cell containing cell organelles. It is also the site where several chemical reactions such as protein synthesis take place.

**Nucleus:** is the largest organelle which contains DNA and control all activity of the cell.

**Ribosomes:** are small cellular structures that are found in large numbers in all cells. The function of ribosomes is to synthesize proteins

**Rough endoplasmic reticulum:** contains the protein synthesizing machinery called ribosome.

**Vesicles**: are small stack-like collections of the membranous sac. They store and transport and ship materials in the cell.

**Mitochondria**: is the sites of respiration to produce energy.

**Lysosomes**: contain digestive enzymes which can be used to digest bacteria or break down unwanted substance in the cell.

**Chloroplast**: are the site for photosynthesis, which contain a green pigment called chlorophyll that can trap the sunlight energy.

## 3.4 Types of cells

**Objectives**

At the end of this section, the student will be able to:

- *describe the difference between prokaryotes and eukaryotic cells*
- *give examples of the two types of cell.*

**Activity 3.10: Group work**

Make a group of three to five students and discuss the structures commonly found in Prokaryotic and Eukaryotic cell, the common cell structures found in both prokaryotic cells and eukaryotic.

Give examples organisms which have prokaryotic cells and eukaryotic

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. 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.

**Attention**

The term Eukaryotic is derived from the Greek eu, true, and karyon, kernel, referring to the nucleus. Thus Eukaryotic cells are cells with a "true nucleus".

Similarly, the term Prokaryotic is derived from the Greek pro means before and karyon means nucleus; "before nucleus", reflecting the earlier evolution of prokaryotic cells. Eukaryotic cells are usually between 10 and 100 micro meters (mm) wide, while prokaryotes are between 1 and 10 m The term Eukaryotic is derived from the Greek eu, true, and karyon, kernel, referring to the nucleus. Thus Eukaryotic cells are cells with a "true nucleus".

Similarly, the term Prokaryotic is derived from the Greek pro means before and karyon means nucleus; "before nucleus", reflecting the earlier evolution of prokaryotic cells. Eukaryotic cells are usually between 10 and 100 micro meters (mm) wide, while prokaryotes are between 1 to 10 mm in size.

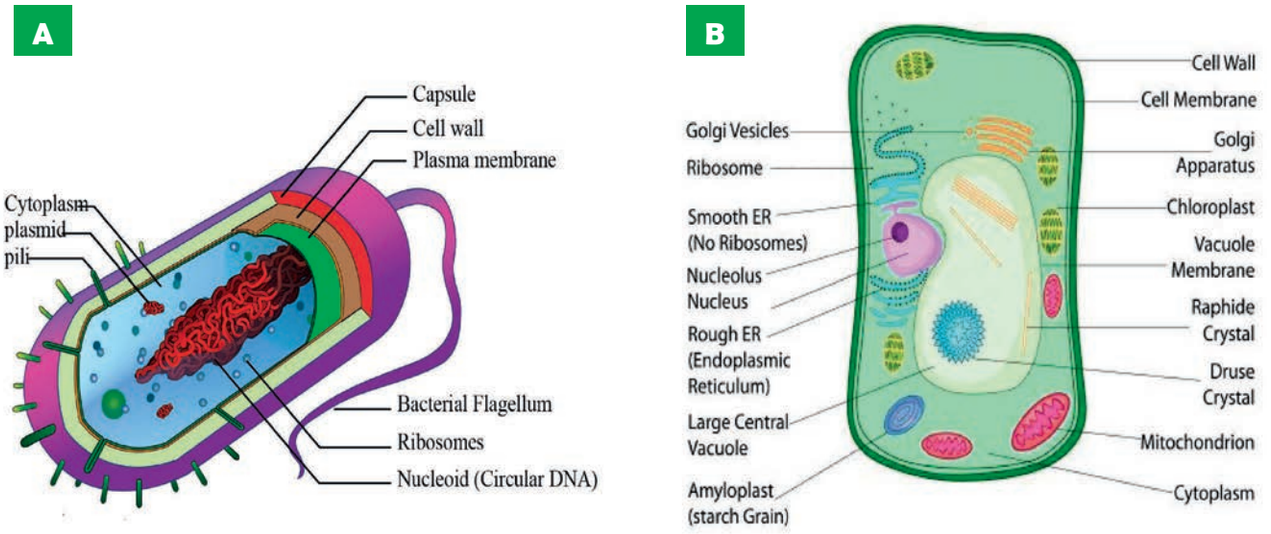



Figure 3.10. A. Structure of a typical prokaryotic cell structure (Example, Bacteria cell) B. Structure of a typical eukaryotic cell (Example, plant cell)

**Table 3.1 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

**Objectives**

At the end of this section, the student will be able to:

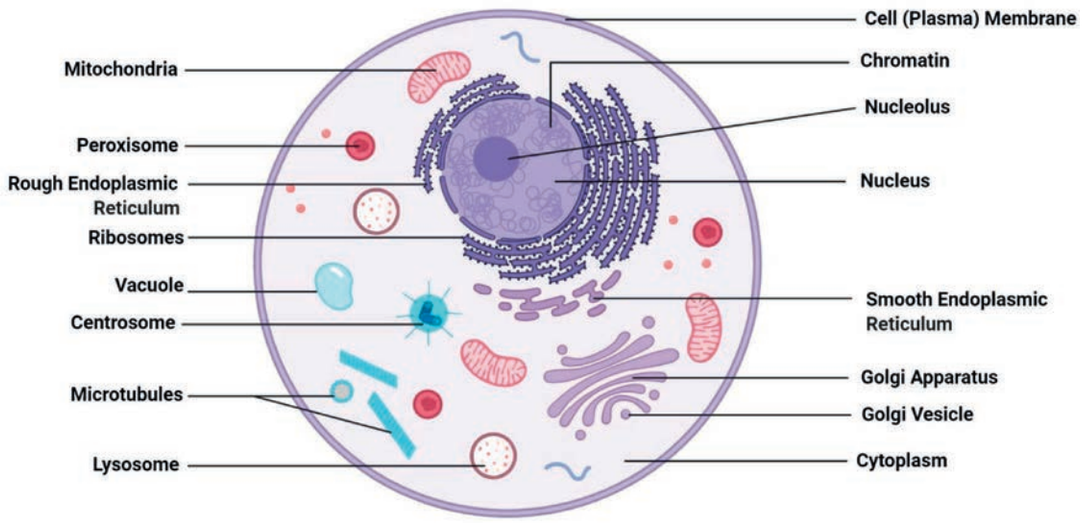
- *list the structures of plant and animal cells, and*
- *describe the differences in structure between plant and animal cells.*

Animal and plant cells have certain features in common like cell membrane, nucleus, cytoplasm, 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 and lysosome are 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

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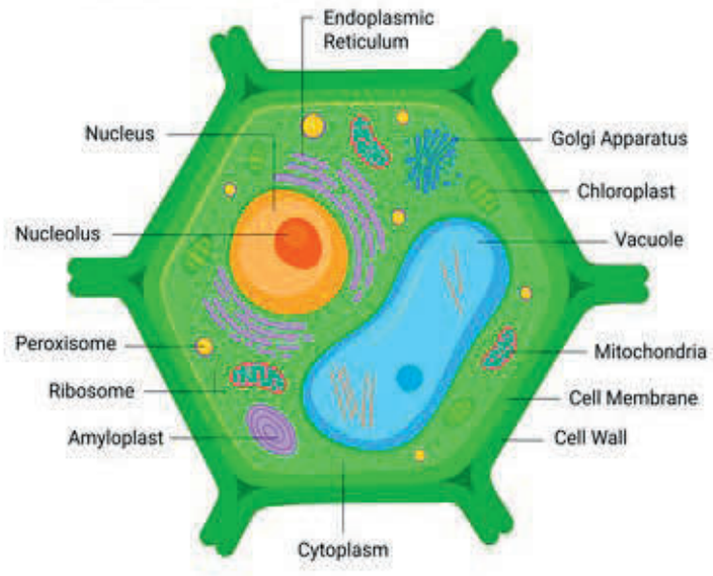



Fig. 3. 11. A. Animal cell as seen with an electron microscope

B. Plant cells as seen with an electron microscope

### Activity 3.11: Self-test

Fill the following table by saying 'present' or 'absent' based on the structure of animal and plant cell.

| **Features** | Plant Cell | Animal Cell |
|---|---|---|
| Cell wall | | |
| Cell membrane | | |
| Nucleus | | |
| Chloroplasts | | |
| Vacuole | | |
| Mitochondria | | |
| Rough and smooth endoplasmic reticulum | | |
| Golgi bodies | | |
| Ribosomes | | |
| Lysosome | | |

## 3.6 Observing cells under a microscope

**Objectives**

At the end of this section, the student will be able to:

- *draw the cell structures as seen under the light microscope, and*
- *label the cell wall, cell membrane, cytoplasm and nucleus of the cell.*

A microscope is an instrument that can be used to observe small objects, even cells. The image of an object is magnified through at least one lens in the microscope. This lens bends light toward the eye and makes an object appear larger than it actually is.

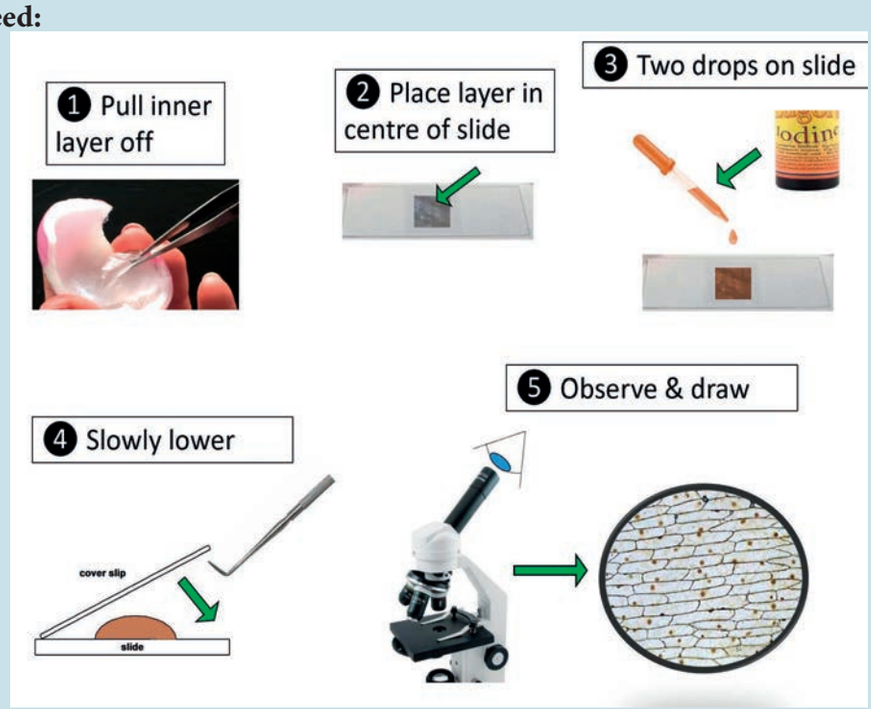
## Activity 3.12: Laboratory Activity

In unit one, you have been introduced to the microscope. In this section, you will learn how to observe the structure of plant and animal cells under a light microscope.

**Objective**: To study the structure of plant cells under a light microscope

**For this activity, you will need:**

- a microscope
- microscope slides
- cover-slips
- forceps
- a mounting needle
- a pipette
- a lamp
- a piece of onion skin
- iodine solution




**Method**

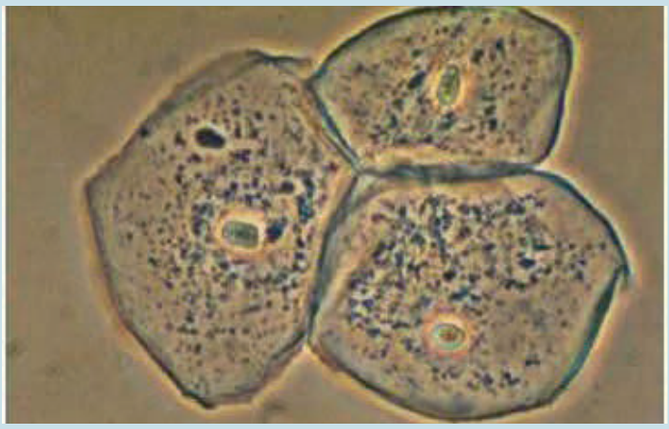
1. Using forceps, peel a piece of epidermal tissue from the inner side of an onion bulb
2. Place the epidermal tissue on a glass microscope slide.
3. Using a scalpel, cut out a 1cm square of tissue (discarding the rest) and arrange it in the center of the slide, Observe the onion cell.
4. Then, add two to three drops of iodine solution for staining. (What do you think the reason for staining? What additional structure can you see in this cell, which could not see in animal cell? Which cellular structure is more visible following staining? Why? )
5. Using forceps, a mounting needle or a wooden splint, support a coverslip with one edge resting near to the onion tissue, at an angle of about 45°.
6. Gently lower the coverslip over the onion tissue, trying to avoid trapping any air bubbles. (Air bubbles will reflect light when viewing under the light microscope, obscuring the features you are trying to observe).
7. Leave the slide for about 5 minutes to allow the iodine stain to react with the specimen.
8. The iodine will stain the cell
9. Place the slide onto the microscope stage, select the lowest power objective lens and focus on the specimen.
10. Increase the magnification using the other objective lenses.
11. Make a large drawing of one cell and label the following parts: cell wall cell membrane, cytoplasm, nucleus. What is the difference between staining and unstaining onion epidermal ell?

## Activity 3.13: Laboratory Activity

Objective: To study the structure of animal cells under a light microscope

For this activity, you will need:

- a microscope
- microscope slides
- cover slips
- forceps
- a mounting needle
- a pipette
- a lamp
- cotton bud
- absolute alcohol
- methylene blue dye



Cheek cell

Method

1. Rinse your mouth with water to remove any fragments of food.
2. Take a cotton bud from a freshly opened pack.
3. Rub the cotton bud lightly on the inside of your cheek and gums to collect some cheek cells in saliva.
4. Rub the cotton bud onto the center of a clean microscope slide, to leave a sample of saliva.
5. Repeat if the sample is too small.
6. Then drop the cotton bud into a container of absolute alcohol (why do we use alcohol in this procedure?).
7. Add two to three drops of methylene blue dye. (What do you think the reason for staining by methylene blue? Which cellular structure is more visible following staining? Why?) Using forceps, a mounted needle or wooden splint, support a cover slip with one edge resting near to the cheek cell sample, at an angle of about 45°.
8. Gently lower the cover slip over the tissue, trying to avoid trapping any air bubbles. (Air bubbles will reflect light when viewing under the light microscope, obscuring the features you are trying to observe.)
9. Leave the slide for a few minutes ( Why do we stay for a few minutes?)
10. Place the slide onto the microscope stage, select the lowest power objective lens and focus on the specimen.
11. Increase the magnification using the other objective lenses.
12. Make a drawing of one cell and label the following parts: cell membrane, cytoplasm, nucleus.
13. Place your used slide in laboratory disinfectant or autoclaving before washing. Why do we disinfect the used slides?

**Note:** This technique which involves studying the epithelial cells taken from the inside of the cheek needs some safety rules because of the very small risk of transmitting the AIDS virus. However, appropriate precautions should be applied to treat contaminated items

## 3.7 The cell and its environment

**Objectives**

At the end of this section, the student will be able to:

- *define the terms diffusion and osmosis,*
- *describe the importance of diffusion and osmosis for the transport of gases and solutes, and*
- *describe the importance of active transport.*

### The Cell membrane

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

**Activity 3.14 Think-pair share**

1. If the cell membrane is to lose its selectivity, what do you think will happen to the cell? Discuss in pairs and share your answers with your classmates.
2. List some of the substances which leave and enter the cell

**Attention**

Thinking of the plasma membrane as your school guard, who is always standing at the entrance of the school gate and control who and what enters and leaves the school, which is a good way of remembering the cell membrane's function.

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.

### 3.7.1 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.

**Attention**

You can think of passive and active transport like rolling a ball on a hill. Imagine that the hill is made of molecules; the lower part of the hill has few molecules, while the upper part of the hill has lots of stacked molecules. If you want to roll a ball downhill (or let molecules flow from where they're piled up to where they're not), you don't have to use any energy. If you want to roll the ball uphill (or push molecules from where they're in low concentration to where they're in high concentration), you have to put in some energy.

**Key Terms**

**Diffusion**: is the net movement of molecules or ions from a region of high concentration to a region of low concentration

**Osmosis:** is the diffusion of water molecules from a region of their higher concentration (dilute solution) to a region of their lower concentration(concentrated solution) .

**Active transport**: is the movement of ions or molecules across the cell membrane, against a concentration gradient, using 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.

**Activity 3.15: Think– Pair –Share**

Discuss in pair what will happen in the following situations, Discuss with your friend and share your idea with the other classmates.

1. When some odor, like incense stick is placed in one part of our home
2. When tea bag is dipping in a glass of hot water

*(a) If a drop of colored ink is dropped into a beaker of water*

*(b) its molecules dissolve*

*(c) and diffuse*

*. (d) Eventually, diffusion results in an even distribution of ink molecules throughout the water.*

Figure 3.12. Diffusion of molecules.

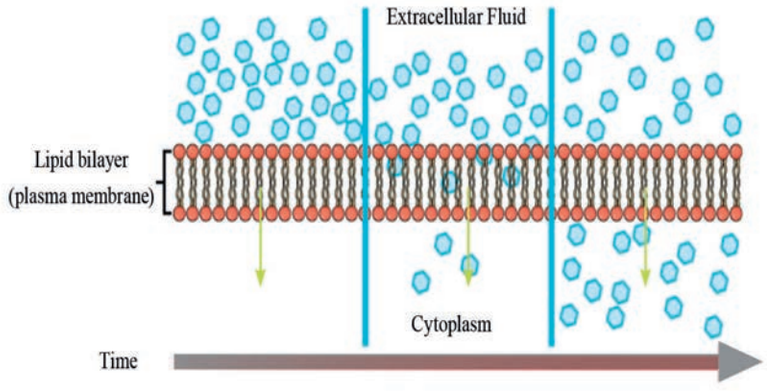



Figure . 3.13 Diffusion through a semi-permeable membrane of cell.

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.

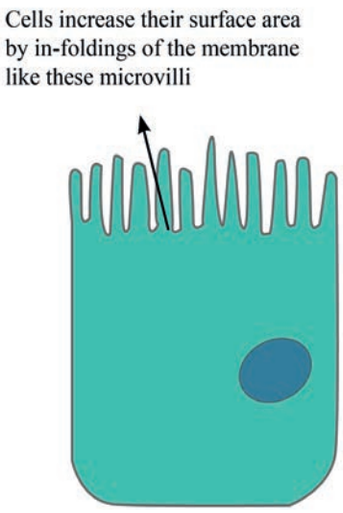



Figure. 3. 14 Microvilli on the surface of small intestine

**Activity 3.16: Group Work**

Select one student for this activity, follow the instruction below and discuss your findings with your classmates.

**Objective**: To study the diffusion of perfume odour from high concentration towards the lower concentration.

**For this activity, you will need:** Bottle of perfume

**Method**

1. Ask your friend to spray some perfume on the front side of your class.
2. Another student should counting number as the smell of the perfume diffuse through the classroom
3. Each student should hand up when he/she smell the odor of the perfume.
4. You'll see a wave of hands moving from the front to the back and sides of the class as the molecules spread out by diffusion.
5. Discuss, how different students smell the odor of the perfume at different times, how long it takes to reach the student in the last row?
6. Repeat the activity by increasing the concentration of the perfume and compare the time with the previous one
7. Do you get a different result when you increase the concentration of the perfume?

**Activity 3.17: Think– Pair –Share**

Discuss with your friend and share your idea with the other classmates why this happen in the following situations

1. Feeling thirsty after having salty food.
2. Swelling of resins and other seeds when they are soaked in water
3. If you put a potato into pure water, it swells up over time.

## 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).

**Activity 3.18: Think– Pair –Share**

Think about osmosis in terms of the solutes. Why do you think water moves toward the area with the greatest concentration of solutes?

Discuss with your friend and share your idea with the other classmates.

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.

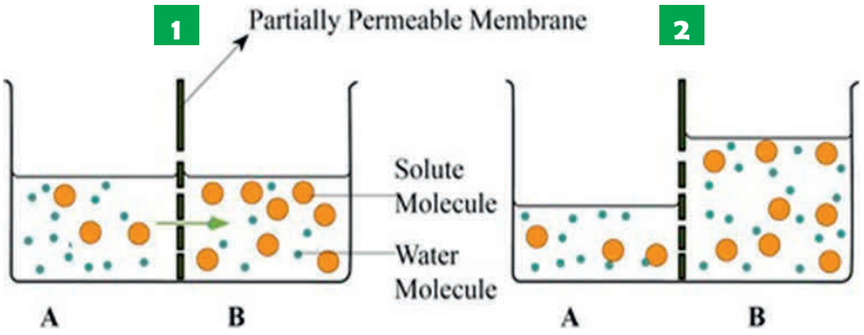



Figure. 3. 15 Osmosis

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 plasmolysed. 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.

**Key Terms**

**Hypertonic solution:** a solution with a high concentration of solute and a low concentration of water.

**Hypotonic solution:** a solution with a low concentration of solute and high concentration of water.

**Isotonic solution:** when the cell and its surroundings have equal solute and water

**Attention**

**Application of osmosis in day to day life**

People have used osmosis to preserve food like meat and fish through salt preservation.

**Activity 3.19: Group work**

Discuss in groups how our society uses the principles of osmosis for the preservation of meat in the rural area where the refrigerator is not available.

## 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 exert 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.

In this figure 3.16 A. shows that if the water concentration of the solution surrounding the plant cell is too high, the cell swells and turgid. B. If it is the concentration water in both is the same C. If the solution surrounding the cell is too high, the plant cell plasmolysed.

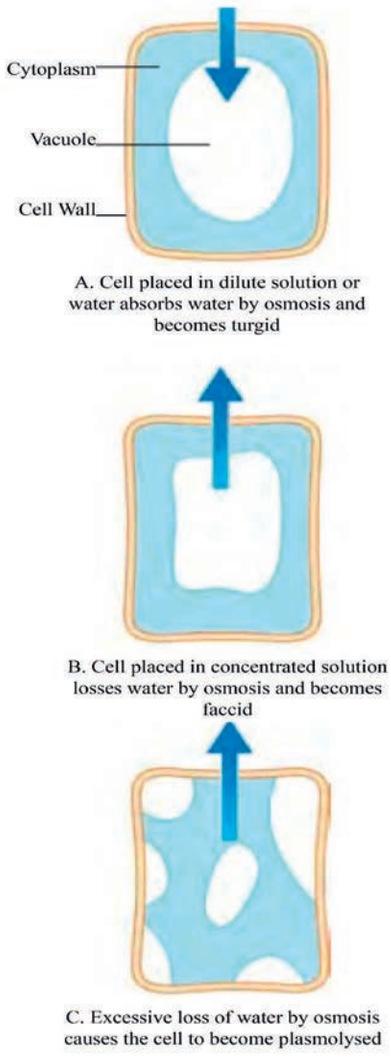



Fig. 3.16. Osmosis in plant


Figure 3.17. The effect of osmosis in plant leaf

Without adequate water, the plant on the left has lost turgor pressure, visible in its wilting. Watering the plant (right) will restore the turgor pressure.

## 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.

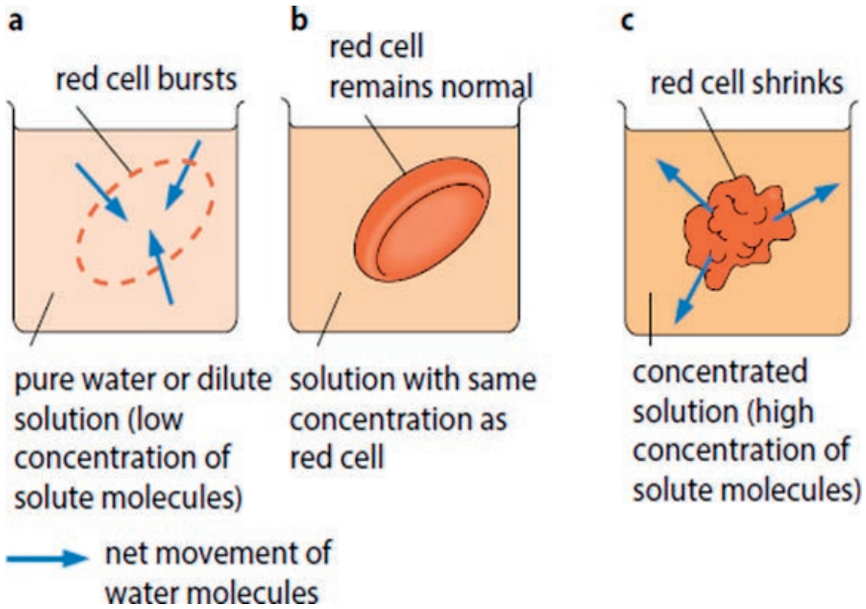



Fig. 3.18. (A) Shows that if the water concentration of the solution surrounding the red blood cell is too high, the water moves to the cell and the cell swells and bursts. (B) If the water concentration in red blood cell and the surrounding solution is the same. (C)If the water concentration of the solution surrounding the red blood cell is low, the water moves from the cell to the surrounding solution and the cell shrinks

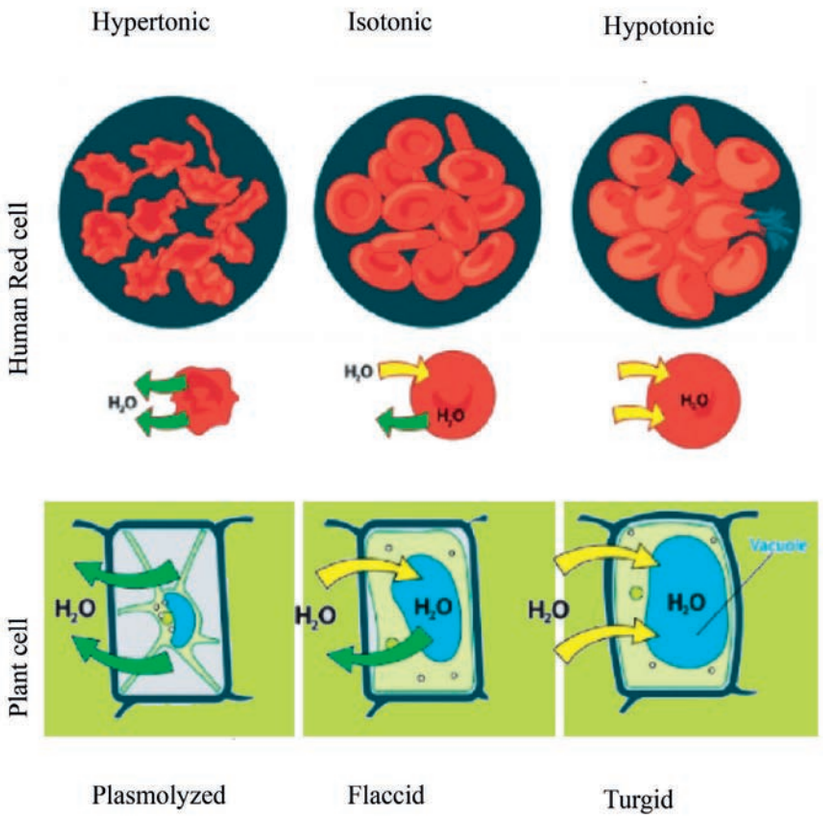



Fig.3.19 Osmosis in plants and animal cell

**Activity 3.20: Group work**

1. Make a group of five students and discuss the conditions that derive us to drink water after a heavy physical exercise?
2. A farmer cultivates a crop pant and he applies too much chemical fertilizers to the soil, does this affect the crop plant? What could happen the crop plant? Why?

**Activity 3.21: Homework /Individual assignment**

Using information from the internet or book, discuss how animals living in freshwater regulate osmosis and how they protect their body from bursting?

## 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.

## Activity 3.22: Laboratory Activity

**Osmosis in plant cells**

**Objective**: To Investigating osmosis in plant cells

For this activity, you will need:

- Potato,
- salt solution,
- Balance

**1. Observing osmosis in potatoes:**

- prepare equal sized potato cubes and measure the weight
- make a salt solution
- bring another bottle and put pure water in it
- put the potato cubes in pure water and salt solution. Speculate what will happen?
- After 1hour observe their difference in size, weight, and conclude.

**2. Observing osmosis in onion cell**

**Objective** : To study plasmolysis using onion cell.

Epidermal strips are useful material for observing plasmolysis. Colored sap makes the observation easier. Suitable sources are the inner surfaces of the fleshy storage and leaves of red onion bulbs.

- Place the strips of the epidermis in a salt or sugar solution.
- Place small pieces of the strips on glass slides.
- Mount in the relevant solution.
- Observe with a microscope.
- What you observe about the shape of onion cell?
- Draw the picture of the cell that you observe under microscope
- Plasmolysis may take several minutes, then discuss in groups about your result.

## Activity 3.23: Laboratory Activity

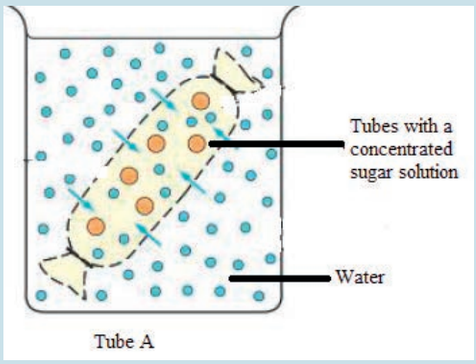
Investigating osmosis using model cell. Dialysis tubing is partially permeable. We can use dialysis tubing to represent the cell membrane and the solution inside it to represent the cytoplasm.

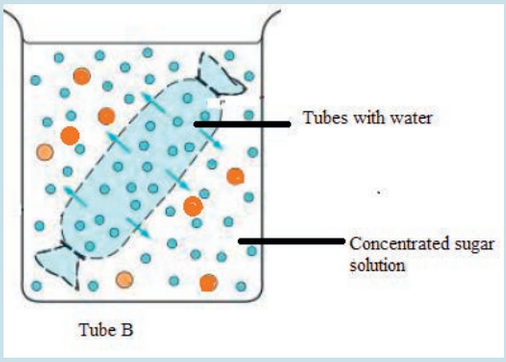
**Objectives**: Objective: To Investigating osmosis in animal model cells

For this activity, you will need:

- Dialysis tube,
- sugar solution,
- beaker.

1. Cut two pieces of dialysis tubing, each 15cm long. Tie one end.
2. Fill one dialysis tube with a concentrated sugar solution (tube A). Fill the other model cell with water (tube B).
3. Put 'cell A' into a beaker of water and put 'cell B' into a beaker containing a concentrated solution of sugar.
4. After 20 to30 minutes take out the two tubes. What happen to the two tubes? Is there any difference in volume between tube A and tube B?



### 3.7.2 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.

**Attention**

Active transport allows cells to maintain internal concentrations of small solutes that differ from environmental concentrations. For example, compared with its surroundings, an animal nerve cell has a much higher concentration of potassium ions and a much lower concentration of sodium ions. The plasma membrane helps maintain these differences by pumping sodium out of the cell and potassium into the cell. This particular case of active transport (called the sodium-potassium pump) is vital to the nervous system of most animals.

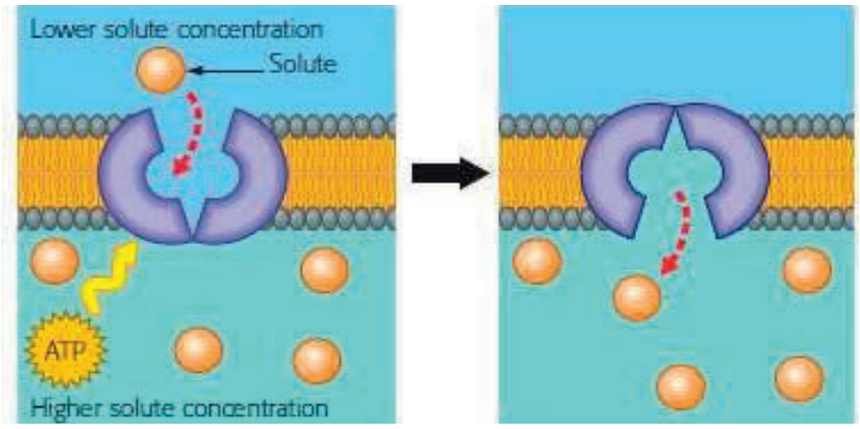



Fig 3.20 Active transport

## 3.8. Levels of Biological Organization

**Objectives**

At the end of this section, the student will be able to:

- *define the terms tissue, organ and organ system, and*
- *list some examples of human systems.*

**Activity 3.24: Think – Pair – Share**

What is the smallest level of biological organization that can display all the characteristics of life? Discuss with a partner and share your answers with your classmates.

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.

**Activity 3.25: Think – Pair – Share**

Discuss with a partner and share your answers with your classmates.

1. How do these different cells and relate to each other? Where do body systems, like the digestive system and nervous system fit into levels of organization?
2. Suppose one organ in a digestive system failed to work properly. How would the digestive system be affected? Would it still be able to function? Explain your reasoning.
3. What might happen if a plant organ, such as a leaf or stem, became damaged? How would the organism be affected?

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.

For example, the stomach is an organ that contains tissues made from epithelial cells, gland cells and muscle cells. These cells are supplied with food and oxygen brought by blood vessels. The heart, lungs,

**Key Terms**

**Tissues**: group of cells that have the same function.

**Organs**: group of tissues that work together to do a particular function.

**Systems**: different organs which are working together

intestines, brain and eyes are further examples of organs in animals. In flowering plants, the root, stem and leaves are the organs.

At the third level of organization, organs are grouped into **systems.** The digestive system, for example, consists of digestive organs like the stomach and intestine. The different systems collectively form an organism. An organism is formed by the organs and systems working together to produce an independent plant or animal.

**Activity 3.26: Group work**

Give examples of some systems in the human body and discuss

The organs from which they are composed of.

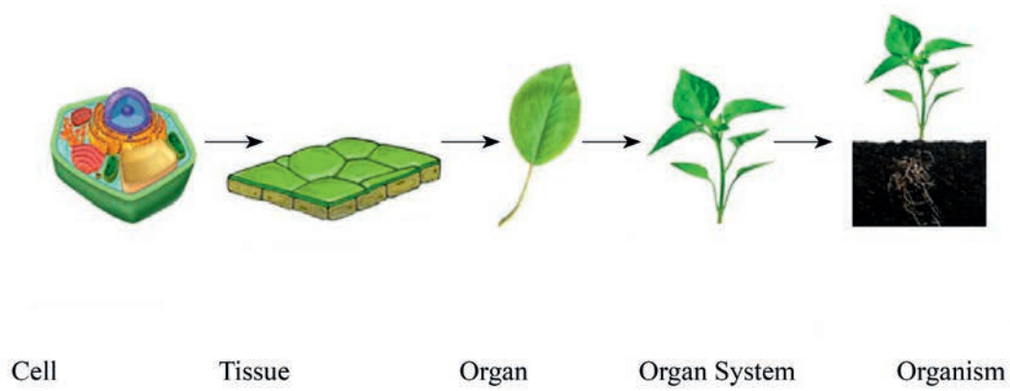



Figure. 3.21 Level of organization in plants

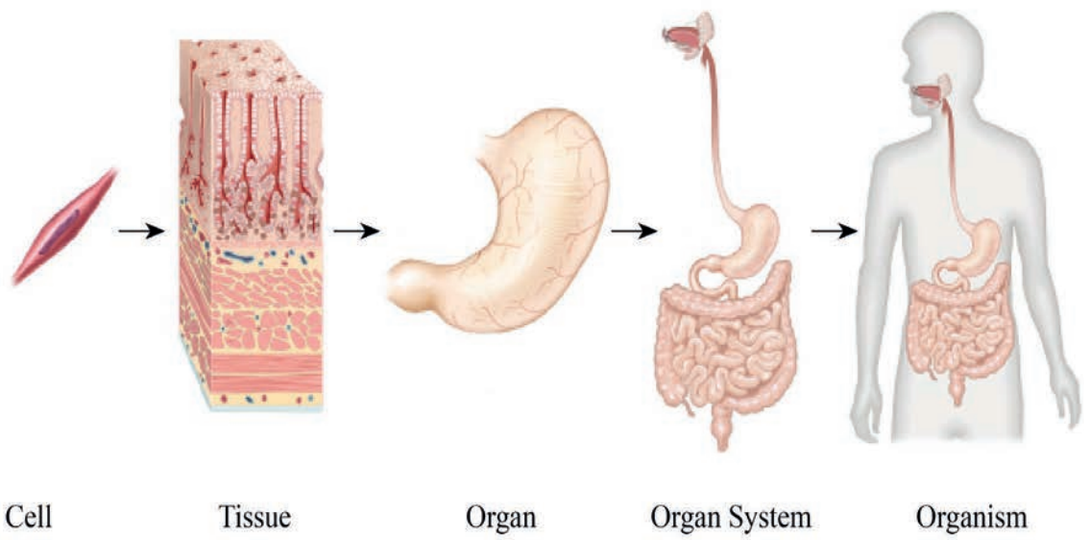



Figure. 3.22 Level of organization in Animals

## Unit review

In this unit, you have learnt about:

- Cell theory is the unifying foundation of cell biology. All organisms are composed of one or more cells. Cells arise only by the division of preexisting cells.
- All cells share simple structural features.
- All eukaryotic cells have a centrally located nucleus, a semifluid cytoplasm, and an enclosing plasma membrane.
- In eukaryotic cells, membranes partition into several functional compartments called organelles. The largest organelle is usually the nucleus. Other organelles are located in the cytoplasm, the region outside the nucleus and within the plasma membrane.
- Nucleus is the structure of the cell which control all activities of the cell. Within the nucleus, DNA and proteins make up chromatin fibers; each very long fiber is a single chromosome. The nucleus also contains the nucleolus, which produces components of ribosomes.
- Endoplasmic Reticulum is the structure consists of membrane-enclosed tubes and sacs within the cytoplasm. Rough ER, named because of the ribosomes attached to its surface, makes membrane and secretory proteins. The functions of smooth ER include lipid synthesis and detoxification.
- The Golgi apparatus refines certain ER products and packages them in transport vesicles targeted for other organelles or export from the cell.
- Lysosomes are sacs containing digestive enzymes, aid digestion and recycling within the cell.
- Vacuoles include the contractile vacuoles that expel water from certain freshwater protists and a large multifunctional central vacuoles of plant cells. Microtubules are an important component of the cytoskeleton, an organelle that gives support to and maintains the shape of, cells.
- Cilia and eukaryotic flagella are appendages that aid in movement.
- Animal and plant cells have a cell membrane, nucleus, cytoplasm and organelles like mitochondria (singular: mitochondrion), Golgi apparatus.
- The difference between animal and plant cells is the presence of centriole, chloroplast, cell walls is large permanent vacuoles only in plant cells.
- 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 concentration without the need for energy to be used. Whereas active transport is the movement of molecules from areas where they're less concentrated to areas where they're more concentrated using energy. 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.

## 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 | | | |

# Unit 4: Reproduction

| Contents | Learning competencies |
|---|---|
| 4.1 Introduction to reproduction<br>4.2 Asexual reproduction<br>4.3 Types of asexual reproduction<br>4.3.1 Fission<br>4.3.2 Fragmentation<br>4.3.3 Budding<br>4.3.4 Vegetative reproduction<br>4.3.5 Parthenogenesis<br>4.4 Sexual reproduction in human<br>4.5 Primary and secondary sexual characteristics<br>4.6 Male reproductive structures<br>4.7 Female reproductive structures<br>4.8 The Menstrual cycle<br>4.9 Fertilization and pregnancy<br>4.10 Methods of birth control<br>4.11 Sexually transmitted infection: transmission and prevention | • Appreciate that life perpetuates from generation to generation through reproduction.<br>• Define asexual and sexual reproductions<br>• Describe asexual reproductions in bacteria, fungi, animals, and plants<br>• Compare and contrast the advantages and disadvantages of asexual and sexual reproduction<br>• Describe the biological, psychological, and social changes during the puberty stage<br>• Differentiate between the primary and secondary sexual characteristics of males and females in humans<br>• Identify the structure and functions of the male reproductive organs.<br>• Identify female reproductive structures and their functions.<br>• Outline the phases of the menstrual cycle<br>• Define fertilization and pregnancy<br>• Discuss the methods of prevention of pregnancy<br>• Describe the types, modes of transmission and preventive mechanisms of sexually transmitted diseases |

## 4.1 Introduction to reproduction

**Activity 4.1. Reflective discussion**

As you know, there were people living in Ethiopia or elsewhere thousand years ago and all were passed away but still there are people living there. Why? Though individuals of a species are mortal, life continues from generation to generation. What biological processes are responsible for this?

**Objectives**

At the end of this section, the student will be able to:

- *appreciate that life perpetuates from generation to*
- *generation through reproduction*

*What is 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 non living 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 itself 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

**Objectives**

At the end of this section, the student will be able to:

- *define asexual reproduction*
- *differentiate the process of asexual reproduction*
- *tell the advantages and disadvantages of asexual reproduction*

*What is common to all types of 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 (Fig.4.1).

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 favourable 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.

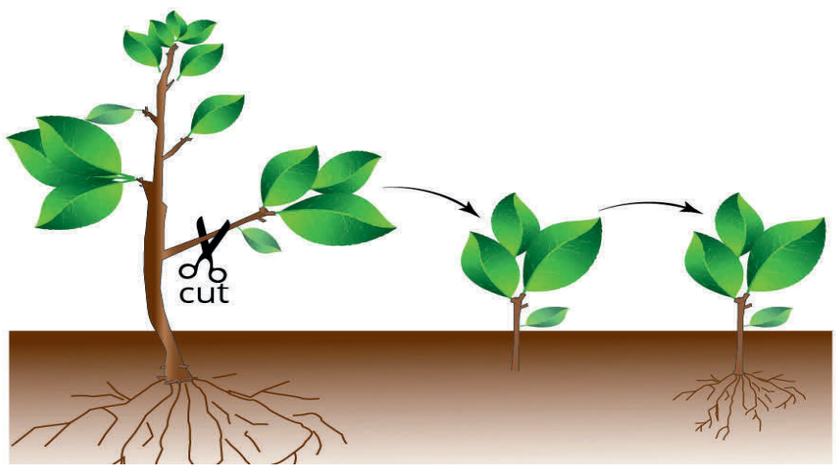



Figure 4.1. Vegetative propagation in plants

**Activity 4.2: Concept mapping**

No organism can live forever, but part of it lives in its offspring. Offspring are produced by the process of reproduction. This process may be sexual or asexual, but in either case, it results in the continuation of the species. Discuss the differences and similarities you observe among the different types of asexual reproduction.

## 4.3 Types of asexual reproduction

**Objectives**

At the end of this section, the student will be able to:

- *describe the process of asexual reproduction in bacteria, protists, fungi, animals and plants*
- *explain the mechanism of fission*
- *discuss the mechanism of fragmentation*
- *describe the mechanism of budding*
- *investigate the mechanism of vegetative propagation*
- *describe the mechanism of parthenogenesis*

**Attention**

The cells of some species, such as bacteria, can divide every 20-30 minutes. When placed on a solid growth medium in a petri dish, a bacterial cell and its daughter cells undergo repeated cellular divisions and form a group of genetically identical cells called a bacterial colony. Such rapid rate of bacterial cell reproduction is one reason why a small number of bacteria can seriously contaminate our food products.

### 4.3.1 Fission

*What are the steps of 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 (Fig.4.2). 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.

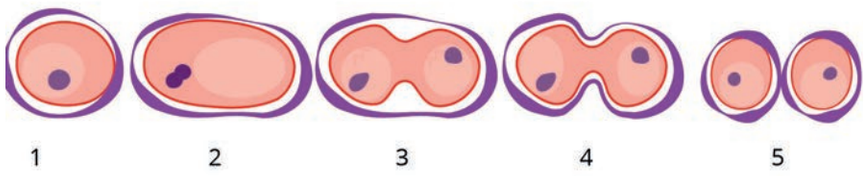



Figure 4.2. Binary fission in bacteria

### 4.3.2 Fragmentation

*What is 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 (Fig.4.3).

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.

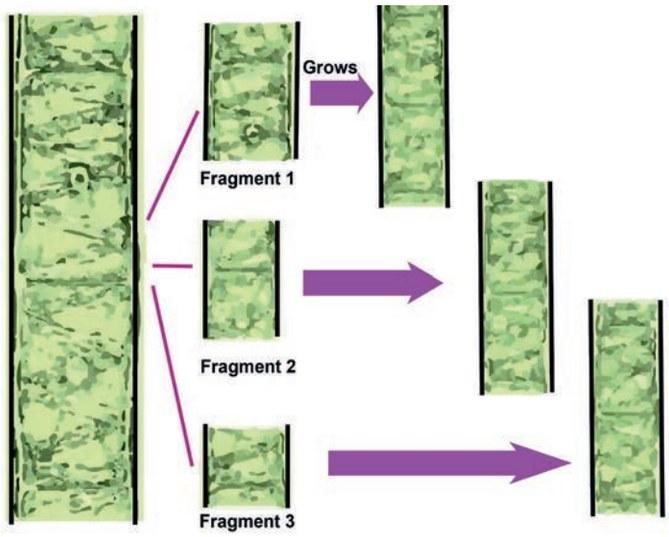



Figure4.3. Fragmentation in filamentous green-algae

### 4.3.3 Budding

*In budding, the two daughter cells are unequal. Why?*

Another common type of asexual reproduction is budding. In this mode of reproduction, the organism divides into two unequal parts. It is common in fungal 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 (Fig.4.4.). Budding also occurs commonly in some invertebrate animals such as hydra.

**Activity 4.3: Experiment on budding and fragmentation**

Make a field visit in your village and collect specimens of organisms that reproduce with budding. Do experimentation on budding and fragmentation. Material required 10% glucose solution , yeast, microscope, slide, cover slip, dropper and test tube.

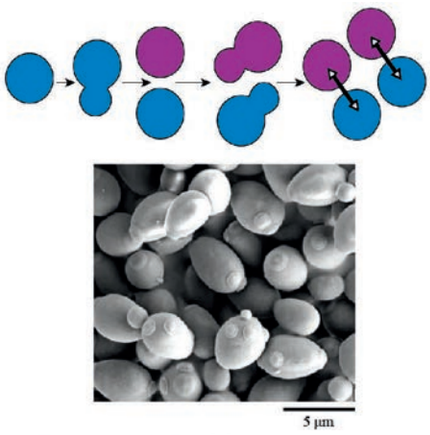



Figure 4.4. Budding in yeast

**Key Terms**

**Chromosome**: the hereditary material that carry the biological information

**Hypha** (pl. hyphae): the long filamentous branches found in fungi

**Mitosis**: type of cell division that produce two identical daughter cells

**Mycelium**: the vegetative part of a fungus, consisting of a network of fine white filaments (hyphae)

**Spore**: reproductive cell

**Sporulation**

*Why sporulation is an ideal means of asexual reproduction in colonizing different habitats?*

The majority of fungi, however, reproduce asexually by the formation of spores (i.e., sporulation). Spores are dispersed often by air currents and if they reach a suitable situation, they grow new hyphae. The hyphae develop into a mycelium (Fig. 4.5; left). At the tip of the hyphae, a swelling or sporangium – spore sac forms. Penicillium and Mucor are examples of mould fungi that grow on decaying food or vegetable matter (Fig. 4.5; right).

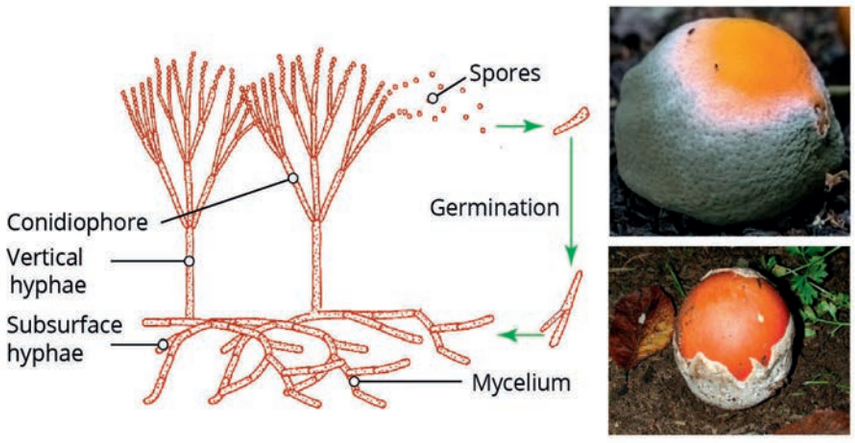



Figure 4.5. Asexual reproductions in fungi

## 4.3.4 Vegetative propagation

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.

**Natural Vegetative propagation**

**Stolons(runners)**

*What is a stolon?*

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

*What is a 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 (Fig. 4.6) is a good example.

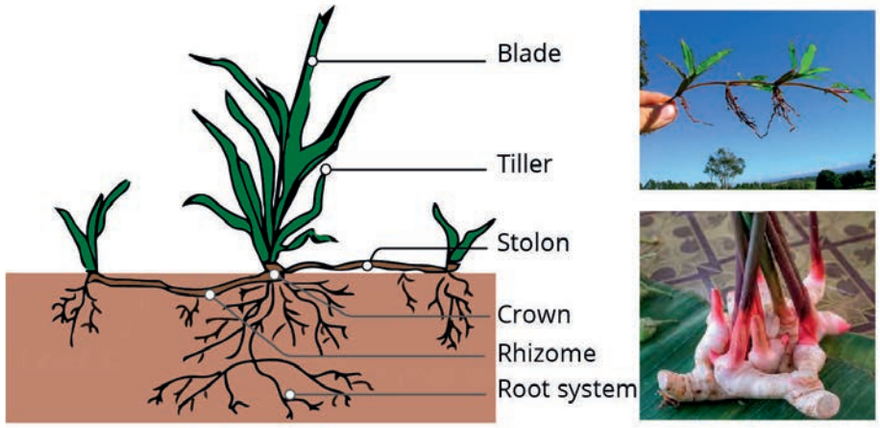



Figure 4.6. Reproduction using stolon and rhizomes

### Corms

*What is a corm?*

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

*What is a tuber?*

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 (Fig. 4.7.).

### Bulb

*What is a 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.

**Activity 4.4: Experimentation on growing potato plants from tuber.**

Make a field visit to your village and collect specimens of potato plants. Materials required include potato tubers, razor blade, iodine solution, microscope, slide, cover slip, and large pot. Take a note on the morphological features and grow potato plants from tubers.

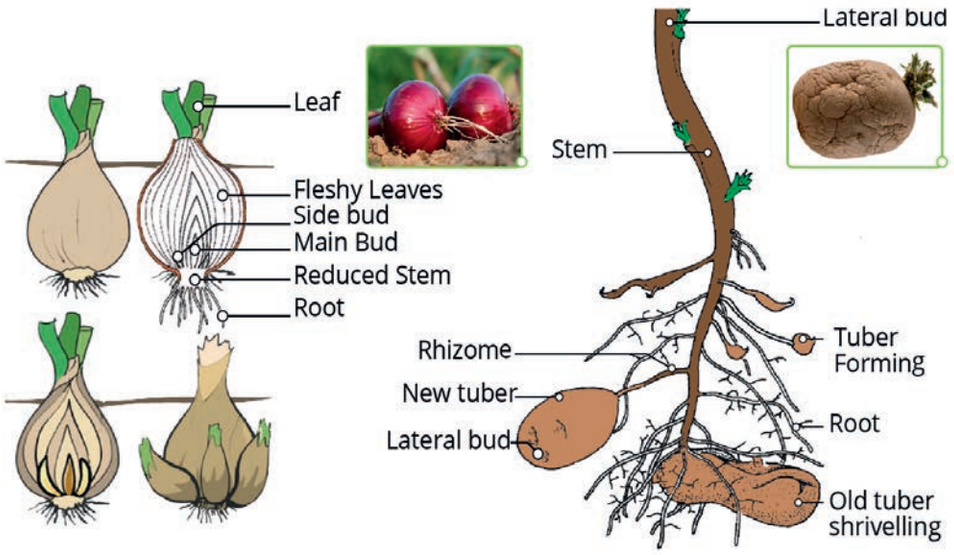



Figure 4.7. Asexual reproduction with tuber and bulb

**Activity 4.5: Experimentation on growing onion plants from bulbs.**

Make a field visit in your village and collect specimens of onion plants. Material required bulb and pot containing soil mixed with compost. Take a note on the morphological features and grow onion plants from bulbs.

**Artificial Vegetative propagation**

Artificial methods of asexual reproduction are frequently used to give rise to new and sometimes novel, plants. They include grafting, cutting, layering, marcotting and micro propagation.

**Grafting**

Grafting is an artificial method of asexual reproduction used to produce plants combining favourable stem and root characteristics. The stem of the plant to be grafted is known as the scion. The root is called the stock.

**Cutting**

Plants such as hibiscus and Aibika are propagated through stem cuttings where a portion of the stem containing nodes and internodes is placed in moist soil and allowed to root. In some species, stems can start producing a root even when placed only in water. For example, leaves of crotons or tanget will root if kept undisturbed in water for several weeks.

**Layering or runner**

A method in which a stem attached to the plant is bent and covered with soil. Young stems that can be bent easily without any injury are the preferred plant for this method.

**Self Assessment 4.1**

1. Discuss the mechanisms of multiple fission.
2. When a food is left open for two or three days, one observes a fruiting body on the food. The taste of food changes? Why?
3. What makes parthenogenesis unique as compared to other mode of asexual reproduction?

### 4.3.5 Parthenogenesis

*Why offspring produced by parthenogenesis is commonly called "virgin birth"?*

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.

**Attention**

Whip tail lizard (*Aspidoscelis uniparens)* produces females by employing parthenogenesis. All the members of this species are female, and all reproduction in the species comes through parthenogenesis. Thus, each new lizard develops solely from one of her mother's eggs, meaning that each is a clone of her mother.

## 4.4 Sexual reproduction in Humans

**Objectives**

At the end of this section, the student will be able to:

- *describe the mechanism of sexual reproduction*
- *compare and contrast asexual and sexual reproduction*

**Activity 4.6. cooperative learning**

Read books and write advantages and disadvantages of sexual reproduction.

*What is sexual reproduction?*

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.

**Key Terms**

**Egg**: female gamete

**Fuse:** union(fertilization) of egg and sperm

**Gametes**: reproductive cell (sex cells - egg or sperm)

Meiosis: type of cell division whereby gametes are produced

**Sperm**: male gamete

**Zygote**: fertilized egg

**Self Assessment 4.2**

1. What are the advantages of asexual reproduction as compared to sexual reproduction?

**Activity 4.7. Inquiring and researching**

During puberty, humans mature physically and become able to reproduce.

What are the major biological, psychological and sociological changes that occur during puberty?

At what ages do you think males and females go through puberty?

**Key Terms**

**Hormones:** Are chemical messengers secreted by endocrine glands.

**Puberty**: the time when secondary sex characteristics begin to develop; as secondary sexual characteristics begin to develop, so does sexual maturity, the potential for sexual reproduction.

**Secondary sex characters**: characteristics that are not primarily involved in formation and delivery of egg/sperm, but that are essential for behavioral and functional success of reproduction.

## 4.5 Primary and secondary sexual characteristics

**Objectives**

At the end of this section, the student will be able to:

- *differentiate between the primary and secondary sexual characteristics of males and females in humans*
- *describe the biological, psychological, and social changes during the stage of puberty*

*What are primary 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.

*What are secondary sexual characteristics?*

Puberty begins in the early teen years. Puberty or adolescence is 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.

*What role do hormones play in puberty?*

The glands of the endocrine system release hormones (chemical substances) 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, 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. 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.

*What are the psychological and social changes during puberty? How do they affect life of the youth?*

Young people must adjust to remarkable physiological, anatomical, and psychological transformations during the process of puberty. Their bodies change rapidly, and thus their body image also changes. Any deviations of their bodies from what they or their peers consider "normal" can lead to low self-esteem. For example, females will worry about the size of their breasts and other aspects of their figures and will not feel feminine if these are not in line with the norm of their peers. Similarly, a male may worry about the size of his penis or his physique; and if these are not within the norm, he will feel that something is wrong with him. Young people should realize that there is considerable variation in the timing of the stages of puberty among different individuals, and that most people develop into "normal" adults in the course of their sexual and physical maturation.

An individual who reaches puberty later or earlier than his or her peers can suffer psychological pain. If not handled in a constructive fashion, early or late puberty can lead to poor self-esteem and problems in sexual and other areas of life. For example, late-developing males may suffer from a poor self-image, and this can influence them in later life. They tend to have a lower occupational attainment, get paid less, marry later, and have fewer children than other men of the same adult height. Early maturing males, on the other hand, can have an easier time of it. They tend to be held in higher esteem by their peers because of their broad shoulders and masculine physiques. Early-maturing females suffer more than early-maturing males. Because of their mature bodies (large breasts), their peers make the assumption that they are sexually experienced and sexually "easy," whereas in actuality, early maturing females tend to be submissive, socially indifferent, and low in popularity. Therefore, such individual should get medical or psychological advice to cope up with problems related early or late puberty.

Adolescence is the period between puberty and adulthood, when a good deal of social learning takes place. The length of this period of youth is socially determined. Its length could be influenced by nature, culture, and civilization. Biologically, teenagers are adult after they have reached puberty, when they are capable of having children.

**Attention**

The hypothalamus secretes a hormone that causes the pituitary gland to release two other hormones. The hormones are follicle-stimulating hormone (FSH) and luteinizing hormone (LH). When FSH and LH are released into the bloodstream, are carried to the testes. In the testes, FSH causes the production of sperm cells. LH causes the endocrine cells that are in the testes to produce the male hormone testosterone. Testosterone influences the production of sperm cells. Testosterone is responsible for the growth and development of secondary sex characteristics in the male. The FSH and LH are also secreted in females and influence the development of secondary sex characteristics.

**Self Assessment 4.3**

1. What are the two hormones involved in male puberty released by the pituitary gland?
2. What are the secondary sex characteristics in females?

Economically, they are adult when they can support themselves and possibly a family. Morally, they are adult when they are responsible for their actions, can express love in a mature manner, and can have productive and meaningful relationships. During adolescence, teenagers must achieve economic and moral adulthood; deal with separation from family.

## 4. 6 Male reproductive structures

**Objectives**

At the end of this section, the student will be able to:

- *Identify the structure and functions of the male reproductive organs.*

**Activity 4.8. Reflective discussion**

The main function of the organs, glands and hormones of the male reproductive system is to produce sperm and deliver them to the female. Discuss the roles of the various parts of the male reproductive system. Draw and label parts of the male reproductive organ along with their function.

*What are the functions of the male reproductive organs?*

The male reproductive system of vertebrates, such as 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 (Fig.4.8). 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 signalling molecules. Sperm constitute less than 5 percent of semen volume.

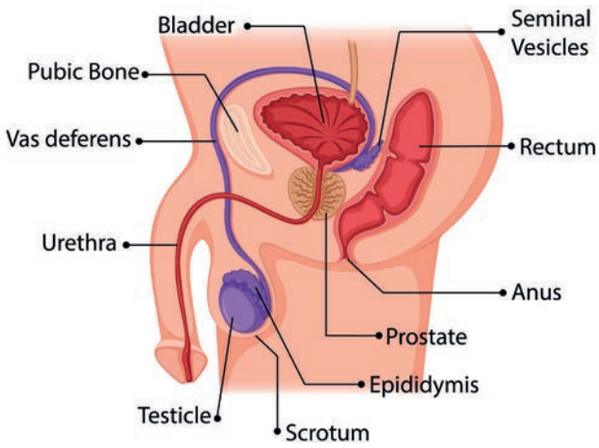



Figure 4.8 Parts of male reproductive systems

*How does the structure of a sperm relate to its function?*

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 (Fig.4.9).

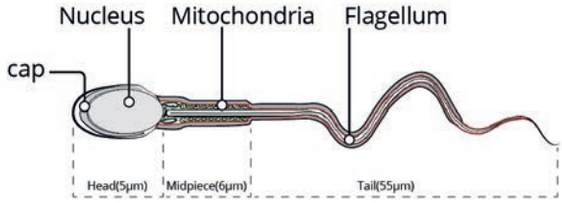



Figure 4.9 Parts of a sperm cell

## Key Terms

**Bulbourethral glands:** secrete a lubricating mucus into the urethra which helps clear the urethra of residual urine.

**Epididymides:** a pair of ducts in which sperm formed in testes mature; each empties into a vas deferens.

**Penis**: male organ of intercourse.

**Prostate gland:** produces alkaline secretions that help raise the pH of the female reproductive tract, making this passage more hospitable to sperm.

**Scrotum**: pouch of skin that encloses a human male's testes.

Semen: sperm mixed with secretions from seminal vesicles and the prostate gland.

**Seminal vesicles:** are exocrine glands which secrete fructose-rich fluid into the vasa deferentia.

**Seminiferous tubules:** inside a testis, coiled tubules that contain male germ cells and produce sperm.

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

**Vas deferens:** one of a pair of long ducts that convey mature sperm toward the body surface.

## Self Assessment 4.4

1. What is the advantage of testes located in the scrotum?
2. What does the mid piece of the sperm contain?
3. What are the function of seminal vesicle and protest gland?
4. What is the purpose of the vas deferens?
5. Which glands secrete alkaline fluids?

## 4.7. Female reproductive structures

**Activity 4.9. Investigating**

Discuss the roles of the different parts of the female reproductive systems. Draw and label the various parts along with their function.

**Objectives**

At the end of this section, the student will be able to:

- *Identify female reproductive structures and their functions.*

*What are the functions of female reproductive organs?*

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 there 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 (Fig.4.10).

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 to 35 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.

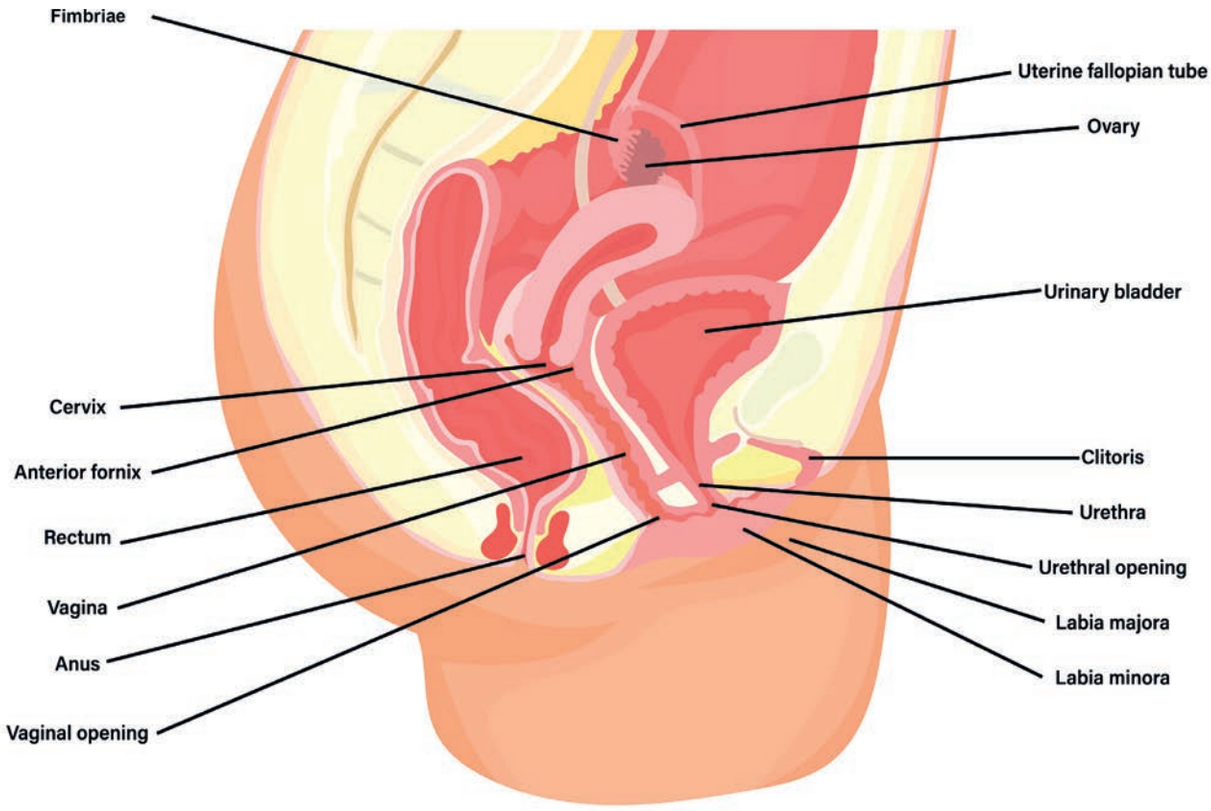



Figure 4.10 Female reproductive systems

## Ovulation

*What is 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 (Fig.4.11).

**Self Assessment 4.5**

1. How are eggs produced?
2. How are eggs released?

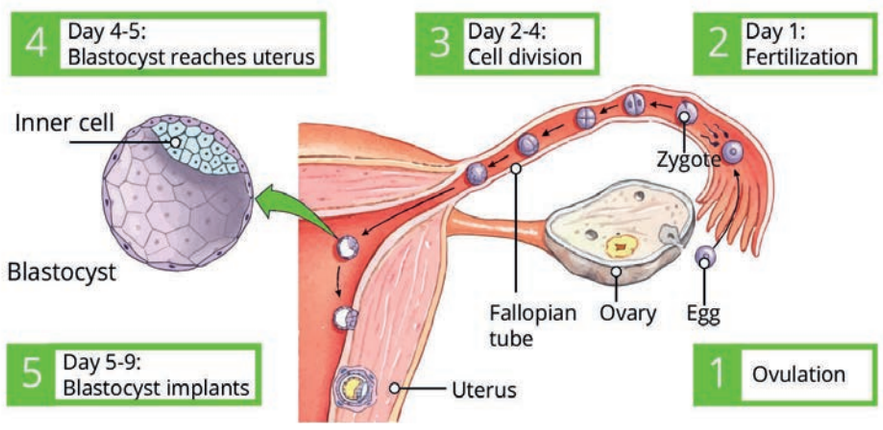



Figure 4.11 Ovulation

## 4.8 The Menstrual cycle

**Activity 4.10: Concept mapping**

Discuss the major changes during the menstrual cycle.

Also discuss the about importance menstrual hygiene and its health benefits. Preparations of menstrual hygiene materials from locally available resources.

**Objectives**

At the end of this section, the student will be able to:

- *Outline the phases of the menstrual cycle*

*What cyclic changes occur in the ovary and uterus?*

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 (flow Phase)**, 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 (Fig.4.12).

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.

**Activity 4.11: Home work**

Make internet search or ask a midwife nurse (Gynecologist) in your village (clinic) about menstrual cycle and the three phases of the cycle and, menstrual hygiene present your results your to classmates.

**Key Terms**

**Corpus luteum:** a structure that secretes the hormones estrogen and progesterone; progesterone causes changes to occur in the lining of the uterus that prepare it to receive a fertilized egg

**Flow phase:** The first phase of the menstrual cycle.

**Follicular phase:** The second phase of the menstrual cycle

**Luteal phase:** The third phase of the menstrual cycle

**Menstrual cycle:** the series of changes in the female reproductive cycle that occur each month, which include producing an egg and preparing the uterus for receiving the egg

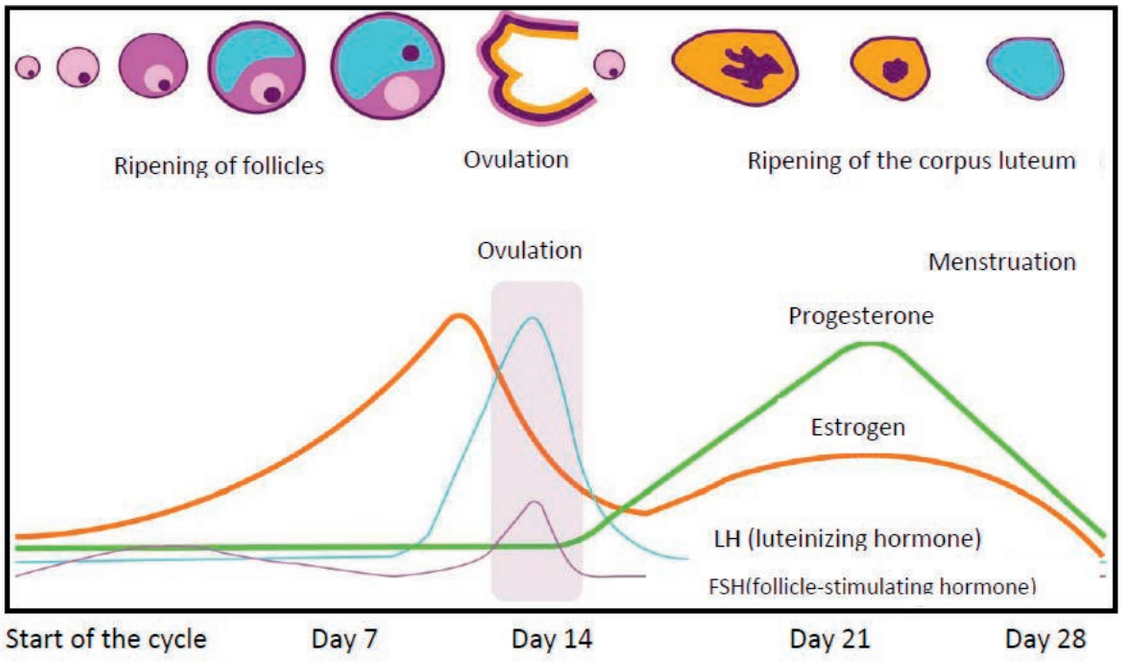



Figure4.12. Menstrual cycle

**Menstrual hygiene and health benefits**

These hygiene practices can help females stay healthy and comfortable during period:

- Wear lightweight, breathable clothing (such as cotton underwear). Tight fabrics can trap moisture and heat, allowing germs to thrive.
- Change menstrual products regularly. Trapped moisture provides a breeding ground for bacteria and fungi. Wearing a pad or period underwear for too long can lead to a rash or an infection.
- Keep genital area clean. Wash the outside of vagina day. In the bathroom, good to wipe from the front toward the back, not the other way. Use only water to rinse vulva. The vagina is a self-cleaning organ.
- Use unscented toilet paper, tampons, or pads. Scented hygiene products can irritate the skin and impact your natural pH balance.
- Drink enough liquids. This can help wash out your urinary tract and help prevent infections, like vaginal candidiasis.
- Track and monitor your period. Your menstrual cycle is a valuable marker for your overall health. Irregular periods can be a sign of conditions like diabetes, thyroid dysfunction, and celiac disease.
- Visit a healthcare provider for annual check-up. An annual full check-up includes a pap smear, a pelvic exam, and a breast exam. These exams are essential for good reproductive health as they can catch early signs of cancer or other health issues.

**Self Assessment 4.6**

1. What are the three phases of the menstrual cycle?
2. What is shed during menstrual flow?
3. What two female hormones are secreted by the corpus luteum?
4. Adolescent girls are more exposed for iron deficiency anemia.

## 4.9 Fertilization and pregnancy

**Activity 4.12 Jigsaw groups**

The union of an egg and a sperm results in a fertilized egg. This single cell must undergo many changes before it develops into a fetus. List the changes that you know occur in the developing embryo and fetus.

**Objectives**

At the end of this section, the student will be able to:

- *define mating, fertilization and pregnancy*
- *describe process of twin formation and types*

### Mating and fertilization

*What is 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.

*What is 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 (Fig.4.13). 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).

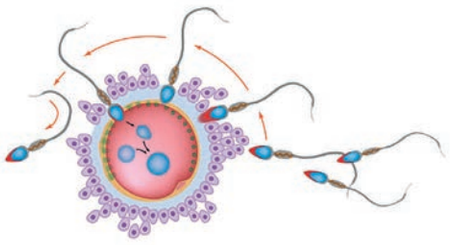


Figure 4.13. Fertilization

**Attention**

Neural tube defects (NTDs) are birth defects of the brain, spine, or spinal cord. It occurs when the neural tube does not close properly in very early within the first month of pregnancy. Women should take folic acid rich foods before and during pregnancy. Folic acid supplementation is recommended at least three months before pregnancy to prevent NTDs. Recommended to take folic acid rich foods, including folate supplement prior to pregnancy.

### Twins (Multiple births)

*How are twins formed?*

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.

## Pregnancy and development

*What is implantation?*

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 (Fig. 4.14), 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.

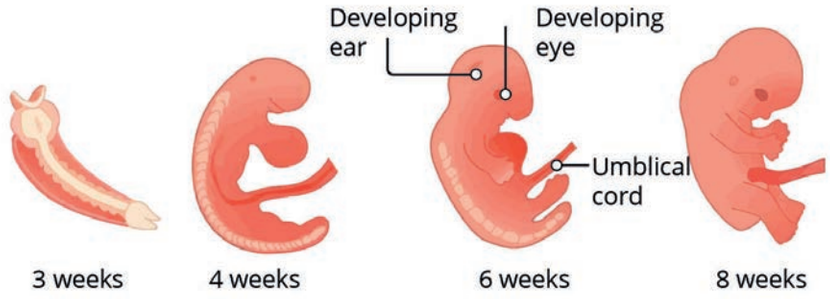



Figure 4.14 Human embryo developmental stages until week eight

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 4.15 shows the human embryo from 5 to 35 weeks surrounded by the amnion and placenta.

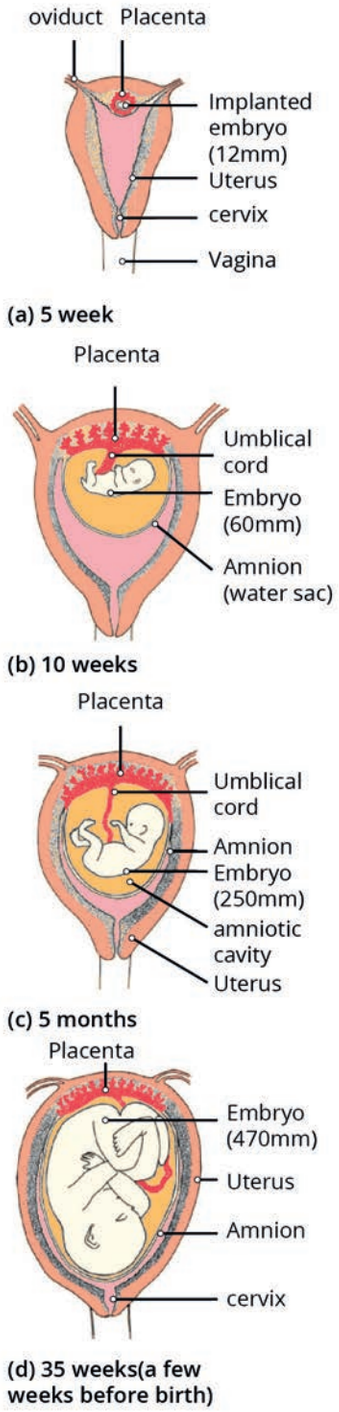



Figure 4.15 Growth and development in the uterus (5 to 35 weeks)

## 4.10 Methods of birth control

**Activity 4.13: Collaborative learning groups**

Contraception, the deliberate prevention of pregnancy, can be achieved in a number of ways. Some contraceptive methods prevent gamete development or release from female or male gonads; others prevent fertilization by keeping sperm and egg apart; and still, others prevent implantation of an embryo. Discuss methods of use, mechanisms of action; advantages and disadvantages; degree of effectiveness of different birth control methods.

**Objectives**

At the end of this section, the student will be able to:

- *discuss the methods of prevention of unwanted pregnancy*
- *explain the advantages and disadvantages of different birth control methods.*

*What can prevent unwanted pregnancy?*

As little as 4 weeks after giving birth, it is possible, though unlikely, that a woman may conceive again. Frequent breastfeeding may reduce the chances of conception. Nevertheless, it would be possible to have children at about 1-year intervals. Most people do not want, or cannot afford, to have as many children as this. All human communities, therefore, practice some form of birth control to space out births and limit the size of the family. Family planning methods could be natural or artificial.

• Some family planning methods such as condoms can help prevent the transmission of HIV and other sexually transmitted infections.

• Family planning /contraception reduce the need for abortion, especially unsafe abortion.

• Family planning reinforces people's rights to determine the number and spacing of their children.

• By preventing unintended pregnancy, family planning /contraception prevents deaths of mothers and children.

Benefits of family planning / contraception

- Preventing pregnancy-related health risks in women
- Reducing infant mortality
- Empowering people and enhancing education
- Reducing adolescent pregnancies
- Slowing population growth

### 4.10.1. 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.

- **Fertility Awareness/Natural Family Planning**

Fertility awareness methods rely on understanding the most likely time that ovulation will take place during the monthly cycle, so that intercourse is avoided, or a barrier method is used.

Fertility awareness methods include:

- Standard Days Methods
- Calendar Rhythm Method
- Symptothermal Method
- Ovulation Method

The effectiveness of fertility awareness methods range from 98% with perfect use to 78% with typical use. Although an important option for women worldwide, fertility awareness methods overall are less effective than other methods. Male partners must be continuously cooperative. Physiologic changes (that is recent childbirth, current breast-feeding, early menstruation, discontinuation of other hormonal methods, approaching menopause) can affect reliability.

**Withdrawal (Coitus Interruptus)**

The withdrawal method for pregnancy prevention refers to the moment a man pulls his penis out of his partner's vagina before ejaculation to avoid ejaculating the sperm. Preventing sperm from entering the vagina (and thus the uterus and fallopian tubes) and fertilising an ovum.

Effectiveness: In terms of pregnancy prevention, withdrawal effectiveness is similar to that of the male condom. Effectiveness is ninety six percent (96%) with perfect use and eighty percent (82%) with typical use. Consider back-up method such as emergency contraception if ejaculation begins before withdrawal.

Advantages

- Withdrawal requires no money, devices, hormones, or medical provider, making it available to anyone.

Disadvantages

- Provides no protection against sexually transmitted infections and HIV.
- Requires a great degree of self-control. For some men, it may be difficult to ensure that they withdraw before ejaculation has started.
- For some people, pleasure may be diminished by the interruption of sexual intercourse.

- **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.

### 4.10.2 Artificial methods of family planning (barrier methods)

**Activity 4.14: Survey/ Interviewing/ role play**

Make Internet search or ask a midwife nurse (Gynecologist) in your village (school clinic) about artificial methods of family planning methods. Alternatively, you could assign one of your classmate to act as midwife nurse (Gynecologist) and ask her/him about methods of use; advantages and disadvantages; degree of effectiveness of different birth control methods.

**Female Condom**

The female condom is a polyurethane sheath - one end is inserted into the vagina while the other remains outside of the vagina and provides some protection to the external genitalia. It contains a silicone lubricant. Additional lubricant is provided with each condom.

Effectiveness: Female condom effectiveness is ninety five percent (95%) with perfect use, and eighty percent (80%) with typical use.

Advantages: Dual protection against pregnancy, and STI/HIV, accessible without prescription, causes few medical side effects, some people find female condoms to be more comfortable and less constricting than male condoms, as they are wider.

Disadvantages: Coitus dependent, more expensive than male condoms, challenge to use in relationships with weak partner cooperation and/ or intimate partner violence

**Male Condom**

Male condoms are available in latex, lambskin, and polyurethane. All three materials effectively prevent pregnancy. Lambskin contains small pores that may permit the passage of bacteria and viruses. Thus they are not recommended for infection prevention.

Effectiveness: Male condom effectiveness is ninety eight percent (98%) with perfect use, and eighty five (85%) with typical use.

Advantages: Provides protection against both pregnancy and STI/HIV, widely accessible without a prescription, causes almost no medical side effects.

Disadvantages: Coitus dependent, reduced sensitivity for men however, this may be an advantage for preventing premature ejaculation, some men have difficulty maintaining erections, especially when they are inexperienced condom users, challenge to use in relationships where there is weak partner cooperation and/or intimate partner violence or coercion and latex allergy.

**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.

**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.

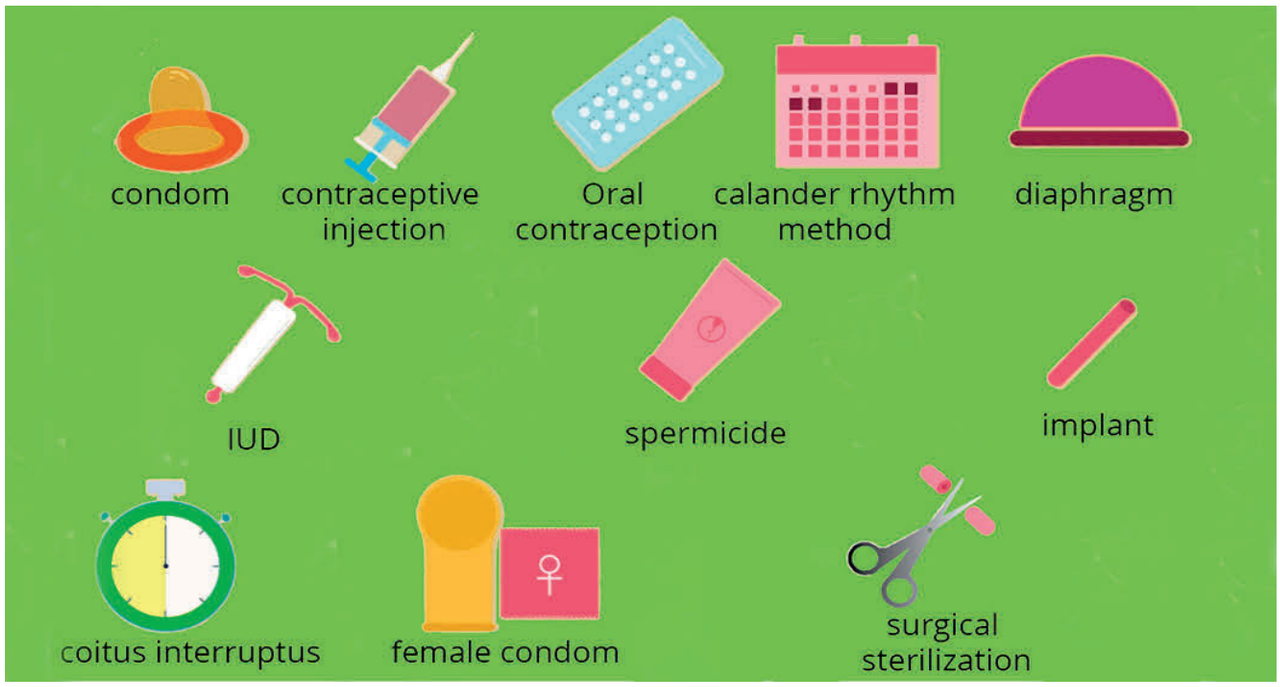



Figure 4.16 The different Contraceptive methods used by females and males

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.

**Self Assessment 4.7**

1. What are the disadvantages of diaphragm?
2. What are the disadvantages of vasectomy and laparotomy?
3. Why is abstinence important for the youth like you?

## 4.11 Sexually transmitted infections (STIs): Transmission and prevention

**Objectives**

At the end of this section, the student will be able to:

- *describe the types, modes of transmission and preventive mechanisms of sexually transmitted infection*

*What are causes and effects of common* ***sexually transmitted infections****,and how are they treated?*

Sexually transmitted infections are infections which spread through

**Activity 4.15: Inquiry and research projects**

Read books or search in Internet or ask a clinical nurse in your village (school clinic) about the most common sexually transmitted infectious in Ethiopia (e.g., HIV/AIDS, syphilis, gonorrhea, trichomoniasis and chancroid). Discuss causes, the modes transmission and methods of preventions.

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.

**Gonorrhea**

Is the second most common bacterial STI is caused by Neisseria gonorrhoeae. Men usually develop symptoms within one week of becoming infected; yellow pus oozes from the penis and urination becomes frequent and painful. By contrast, most women have no early symptoms. In both sexes an infection can damage reproductive ducts and cause sterility. Gonorrhea is treated with antibiotics, but strains resistant to the most widely used antibiotics are increasingly common. Gonorrhea could harms the joints and skin, but can also affect the heart and liver.

**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.

**Activity 4.16: Peer conferencing**

AIDS: Acquired Immune Deficiency Syndrome. The virus that causes AIDS is the human immunodeficiency virus (HIV). Discuss the transmission mechanisms of HIV; the different control method of the spread of AIDS and responsible sexual behavior and HIV/AIDS

## 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.

### Spread of HIV

The disease HIV is spread from an infected person through blood or body fluids. This can occur through direct contact with the infected blood or body fluids. It also can occur through contact with objects that have been contaminated by infected blood or body fluids. Intimate sexual contact and use of contaminated intravenous needles are known methods of disease transmission. HIV also can be transmitted by blood transfusion if the blood is contaminated. A pregnant woman who has HIV can transmit it to her fetus. The virus also can be transmitted through breast milk.

*What are the symptoms of AIDS?*

The first symptoms of AIDS may not appear for as many as ten years after a person is infected. During this time, the AIDS virus reproduces, infecting more and more immune cells. People infected with HIV may develop AIDS. Early symptoms of AIDS may include swollen lymph nodes, loss of appetite, weight loss, fever, rashes, night sweats, and fatigue. It is not known how many people who are infected with HIV will develop AIDS. AIDS weakens the body's immune system and the body cannot fight off other infectious diseases or certain forms of cancer.

### Prevention and control of HIV

Abstinence from intimate sexual contact protects against HIV and other sexually transmitted diseases. HIV transmission can be prevented among users of illegal drugs if they do not share needles. When AIDS first appeared, there were no effective drugs. Today, there is a range of drugs that can be given separately or as a 'cocktail', which slow the progress of the disease. Research to find a vaccine and more effective drugs is ongoing. There is a range of blood tests designed to detect HIV infection. These tests do not detect the virus but do indicate whether antibodies to the virus are in the blood. If HIV antibodies are present, the person is said to be HIV positive. The tests vary in their reliability and some are too expensive for widespread use.

### 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.

**Self Assessment 4.8**

1. What are the common sexually transmitted infections in Ethiopia? How do we control them?

## Unit review

- Reproduction is one of the ubiquitous properties 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.
- Asexual reproduction is the process resulting in the production of genetically identical offspring from one parent. It occurs without gametes or fertilization.
- The basic forms of asexual reproduction are fission (binary and multiple), budding, and fragmentation.
- Many flowering plants reproduce asexually by vegetative propagation. The stolon of the strawberry plant is a horizontal stem that grows above the ground, takes root at the nodes and produces new plants. Rhizomes, corms, bulbs and tap root may store food, which is used to accelerate early growth.
- Sexual reproduction is the process involving the fusion of the nuclei of two gametes to form a zygote and the production of offspring that are different from each other. The male gamete is small and mobile. The female gamete is larger and not often mobile. The female gamete of an animal is an egg.
- Fertilization is the fusion of gamete nuclei. Fertilization happens when a sperm enters an ovum and the sperm and egg nuclei join up (fuse).The fertilized egg (zygote) divides into many cells and becomes embedded in the lining of the uterus. Here it grows into an embryo.
- 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.
- 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.
- 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.
- Young people must adjust to remarkable physiological, anatomical, and psychological transformations during the process of puberty.
- Young people should realize that there is considerable variation in the timing of the stages of puberty among different individuals, and that most people develop into “normal” adults in the course of their sexual and physical maturation.
- Adolescence is the period between puberty and adulthood, when a good deal of social learning takes place.
- Biologically, teenagers are adult after they have reached puberty, when they are capable of having children.
- Economically, they are adult when they can support themselves and possibly a family.
- Morally, they are adult when they are responsible for their actions, can express love in a mature manner, and can have productive and meaningful relationships.

- During adolescence, teenagers must achieve economic and moral adulthood; deal with separation from family,
- Human testes reside within a scrotum. They produce sperm and testosterone. Sperm form continually from germ cells inside the testes' seminiferous tubules. The sperm mature in an epididymis that opens into a vas deferens.
- Secretions from the seminal vesicles and prostate gland join with sperm to form semen. Semen is expelled from the body through the urethra that runs through the penis.
- Human ovaries produce eggs and sex hormones. An oviduct conveys an egg to the uterus. The cervix of the uterus opens into the vagina, which serves as the organ of intercourse and the birth canal.
- Pituitary release follicle stimulating hormone (FSH) and luteinizing hormone (LH).
- FSH causes an ovarian follicle to begin maturing. Follicle cells around an egg, which formed before birth, proliferate and secrete estrogens and progesterone.
- LH triggers ovulation of the egg. After ovulation, the corpus luteum secretes progesterone that primes the uterus for pregnancy. When the corpus luteum breaks down, menstruation occurs.
- The ovarian cycle is coordinated with cyclic changes in the uterus. We refer to the approximately monthly changes in the uterus as the menstrual cycle.
- Spermenters the cytoplasm of the egg and the male nucleus of the sperm fuses with the female nucleus. This is the moment of fertilization.
- 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.
- Soon after the ball of cells reaches the uterus, some of the cells, instead of forming the organs of the embryo, grow into a disc-like structure, 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.
- Sexual intercourse can pass protozoan, bacterial and viral pathogens between partners. The consequences of a STIs range from mild discomfort to sterility and systemic disease.
- Protozoan and bacterial STIs can be cured with antibiotics, but there are no drugs to cure viral STIs.
- There are natural and artificial methods birth control methods. Abstaining from sex is the effective method with added advantage of preventing exposure to sexually transmissible pathogens.
- Artificial methods of family planning barrier methods includes sheath or condom, diaphragm, femidom, spermicides, intra-uterine device (IUD), intra-uterine system (IUS), contraceptive pill, contraceptive implant, contraceptive injection, vasectomy and laparotomy.

## Review Questions

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

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

**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 advantage 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. Is fertilization likely to occur if mating takes place:
   a. 2 days before ovulation
   b. 2 days after ovulation
5. Define, and distinguish among, the terms fission, fragmentation, parthenogenesis, budding and vegetative propagation.
6. 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?
7. Explain how the female hormones FSH, LH, and estrogen interact during the menstrual cycle to induce ovulation and, subsequently, formation of the corpus luteum.
8. What are the male sex hormones and what are their functions?
9. One of the first signs of pregnancy is that the menstrual periods stop. Explain why you would expect this.
10. What are causes and effects of common STIs, and how are they treated?
11. Describe, and distinguish among, the birth control methods - vasectomy, diaphragm, contraceptive pill, spermicides and laparotomy.
12. 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.
13. 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 | | |

# Unit 5: Human Health, Nutrition, and Disease

| Contents | Learning competencies |
|---|---|
| 5.1 What is food?<br>5.2 Nutrition<br>5.3 Nutrients<br>5.4 Balanced diet<br>5.5 Deficiency diseases<br>5.6 Malnutrition<br>5.7 Substance abuse<br>5.8 Types of diseases<br>5.8.1. Infectious diseases<br>5.8.2. Non-infectious diseases<br>5.9 Renowned Nutritionists in Ethiopia | • Define nutrition<br>• List the types of nutrients<br>• Describe the role of a balanced diet especially for children, nursing mothers, athletes, and people with HIV/AIDS<br>• Describe with examples the sources and deficiency diseases of vitamins and minerals.<br>• Define malnutrition<br>• Discuss the feeding habits that may lead to obesity<br>• Examine the effects of smoking, alcohol use, chewing khat, cannabis, and other drug use, on the health, social, economic, cultural, and psychological wellbeing<br>• Explain the modes of transmission and prevention of infectious and noninfectious diseases<br>• List and appreciate renowned nutritionists in Ethiopia |

## 5.1. What is food?

**Objectives**

At the end of this section, the student will be able to:

- *Explain about 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.

**Activity 5.1: Think-pair-share**

Discuss with your friend next to you and share your idea with the other classmates.

1.How food is important for living things like us?

2.What would happen if someone don't eat food?

3.Relate the importance of food with the particular type of food we eat. For example eating bread

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

**Objectives**

At the end of this section, the student will be able to:

- *Explain about 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

**Objectives**

At the end of this section, the student will be able to:

- *list important nutrients*
- *explain about the importance nutrients and their deficiency*

**Activity 5.2: Group work**

I. What is difference between nutrition and nutrients?

II. Explain the function of food

**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 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.

An unavailable or indigestible carbohydrate provides dietary fiber that does not serve as a source of energy. This indigestible part is a product of plant's cell walls that consists mainly of cellulose. Human body does not have any enzymes for the digestion of this cellulose. Therefore, the plant cell walls reach the large intestine (colon) without being digested. This undigested part of the diet is called fiber or roughage. The colon contains many bacteria that can digest some of the substances in the plant cell walls to form fatty acids.

The fibre and the bacteria, which multiply from feeding on it, add bulk to the contents of the colon and help it to recollect water. This softens the feces and reduces the time needed for the undigested residues to pass out of the body. Both effects help to prevent constipation and keep the colon healthy and increase bowel movement. It is found in vegetables, fruits, and grains.

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. 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

**Attention**

The energy produced from the raw materials is usually measured in units known as calories; one calorie is the amount of energy needed to raise the temperature of 1 g or cubic centimeter (cc) of water in 1°C. The calorie units usually referred to in biology and nutrition are kilogram-calories (Kcal); each is 1,000 gram-calories.

**Activity 5.3: Home work**

Referee to biology books in the library or search from the internet in order to list example food that belong to fructose, sucrose, starch etc.

In which group of carbohydrate do honey and table sugar belong?

starch. In addition it stored in animals as glycogen. 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.

**Activity 5.4: Think-pair-share**

Compare the amount energy obtained from one gram of carbohydrate and the same amount of lipid. Discuss with your friend next to you and share your idea with the other classmates.

**Table 5.1: 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 carbohydrate); insulation against heat loss; some hormones; cell membranes; insulation of nerve fiber |
| Protein | Meat, fish, eggs, soya, groundnuts, milk | Growth; tissue repair; enzymes; some hormones; 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.

**Activity 5. 5: Group work**

Make a group each of with four or five students and have a discussion on:

I. List some foods, which are the source of minerals and vitamins.

II. Think about the types of food you ate in the past 24 hours, construct a table similar to that of table 5.1. and classify the foods you ate accordingly. Was it a balanced diet? If not, What do you propose it should be?

**Activity 5. 6: Group work**

Use reference books or your text book to fill the following table

| Nutrient | Sources | Use in the body | Deficiency disease |
|---|---|---|---|
| Vitamin C | | | |
| Vitamin D | | | |
| Vitamin A | | | |
| Iron | | | |
| Iodine | | | |
| Calcium | | | |

**Key Terms**

**Nutrients**: are chemical substance found in food and used by the human body for growth, or to provide energy.

**Carbohydrates:** are types of nutrients that provide energy for the human body. One gram of carbohydrate can provide, on average, 16 kilojoules (kJ) of energy while

**Fats and oils: t**ypes of nutrients divided into fats (solid at room temperature) and oil (liquid at room temperature). One gram of lipid gives 37 kJ of energy.

**Proteins:** are nutrients used for growth of the body and build a new cell. It can also provide energy. One gram of protein can provide 17 kJ of energy.

**Vitamins**: are nutrients that are essential in small quantities for human body. They are organic substances needed for chemical reactions inhuman cells. The major vitamins are: Vitamin A, vitamin B, Vitamin D, Vitamin C

**Minerals**: are inorganic substances, which are essential in small quantities. The major minerals are Calcium, Iron, phosphorous and Iron.

**Fiber:** is the indigestible part of the vegetables and other plant material, prevent constipation and keep the colon healthy.

## 5.4. Balanced diets

**Objectives**

At the end of this section, the student will be able to:

- *explain the meaning of balanced diet*
- *list types of food which make a balanced diet*

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.


Figure 5.1. 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.


Figure 5.2. Balanced diet

**Key Terms**

**Diet**: the food that you eat

**Balanced diet:** the diet that contains all of the nutrients in the correct amount and proportion

**Deficiency disease:** disease occurs when a person does not have enough amount of one particular nutrient and suffers health problems.

**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.

**Activity 5.7: Think – Pair – Share**

Discuss with a friend next to you and share your idea with the other classmates. Do you think that that our body needs energy when we are resting, such as lying on our bed?

If your answer is yes, why do we need food when we lying on our bed?

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.

**Table 5.2: Energy requirement by the body depends on age, sex, activities and lifestyles**

| Different groups of human | Energy used in a day/kilocalories | |
|---|---|---|
| | Male | Female |
| 8-year-old child | 2031 | 2031 |
| Teenager, aged 14 | 2987 | 2318 |
| Adult office worker | 2629 | 2342 |
| Adult manual worker | 3585 | 2987 |
| Pregnant woman | | 2390 |
| Breast-feeding mother | | 2748 |

**Activity 5.8: Group work**

Make a group of four or five students and:

Compare the daily energy requirements of the people shown in table 5.2 and explain what makes the differences in their energy requirement.

## 5.5 Deficiency diseases

**Objectives**

At the end of this section, the student will be able to:

- *explain the meaning of deficiency disease*
- *list the main deficiency diseases caused by different diets*
- *identify different diet as a source balanced diet*

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.

**Marasmus**

Marasmus is a deficiency disease caused by inadequate carbohydrate content in the human body. Like kwashiorkor, the incidence of ma rasmus 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.

**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.

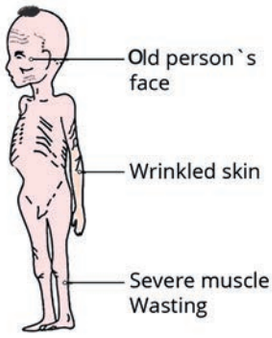



Figure 5.4. child suffering from Marasmus

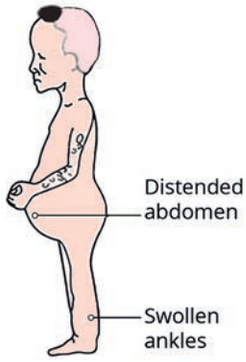



Figure 5.5. Child suffering from Kwashior

**Attention**

The term 'marasmus' is a Greek word, meaning decay.

**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 haemoglobin if the amount of iron in the blood is insufficient. Less haemoglobin 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.

**Activity 5.9: Think-pair-share**

Discuss with your friend next to you and share your idea with the other classmates.

i. What is the function of vitamin D in the human body?

ii. What is the main source of vitamin D?

**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

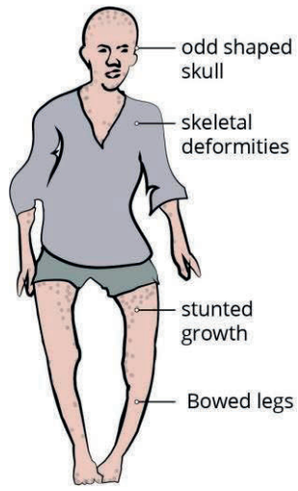



Figure 5.6. Child suffering from rickets

is the only vitamin that the human body can make upon exposure of the skin to morning and evening 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.

**Scurvy**

Scurvy is a deficiency disease caused by a lack of vitamin C (ascorbic acid). This deficiency disease occurs when fibres 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.

Figure 5.6. an individual suffering from scurvy

**Table 5.3: 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

**Objectives**

At the end of this section, the student will be able to:

- *explain the meaning of malnutrition*
- *differentiate problems relating to malnutrition*
- *discuss how stunting, wasting, underweight and micro-nutrient deficiency*
- *explain what cause obesity*
- *explain about body mass index (BMI)*

**Activity 5.10: Think-pair-share**

Discuss with your friend next to you and share your idea with the other classmate.

Sometimes a person can eat a lot of food, can this cause 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. Malnutrition causes tissue damage, growth retardation, disorderly differentiation, reduce developing of children's brain including negative behavioural issues which can cause poor intellectual capacity, class repetition, reduce productivity.

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.

**Key Terms**

**Malnutrition**: the insufficient, excessive or imbalanced consumption of nutrients, which leads to health problems.

**Wasting** : low weight for hight

**Stunting**; low height for age

**Underweight**: low weight for age

**Obesity**: can be caused by a high intake of fatty foods, foods containing a lot of added sugar plus the effects of too little exercise.

**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.

In order to prevent malnutrition, it is better to

- Consume diverse and nutrient dense food,
- avoid junk foods and sugary foods,
- do regular physical exercise, etc.

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.

People who are overweight and obese are at high risk to have health problems such as, heart disease, high blood pressure, diabetes and arthritis (worn joints).

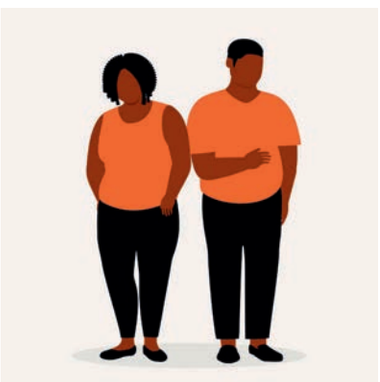


Fig 5.7 Persons with obesity

**Activity 5.11: Group work**

Make a group, each with four or five students and discuss in group about:

Which of the following activities may cause or may not cause obesity?

Why does it may or may not cause obesity?

i. Sitting and watch TV

ii. Playing football in the field

iii. Playing computer games

iv. Going to school by Walking

v. Going to school by taxi

vi. Eating breakfast with high fats and sugars contents

**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

**Attention**

There are two ways in which people can identify being obese:

- being 20% above the recommended weight for his or her height
- having a body mass index (BMI) greater than 30. Body mass index = body mass (kg) / height2 (metres2)

*A person with a BMI Status below 18.5 is underweight,18.5–24.9 normal weight,25.0–29.9 overweight, 30.0 and above obese.*

Adolphe Quetelet, a Belgian statistician and scientist, developed BMI in the 19th century. He based the formula on measurements of thousands of soldiers. It provided a useful guide to check on a healthy body mass, but it may not tell the whole story. Fitness training builds up larger muscles, which weigh more than fat and can make the BMI of a very high therefore, athlete with a large frame appear in the 'overweight' category.

**Activity 5.12: Class work / Individual assignment**

1. Calculate the BMI of a person who has a body mass of 80 kg and he is 1.85m tall. Is he/she likely to be obese?

If yes why?

2. Form a group of 5-7 students and go to nearby health facility, measure your weight and height, calculate your body mass index and compare it with your age then present to the students/ class

## 5.7. Substance abuse

**Objectives**

At the end of this section, the student will be able to:

- *describe the effects of tar and carcinogens in tobacco smoke on the gas exchange system*
- *describe the short-term effects of nicotine and carbon monoxide on the cardiovascular system*
- *explain the social and psychological effect of chewing Khat*
- *discuss the consequences of doping.*

**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 a 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).

*Can drugs be found in our food?*

Drugs are present in many food products such as: tea, coffee, energy drinks and alcoholic drinks. Though they have many useful medicinal

**Activity 5.13: Think-pair-share**

Discuss with your friend next to you and share your idea with the other classmate.

i. What are drugs?

ii. List some drugs which have medicinal value

iii. Can we get drugs from food ? if your answer is yes list some of them

iv. List some stimulant drugs which are taken for recreational purpose.

properties their stimulant properties can produce caffeine, a nasty condition that can readily addict.

*What is substance abuse?*

Substance abuse is using legal or illegal drugs (substances) in the wrong way or in the excess amount. Some of the drugs are medical drugs taken legally to reduce a symptom and pain of diseases. These drugs designed to suppress pain, treat and cure diseases. In addition to medical substances, other legal substances are present in many products such as:

- tea, coffee and 'energy drinks' (caffeine)
- tobacco(nicotine)
- alcoholic drinks (alcohol)

Although these substances are legal, they can cause serious effects when taken excessively or over long periods of time.

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**

**Activity 5.14: Group work**

Make a group of four or five students and make a discussion on some of the common smokers reaction or their habits during 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.

i. **Tar**

**Attention**

Currently, The smoking of a flavored tobacco called shisha has become fashionable among young people. However, the social, economic and psychological effect of shisha is similar to that of ordinary cigarette.

Tar is the black sticky substance found in cigarette that collects in the lungs when the smoke cools. The health effect of tar can be chronic bronchitis, lung cancer etc.

**Chronic bronchitis**

When people smoke cigarette, the chemical substance called tar accumulates in the bronchioles. Tar irritates the lining of the bronchioles and stimulates the production of excess mucus. The function of cilia in our lung is to remove dust, dirty and excess mucus from the lining of lungs. However, when cilia damaged by smoking, it will be difficult for cilia to remove the excess mucus and dirt. This leads to the collection of dirt, bacteria and viruses that block the

bronchioles. This stimulates smoker's to cough which is an effort to move the mucus, the bronchioles and bronchi becomes thicker. This thickening of the bronchioles causes them to narrow and makes it difficult to breathe, this leads to infections such as pneumonia. This damage and obstruction of the airways is chronic bronchitis.

In addition, there are different chemical compounds in tar such as carcinogen (produce cancer) compounds. Cancer starts because of the changes in the epithelial cells of the lungs that lead to the development of a mass of cells, known as a tumor. It is this tumor which results in cancer.

**Emphysema**

Smokers usually have weakened alveoli wall because of the above action of tar that result in coughing. During coughing, some of the weakened alveoli burst. Then the amount of alveoli decrease as well as absorbing surface of the lungs is greatly reduced. Then the smoker cannot oxygenate his or her blood properly and the least exertion makes the person breathless and exhausted. Bronchioles collapse during expiration, trapping air in the alveoli, which often burst. This condition is called emphysema.

**ii. Carbon monoxide**

Carbon monoxide is a poisonous gas found in cigarette. During cigarette smoking, the carbon monoxide enters to lung. This carbon monoxide diffuses across the walls of the alveoli and diffuses into red blood cells where it combines with haemoglobin to form the compound carboxy- haemoglobin.

The carbon monoxide combines permanently with hemoglobin. Then no more oxygen is carried by hemoglobin that results in the reduction of the volume of oxygen in blood. Therefore, less oxygen is supplied to the heart. In this case, the heart beat increases to get more oxygen. Carbon monoxide may also damage the lining of the blood vessels. In this case, smokers put the health of their cardiovascular system at risk. The damaging of the walls of arteries may lead to the build-up of fatty tissue and the reduction of blood flow. This may result coronary heart disease (CHD) and stroke. These diseases are a major cause of death and disability in the world.

**iii. Nicotine**

Nicotine is a compound found in cigarette. It is a stimulating and relaxing compound which has a molecular structure that allows it to interact with our nervous system. In addition to its stimulating effect, nicotine is a compound which produce addiction.

When people smoke cigarettes, nicotine from cigarette is absorbed

**Activity 5.15: Think-pair-share**

Discuss with your friend next to you and share your idea with the other classmate.

I. What is the function of hemoglobin?

II. How does carbon monoxide reduce amount of oxygen in smokers lung?

through the alveoli to enter the Blood stream. Then it is able to go to the brain through blood circulation.

In the brain, nicotine activates the release of dopamine. Dopamine is the natural neurotransmitter substance associated with our experience of pleasure. Long-term exposure to nicotine eventually comes to have the reverse effect, actually depressing the ability to experience pleasure. So more nicotine is needed to 'satisfy', and cigarettes become addictive. Smokers find it increasingly hard to quit the habit.

Nicotine also increases the heart rate and blood pressure. It narrows the arterioles, which increases blood pressure. It decreases the blood flow, particularly in the hands and feet, and it makes blood clotting more likely. It also increases the stickiness of blood platelets that promote blood clotting.

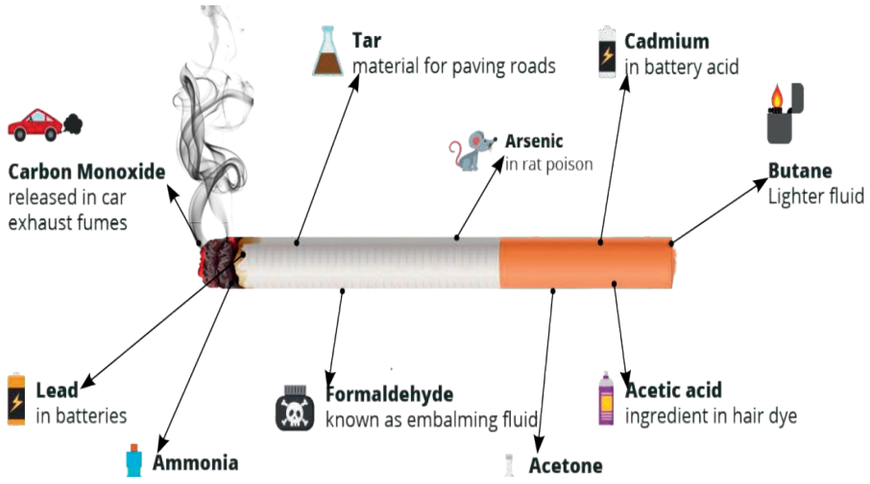



Figure 5.8 Substances in tobacco smoke

**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.

To decreases the risk of alcohol-related harms, the World health organization identifies a standard drink as having 10 grams of pure ethanol. It recommended no more than two drinks per day on average for both men and women.

Alcohol is a depressant. It affects the brain by slowing down the transmission of nerve impulses. Consuming larger quantities of alcohol leads to:

**Attention**

The breaking down of alcohol by liver enzyme happens more quickly in men than in women because men have more of these enzymes and their enzymes tend to be more active. They also have more water and less fat in their bodies than women do, which tends to cause the concentration of alcohol in the blood to decrease more quickly.

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

**Activity 5.16: Group work**

Discuss with your friend next to you and share your idea with the other classmate.

What is the common reaction of alcohol drunken man?

Why is everybody discouraged from drinking particularly when driving?

**Alcohol drink and addiction**

Some people become dependent upon alcohol and they are referred to as alcoholics. They feel tense and irritable. It is hard to cope with everyday problems without drinking they develop a tolerance as more enzymes that metabolize alcohol are made in the liver. They therefore need to take greater quantities of alcohol to get the same effect. Alcoholics can cause their families pain and unhappiness. They can become aggressive after drinking and spend a lot of money on drink. There are also other social problems such as crime, family disputes, marital breakdown, child neglect and abuse, absenteeism from work, vandalism, assault and violent crime including murder.

**Long-term effects of alcohol**

Drinking large quantities of alcohol over a number of years can lead to stomach ulcers, heart disease and brain dam- age. In addition, large amount of alcohol damage the liver tissue and replaced by scar tissue known as cirrhosis. This condition may leads to death unless the person stops drinking.

**Attention**

The liver is the site of the breakdown of alcohol and other toxins. Drugs are broken down in the body by enzymes and the products are excreted. The breakdown products can be detected in the urine, and this is why urine tests are carried out to see if people have been taking drugs. Athletes taking part in competitions and car drivers who have been in accidents are routinely tested for drugs.

**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 provide 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

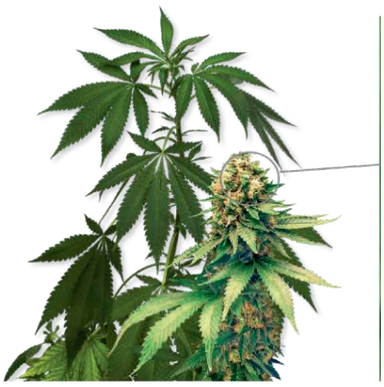


Figure 5.9 Cannabis

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 Tetrahydrocannabinol (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.

**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.

Figure 5.10. Khat

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.

Although khat can be ingested as an infusion or smoked, the most common route of administration is to chew the fresh plant. The juice of the masticated material is swallowed, while the residues are spat out. In some places, teas from dried leaves are also consumed.

Ethiopia is one of the country where large number of people with the habit of chewing chat. In the previous years, it was mainly cultivated in eastern part of the country. However, currently, it is grown and consumed in all parts of the country.

This current increment in khat consumption brings socio-economic, psychological and physical health consequence on the individuals involved. Chewing khat induce a state of joy and feelings of increased alertness and stimulation. At the end its consequence results in a depressed mood, irritability, loss of appetite, gastritis and peptic ulcer, disease and difficulty sleeping. In addition, the habit of chewing khat leads to some social problems like family fragment, multiple sexual practices and the spread of sexually transmitted infections (STIs) due to unprotected sex. Early initiation of sexual activity was also reported

**Activity 5.17: Group work**

1. Make a group of four or five students and make a discussion on some of the social, economic and behavioral problems of chewing chat.

2. What are the common reactions of a person after chewing chat? Why ?

among Khat chewers.

**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.

*Why is doping such a big deal?*

The most important reason doping is a big deal is the fact that many of these substances can have harmful and long-lasting side effects which may include :

**Cardiovascular**: irregular heart rhythm, elevated blood pressure, heart attack, sudden death.

**Central Nervous System:** insomnia, anxiousness, depression, aggressive behavior, suicide, headache, addiction with withdrawal, psychosis, tremor, dizziness, stroke

**Respiratory**: nose bleeds, sinusitis

**Hormonal**: infertility, gynecomastia (enlarged breasts), decreased testicular size, low sex drive, acromegaly (coarse bones in face, hands, and feet), cancer

The second issue is more of a moral dilemma. These banned substances are used to gain an unfair advantage which significantly diminishes the spirit of competition.

The World Anti-Doping Agency (WADA), has a program which has a purpose, to protect the athletes' fundamental right to participate in doping-free sport and thus promote health, fairness and equality for athletes worldwide.

*What substances are banned from use?*

Some drugs are banned both in and out of competition due to their performance enhancing properties, while others are only banned during competition. Another reason for banning a drug is due to their ability to mask the presence of a different banned drug during testing.

In general, the following classes of drugs are banned: Street drugs, stimulants, anabolic steroids, peptide hormones (i.e. human growth

**Activity 5.18: Group work**

Make a group of four or five students and make a discussion on:

1. All athletes test their blood and urine before the athletics competition. Why?
2. Have you heard about doping? If yes, discuss its meaning.

**Attention**

The word doping is probably derived from the Dutch word dop, the name of an alcoholic beverage made of grape skins used by Zulu warriors in order to enhance their prowess in battle.

**Key Terms**

**Drugs**: refers to any substance taken into the body that modifies or affects chemical reactions in the body.

**Heroin** is a powerful depressant affecting the nervous system. It is taken into the body in the form of injection. People often share needles for injection. Sharing needles can result in infections such as HIV/ AIDS

**Nicotine**: it is also a stimulant, it increases pulse rate and narrows blood vessels which can cause damage

**Emphysema**: walls between alveoli break making large sacs, reducing surface area massively and making difficult to breathe.

**Carbon monoxide:** irreversibly bonds with hemoglobin which can lead to oxygen starvation

**Cannabis**: stimulant or psychoactive component called Tetrahydrocannabinol (THC)

**Cathinone** ; a chemical compound found in Khat which affects central nervous system (CNS).

**Doping** is the use of prohibited medications, drugs, or treatments in competitive sports.

hormone [hGH]), alcohol and beta blockers (for archery and rifle shooting only), diuretics, beta-2 agonists, anti-estrogens, blood doping, and gene manipulation.

**Prohibited list:** some drugs are listed on Prohibited list which is the document identifying the substances and methods that are prohibited in competition, out of competition, and in particular sports.

The criteria for adding a substance to the prohibited list are:- Must meet any 2 of the following 3 criteria:

- It has the potential to enhance or enhances sport performance;
- It represents an actual or potential health risk to the athlete;
- It violates the Spirit of Sport.

Substances & methods prohibited at all times: all prohibited substances in this class are non-specified substances anabolic agents are prohibited, ptide hormones, growth factors, related substances, and mimetics, growth factors and growth factor modulators, beta-2 agonists, hormone and metabolic modulators, diuretics And gene doping, masking agents, blood doping, Substances & methods prohibited in competition: Stimulants, narcotics, cannabinoids, glucocorticoids

**Prohibited in particular sports:- Beta-blockers**

For athletes who need a banned drug for legitimate medical reasons, the anti-doping programs offer a way to request a therapeutic use of exemption (TUE) so the athlete can use the drug. The athlete must have a physician complete a TUE form that states the athlete needs the drug to treat their medical condition and that an alternative non-banned drug is not available or insufficiently treats their condition. The TUE is reviewed by a medical committee, which either allows the athlete to take the drug or denies the athlete's request.

**Doping Consequences**

**1. Physical and Mental Health: -** Physical health: depending on the substance, the dosage, and the consumption frequency, doping products may have particularly negative side effects on health. Some damages to the body are irreversible and may lead the athlete's life to be in great danger. The following section will outline the possible health consequences and sports benefits to using certain groups of doping substances.

**Steroids**: General side effects:

- Increased risk of liver disease
- Increased risk of cardiovascular disease
- High blood pressure

- Acne
- Baldness

**In Males:** Shrinking testicles, sexual side effects (reduced sperm production, impotence, libido disorders) Breast growth

**In Females:** Deepening of voice Excessive hair growth on face & body abnormal menstrual cycles

Enlarged clitoris

**Erythropoietin (EPO)**

Increased blood viscosity (thickness/stickiness)

- Pulmonary embolism
- Increased risk of heart attack and stroke
- General weakness
- High blood pressure

**Human Growth Hormone**

- Severe headaches
- Loss of vision
- High blood pressure and heart failure
- Diabetes and tumors
- Crippling arthritis
- Irreversible acromegaly
- Enlargement of the hands & feet
- Protruding forehead, brow, skull & jaw
- Heart enlargement
- Water retention
- Liver and thyroid damage

**2. Psychological health-** Some doping substances may not be detrimental to the body but exercise an impact on mental health. It has been scientifically evidenced that anxiety, obsessive disorders, or psychosis are direct consequences of doping.

- Psychological dependence
- Increased aggression
- Mood swings

**3. Social consequences-** The existence of an athlete who was held guilty of doping may be completely disrupted. Indeed, doping may represent a danger to health, but it may also be prejudicial to fame, respect, and creditworthiness. Even in the future negative findings are regularly questioned by the media and the entourage. The poor image will remain in the collective unconscious and the athlete could remain isolated.

**4. Financial consequences:-** As regards high-performance sports, an infringement of anti-doping rules often leads to a loss of income, the reimbursement of prize money, and of sponsorship money. An athlete suspended for several years, or even life-banned, cannot earn his/her living as usual and can be forced countries loss foreign treasures from athletes even banned countries from any sport competition in the world.

5. **Sporting consequences:-** A doping violation may mean loss of results, rankings, medals, and qualification places at events. It could also have an impact on members of a team causing medals to be lost a day-to-day basis.

**6. Legal consequences**:- Doping may have major legal consequences. A doped athlete may be suspended, i.e., he/she may not take part in a sports competition on or in organized training sessions.

**Problems of using drugs**

Peoples start using substances because of different reasons. Some people taking substances for stimulation, some for recreational value, and others use it because of the pressure from other people. Whatever the reason, the effect is almost similar among all the users. When substance users first start taking a substance, users may think they can control how much they use. However, when time passes, they may want more of the drug to get the same feeling or effect. Over time some people can reaches beyond abuse to addiction. Addiction can produce health, social, economic and cultural problems. Some of the problems that drug users faced are:

» Eat more or less than normal
» Change their friends a lot
» Stop taking care of themselves
» Sleep at unusual hours
» Lack concern in things they used to love
» Have problems at work or with family
» Spend more time alone than they used to
» Switch quickly from feeling good to bad
» Financial problems – stealing, loss of job
» Strong desire to use the substance
» difficulty to keep a job,
» family breakdown and homelessness, tendency to avoid friends and families,
» Preferring the company of other addicts, and so they become isolated from the society

*How people recover from drug addiction?*

Addictions are treatable. With the right plan and resources, recovery

is possible. The following are important steps in recovering.

Anyone who is addicted for any drug should admit to his friends, and to himself, that he has a problem.

- Find support from others.
- Rewrite daily routine.
- Enjoy the small successes.
- Recognize and avoid relapse.
- Reach freedom, and stay there

## 5.8. Infectious and noninfectious diseases

**Objectives**

At the end of this section, the student will be able to:

- *identify infectious and non-infectious diseases*
- *list the major infectious diseases*
- *explain about modes of transmission and prevention of infectious diseases*
- *explain about COVID-19*

**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.

**Activity 5.19: Group work**

Make a group of four or five students and discuss about

i. The difference between infectious and non-infectious diseases

ii. List two infectious and non-infectious diseases.

iii. List some diseases that occur in your surrounding and arrange them in the following table.

| Name of the disease | Infectious | Non infectious | causes |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |

### 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.

**Attention**

**Endemic**: This disease is occurring when disease-causing agent exists permanently in specific place or population, For example malaria is endemic in Afar region.

**Epidemics** are diseases that occur suddenly and then spread in a specific area or within a specific population group, For example, in 2015 Ebola was epidemic in west Africa.

**Pandemic** is an epidemic that spreads far more widely throughout the whole world. It affects a huge number of people. Example COVID-19

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 favour 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 into covered bins and collected at regular intervals.

6. 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.

**Activity 5.20: Think – Pair – Share**

Discuss with your friend next to you and share your idea with the other classmate.

Explain the difference between being HIV-positive and having AIDS

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.

**Transmission of HIV- AIDS**

HIV can be passed from one person to another by direct exchange of body fluids such as:

- Fluid transfer from one person to another during sexual intercourse
- Blood transfusion from one person to another, during blood donation
- Sharing needles in intravenous drug users
- Mother to fetus across placenta, more often, through the mixing of blood during birth
- Mother to infant in breast milk

**Prevention and control of HIV-AIDS**

There are no cure drug for HIV-AIDS and no vaccine for HIV, therefore it is very important to prevent this disease by the following methods.

**Attention**

T- Lymphocyte cells (Immune cells) have another name called T-helper cells that defend our body from infection. Opportunistic diseases: disease caused by different disease causing organisms that occurs when the body diseases resistance mechanism.

Retroviral drugs are drugs that are used to stop or reduce viral replication in human, but they don't kill the virus.

- All blood should be tested before transfusions in activity of blood donation
- Needles used by intravenous should be sterile and used only once.
- People should avoid multiple sexual activity
- Using condoms, If condom is properly used, it can pre-vent the virus transmission from carrier to healthy per-son
- HIV-positive mother should be treated with appropriate retroviral drugs. These retro-viral drugs can also significantly increase the length of time between a person be-coming infected with HIV and developing symptoms of AIDS and can significantly prolong life.

**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.

**Key Terms**

Drug resistance bacteria: are bacteria that does not killed by commonly used drugs. More powerful called second line drugs are important to kill these resistant bacteria.

Vector: is an organism that carries a disease-causing organism and transmit from one person to another or from an animal to a human. For example Anoph-

eles mosquito.

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.

**Avoid overcrowding**: TB is a disease transmitted by inhales the bacteria when infected person cough and sneeze. Therefore, covering the mouth and nose when coughing or sneezing reduces the spread of TB bacteria, and good ventilation is important to prevent this disease.

**Avoid eating undercooked** meat and avoid drinking unpasteurized or not boiled milk. This is important to prevent TB transmission from animal to human.

### Malaria

**Activity 5.21: Group work**

Make a group, each with four or five students and discuss in group about:

i. The causes of malaria,
ii. If you are living in malaria endemic area observe your surrounding and discuss how malaria is transmitted from patient to healthy person ( If your living area is not endemic for malaria, please use reference or internet to answer this question).
iii. What is vector?
iv. How can we prevent 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.

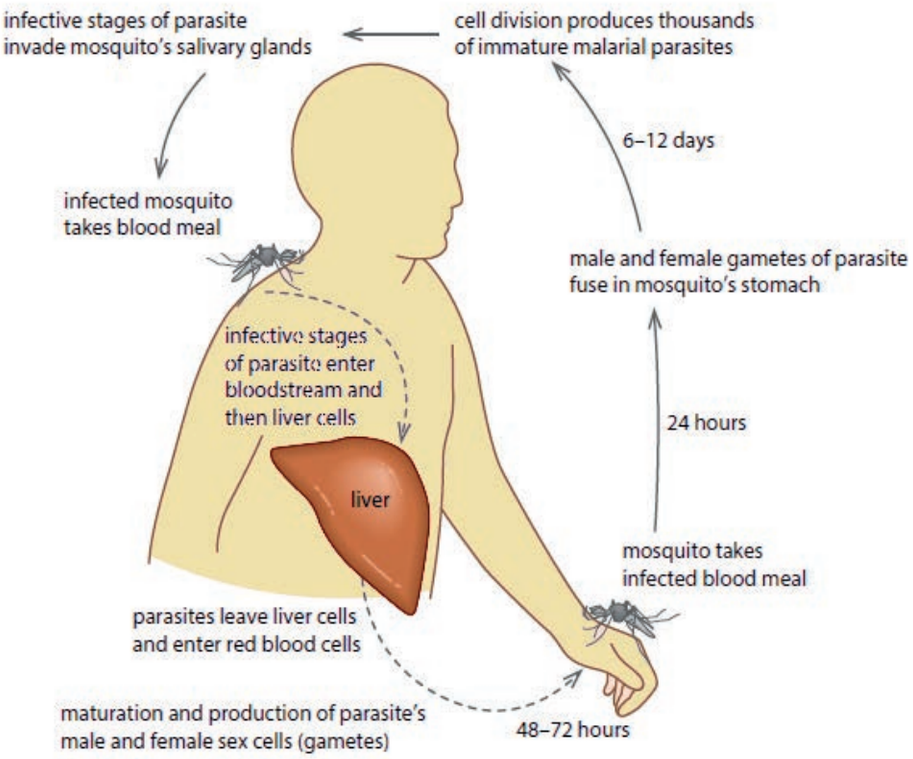



Figure 5.11. Life cycle of malaria

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 Artemisinin combination therapy ( ACT) or Quartem and chloroquine to treat infected people. However, in many parts of the world Plasmodium has evolved resistance to some of these drugs. Chloroquine resistance for plasmodium falciparum is widespread in parts of South America, Africa; newer drugs such as mefloquine are used in these areas.

**Activity 5.22: Individual / Home work**

Construct the table that shows the cause, method of transmission, and prevention and control methods for infectious diseases like Ameba, Giardia,. Typhoid fever.

**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.

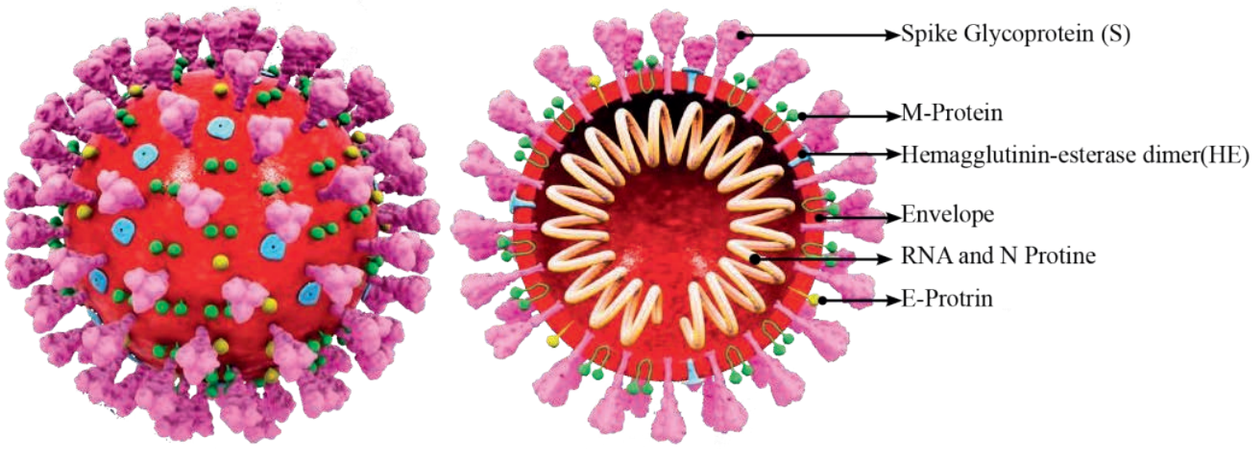



Figure 5.12 Structure of COVID-19

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).

Most people infected with the COVID-19 experience mild to moderate respiratory illness and recover without requiring special treatment. Older people and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness.

**Key Terms**

**"coronavirus"** : is derived from Latin corona , meaning "crown" or "wreath", itself a borrowing from Greek

**Incubation period:** is a period from the time of exposure or entrance of infectious agent up to the time of the appearance of signs or symptoms of the disease.

**Activity 5.23: Think- pair-share**

Discuss with a friend next to you and share your idea with the other classmate. What is pandemic?

Fig. 5. 13 Pandemic of 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.

Figure 5.15. Vaccine for corona

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, diabetes, podoconiosis, etc.
- Tobacco use, physical inactivity, the harmful use of alcohol and unhealthy diets are all increase the risk of dying from non-infectious diseases.
- Unhealthy diets and a lack of physical activity may show up in people as raised blood pressure, increased blood glucose, elevated blood lipids and obesity. These can lead to cardiovascular disease, the leading non infectious disease in terms of premature deaths.
- Detection, screening and treatment of non-infectious diseases , as well as palliative care, are key components of the response to non-infectious diseases.

## 5.9 Renowned Nutritionists in Ethiopia

Nutritionists are researchers or scientists who study nutrition.

**Activity 5.24: Home work /Individual assignment**

Using Internet and books as a source of information write a paragraph on known nutritionists In Ethiopia.

# Unit review

- **Nutrition** is the process of taking in food and converting into energy and other vital nutrients required for life. The important function of food in living things: Growth, repair, energy, Replacement of damaged tissues, Protect from diseases.
- **Nutrients** are important chemical substances in food. These important nutrients are:
- **Carbohydrates**: are one type of nutrients which provide energy for the human body. One gram of carbohydrate can provide 16 kJ of energy
- **Protein**: Proteins are nutrients used for growth of the body and build a new cell when it is damaged. It is made up of amino acid composed of carbon, hydrogen, oxygen and nitrogen. One gram of protein can provide 17 kJ of energy
- **Lipids (Fats and oil)** another nutrient which provide energy, composed of carbon, hydrogen oxygen. One gram of lipid can provide 37 kJ of energy
- **Vitamins**: are nutrients organic substances which are essential in small quantities for human body.
- **Minerals**: Minerals are inorganic substances which are essential in small quantities
- **Water**: Major composition of body fluid
- **Fiber**: help to prevent constipation and keep the colon healthy.
- The diet which contains all of the nutrients in the correct amount and proportion is called a **balanced diet.**
- 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. Malnutrition is caused by under nutrition.
- Obesity is overweight which is caused as a result of an imbalance between the energy in human body and the energy he or she released.
- Substance abuse is using of legal or illegal drugs/ substances in the wrong way or in the excess amount. The three important substances found in cigarette are: tar, carbon monoxide and nicotine.
- Tar is a black sticky substance found in cigarette produce chronic bronchitis and lung cancer Carbon monoxide is a poisonous gas found in cigarette which can produce heart disease and stroke.
- Alcohol gets distributed throughout the body by the help of blood circulation. It is absorbed by liver cells and broken down by liver enzymes, Therefore its concentration in the blood decreases gradually.
- Khat is bushy plant whose leaves are chewed for its stimulant effect. The scientific name of this plant is known as *Catha edulis* plant which is grown in southern Arabia and Eastern Africa, including Ethiopia, Somalia, and Kenya.
- A disease is an illness or disorder of the body or mind that leads to poor health; each disease is associated with a set of signs and symptoms.
- Infectious diseases are diseases that are caused by causative agent organism.
- Non-infectious diseases are not caused by pathogens. They are inherited or genetic diseases and others are deficiency diseases.

## 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. List the components of a balanced diet and give a good source of food for each.
3. Explain the modes of transmission of infectious diseases.
4. What are the three substances which are banned from use during sport competition?

# Unit 6: Ecology

| Sections | Learning competencies |
|---|---|
| 6.1 Ecology<br>6.1.1 Definitions of common ecological terms<br>6.1.2 Biotic and abiotic components<br>6.1.3 Ecological levels<br>6.1.4 Ecosystems<br>6.1.5 Biomes<br>6.1.6 Ecological succession<br>6.2 Ecological relationships | • Define ecological terms<br>• Explain the biotic and abiotic components of an ecosystem<br>• Describe the ecological levels<br>• Explain the terrestrial and aquatic ecosystems<br>• Define biome<br>• Describe the major terrestrial and aquatic biomes<br>• Mention the fauna and flora of each biome<br>• Describe ecological succession<br>• Express love and respect to fauna and flora and their biomes<br>• Investigate how elder people in their localities care for plants and wildlife |

## 6.1 Ecology

### 6.1.1 Definitions of Common Ecological Terms

**Objectives**

At the end of this section, the student will be able to:

- *define ecological terms*

**Activity 6.1: Question and answer**

What is ecology? When you hear the word ecology, what do you think of? Make a list of some of the topics you think you will learn about as you study about ecology.

Every day you share your environment with many organisms. These can be as small as houseflies or mosquitoes. They can be dust mites that you cannot even see. Larger animals include dogs, cows, and hyenas. You need to know about your environment. The reason is simple: your environment affects you and every other organism in it.

*What is Ecology?*

The branch of biology that deals with the study of the interactions among organisms and with their environment is known as ecology. Scientists who study ecology are called ecologists. Because our planet has many diverse plants, animals, and environments, ecologists tend to study smaller areas called ecosystems. An ecosystem consists of the physical environment (abiotic factors) and all the living things (biotic factors) within it. Animals are consumers since they cannot

make their own food and must obtain their food from producers or other consumers. Bacteria and fungi are decomposers. They eat dead plant and animal remains and convert them into substances that can be reused.

Each type of living thing in an ecosystem has a place in which it lives. This is known as its habitat. The combination of the job an organism does and the place in which it lives is called its niche. What are some jobs that organisms do? Plants and algae trap the energy in sunlight and produce their own food. Because of this, they are known as producers. Animals are consumers; bacteria and fungi are decomposers.

**Self Assessment 6.1**

1. Describe what animals share your surrounding?
2. What do ecologists study?

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

**Activity 6.2: Discussion**

Discuss the various abiotic and biotic factors that influence the distribution of organisms in their environment. Enumerate at list five abiotic and biotic factors you knew.

**Objectives**

At the end of this section, the student will be able to:

- *explain the biotic and abiotic components of an ecosystem*
- *discuss the effects of biotic and abiotic factors on the distributions of species*

### 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.

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 (Fig.6.1). 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.

The distribution and abundance of photosynthetic organisms, including plants, algae, and photosynthetic bacteria, depend on the availability of **inorganic nutrients** such as compounds of nitrogen and phosphorus. Plants obtain these nutrients from the soil. **Soil structure**, **pH**, and **nutrient content** often play major roles in determining the distribution of plants. In many aquatic ecosystems, low levels of nitrogen and phosphorus limit the growth of algae and photosynthetic bacteria.

Several abiotic factors are important in aquatic, but not terrestrial, ecosystems. While terrestrial organisms have a plentiful supply of oxygen from the air, aquatic organisms must depend on **oxygen dissolved** in water. This is a critical factor for many species of fish. Cold, fast-moving water has higher oxygen content than warm or stagnant water. **Salinity (saltiness),** currents, and tides also play a role in many aquatic ecosystems.

Some abiotic factors affect terrestrial, but not aquatic, ecosystems. For example, **wind** is often an important factor on land. Wind increases an organism's rate of water loss by evaporation. The resulting increase in evaporative cooling can be advantageous on a hot summer day, but it can cause dangerous wind chill in the winter. In some ecosystems, frequent occurrences of natural disturbances such as storms or fire play a role in the distribution of organisms.

**Activity 6.3: Field observation**

Make a field visit in your village or school compound take note on the various abiotic factors (e.g., temperature, water, pH, salinity etc.). Materials required include notebook, pencil, plastic bags, pH meter, thermometer, pot, and hygrometer.

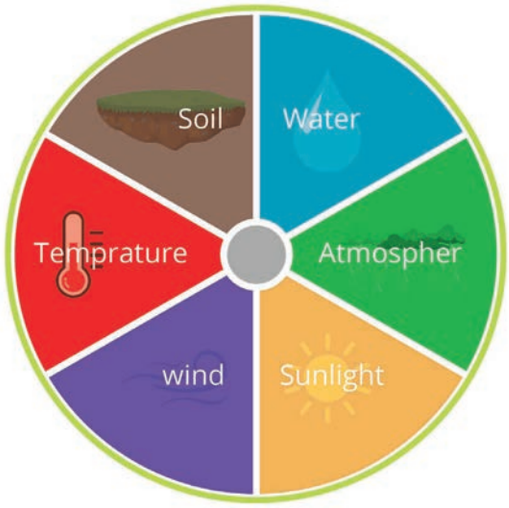



Figure 6.1. Common abiotic factors of territorial and aquatic biome

**Activity 6.4: Field observation**

Make a field visit in your village or school compound take note on the effects various biotic factors that affect the distribution of organisms (e.g., predators, herbivores, parasite, decomposers, competing organisms etc.).

Alternatively, ask an ecologist or a biologist in your village how the distribution of herbivores/ predators affect the distribution of food species. Materials required include notebook, pencil, binocular and meter.

**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 (Fig.6.2).

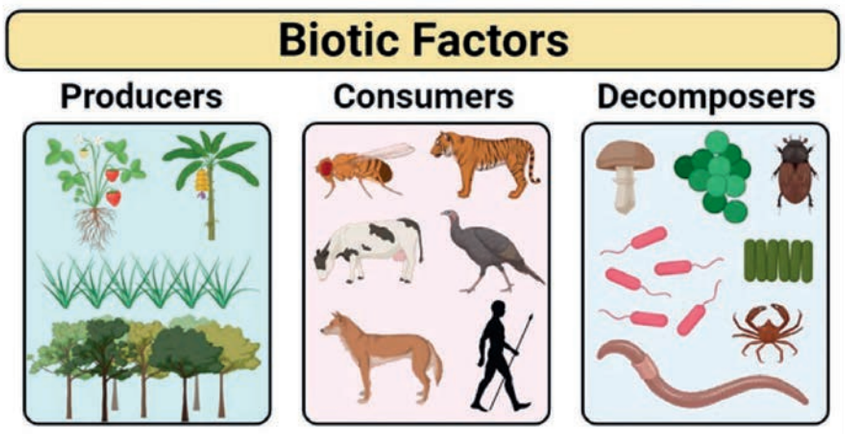



Figure 6. 2 Common biotic factors of territorial and aquatic biomes

**Self Assessment 6.2**

1. Why is solar energy such an important factor for most ecosystems?
2. Which abiotic factor is more important for aquatic organisms compared to terrestrial ones? Explain.

## 6.1.3.Ecological levels

**Objectives**

At the end of this section, the student will be able to:

- *describe the 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 (Fig.6.3).The traditional ecological investigation usually starts at the level of the individual.

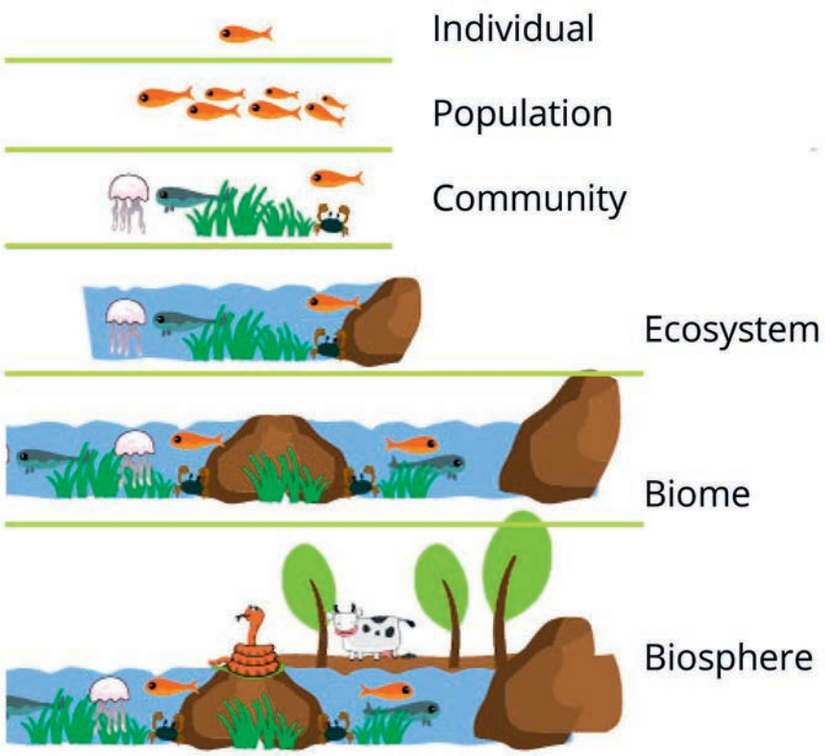



Figure 6.3 Ecological levels

*What is a population?*

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.

**Activity 6.5: Jigsaw groups**

What are ecological levels? Summarize the properties of the different ecological levels and present the results to your classmates.

**Activity 6.6: Field observation**

Make a field excursion to the nearest national park or sanctuary and study the population of plants or animals. Ask an ecologist or a wildlife biologist in a park/zoo about properties of population of plants and animals. Materials required include notebook, pencil, binocular, and meter.

**Activity 6.7: Sharing observations and reflections**

Make a field excursion to the nearest national park, wildlife reserve, forest or sanctuary and study the properties of biological community. Ask an ecologist or a wildlife biologist in the park/zoo about properties of biological community. Materials required includes notebook, pencil binocular, meter.

*What is a biological community?*

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.

**Self Assessment 6.3**

1. How do the young tadpoles and adult frogs reduce competition for food?
2. Write the characteristic features of a biological community

**Attention**

A variety of methods can be used to sample populations to determine their size and density. For immobile organisms such as plants, or for very small and slow-moving organisms, a quadrat may be used. A quadrat is a way of marking off square areas within a habitat, either by staking out an area with sticks and string, or by the use of a wood, plastic, or metal square placed on the ground. After setting the quadrats, ecologists then count the number of individuals that lie within their boundaries. The number and size of quadrat samples depends on the type of organisms under study and other factors, including the density of the organism. This ensures that enough individuals of the species are counted to get an accurate sample that correlates with the habitat, including areas not sampled.

## 6.1.4. Ecosystems

**Activity 6.8: Inquiring and researching**

What are ecosystems? Make a discussion on the concept of ecosystem and write the properties of an ecosystem.

**Objectives**

At the end of this section, the student will be able to:

- *explain the terrestrial and aquatic 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. The communities in this habitat, together with their watery environment, make up a self-supporting ecosystem. A carp is a secondary consumer at the top of a food chain, where it is in competition with other species of fish for food and with other carp for food and mates. The whole of that part of the Earth's surface which contains living organisms (called the biosphere) may be regarded as one vast ecosystem. No new material (in significant amounts) enters the Earth's ecosystem from space and there is no significant loss of materials. The whole system depends on a constant input of energy from the Sun and recycling of the chemical elements.

**Activity 6.9: Sharing observations and reflections**

Make a field excursion to the nearest terrestrial and or aquatic ecosystem and study the how the different components of ecosystem interact. Ask an ecologist or biologist about components of ecosystem. Materials required includes notebook, pencil, etc.

**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 salt-water (marine) ecosystem.

**Self Assessment 6.4**

1. What is a habitat?
2. What is an ecosystem made of?
3. An ecosystem is self-supporting. Explain.
4. Name four examples of ecosystems.
5. What is the biosphere?

## 6.1.5 Biomes

**Objectives**

At the end of this section, the student will be able to:

- *define biome*
- *describe the major terrestrial and aquatic biomes*
- *mention the fauna and flora of each biome*
- *express love and respect to fauna and flora and their biomes*

**Activity 6.10: Reflective discussion**

What are Biomes? Section 6.1.5 presents how the abiotic factors you learned about in the previous section are largely responsible for the distribution of life on Earth. Discuss the characteristic features of the typical terrestrial or aquatic biomes in your locality.

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 centimetres. Regular rains, combined with an average temperature of 25°C (77°F) and little variation in day length, allow photosynthesis to continue year-round.

Plants are vertically layered, and competition for light is intense (Fig.6.4). 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.

Figure 6. 4 Picture Tropical forest

*What is a desert?*

Deserts receive an average of less than 10 centimetres 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 vapour in the air allows the temperature to fall fast.

The plants include succulents such as cacti or euphorbs, deeply rooted shrubs, and herbs that grow during the infrequent moist periods (Fig.6.5). Desert plant adaptations include tolerance of heat and desiccation, water storage, and reduced leaf surface area. The desert fauna include snakes and lizards, scorpions, ants, beetles, migratory and resident birds, and seed-eating rodents. Many species are **nocturnal**. Water conservation is a common adaptation with some species surviving solely on water obtained from breaking down carbohydrates in seeds. Urbanization and conversion to irrigated agriculture has reduced the natural biodiversity of some deserts.

Figure 6. 5 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

**Activity 6.11: Sharing observations and reflections**

Read books and/or search in the int Make a field excursion to the nearest savanna biome and study the characteristic features. Ask an ecologist or a biologist about the plants and animal species in savanna biome. Materials required include notebook, pencil, plastic bags, pH meter, and thermometer. ernet for the scientific and the local names common Ethiopian plants and animals species. Present your report to your classmates.

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 (Fig.6.6).Herbivores include giraffes, zebras, elephants, a variety of antelopes, and immense herds of wildebeests. Lions and hyenas are carnivores that eat the grazers.

During seasonal droughts, grazing mammals often migrate to parts of the savanna with more forage and scattered watering holes. The earliest humans may have lived in savannas. Fires set by humans may help maintain this biome, though overly frequent fires reduce tree regeneration by killing the seedlings and saplings. Cattle ranching and over-hunting have led to declines in large-mammal populations.

Figure 6.6. 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 (Fig.6.7). Today, these predators and prey are absent from most of their former range.

Figure 6.7. 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 (Figure 6.8). 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.

Figure 6.8. 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(Fig.6.9).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.

Figure 6. 9 Temperate Broad-leaf Forest biome

**What are the tundras?**

**C**over 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 (Figure 6.10).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 impact are mineral and oil extraction.

Figure 6.10 Tundra biome

**Self Assessment 6.5**

Match the terms at column A with description with the most suitable descriptions a column B.

| | A | | B |
|---|---|---|---|
| 1. | African grassland with trees | A. | Desert |
| 2. | North American grassland | B. | Tundra |
| 3. | Low-Growing plants at high latitudes or elevations | C. | Tropical rain forest |
| 4. | The dominant plants are deciduous trees | D. | Prairie |
| 5. | At latitudes 30° north and south | E. | Savanna |
| 6. | Broadleaf forest near equator | F. | Temperate broad leaf Forest |
| 7. | Conifers dominate | G. | Boreal Forest |

## 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% (Fig.6.11). Aquatic biomes are classified into freshwater and marine.

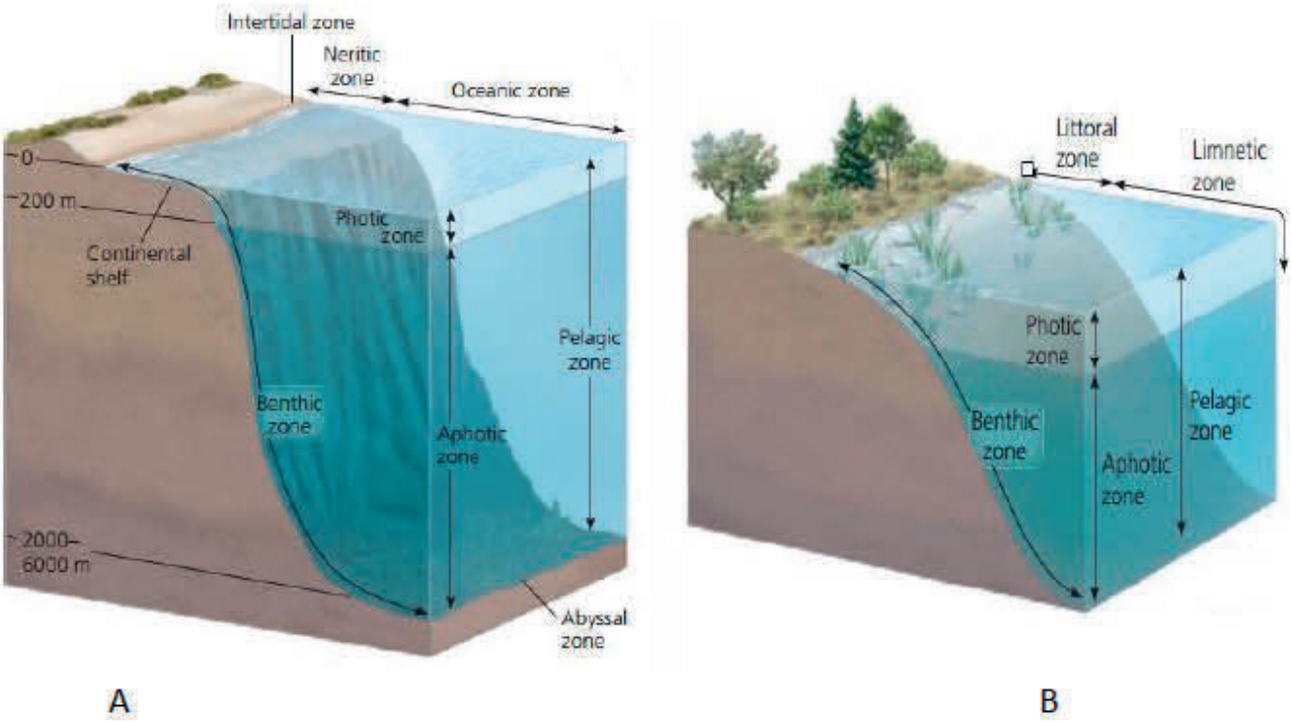



Figure. 6.11 Zonations of marine (A) and freshwater (B) biomes

*What are the lakes?*

Standing bodies of water range from ponds a few square meters in area to lakes covering thousands of square kilometres. The salinity, oxygen concentration, and nutrient content differ greatly among lakes and can vary with season (Fig. 6. 12).

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.

**Key Terms**

**Aphotic zone:** There is little light penetration

**Photic zone:** zone of sufficient light for photosynthesis

**Pelagic zone:** The photic and aphotic zones together

**Abyssal zone:** the part of the ocean 2000–6000 m below the surface

Figure 6.12 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 (Fig.6.13).Wetlands are among the most productive biomes on Earth.

Woody plants dominate the vegetation of swamps, while bogs are dominated by sphagnum mosses. Wetlands are home to a diverse community of invertebrates, birds, and many other organisms. Wetlands help purify water and reduce peak flooding. Draining and filling have destroyed up to 90% of wetlands in Europe.

Figure 6.13 Wetlands biome

*What are streams and rivers?*

The most prominent physical characteristic of streams and rivers is the

**Activity 6.12: Sharing observations and reflections**

Make a field excursion to the nearest lakes biome and study the characteristic features. Ask an ecologist or a biologist about the plants and animal species and the major human impacts. Materials required include notebook, pencil, plastic bags, pH meter, and thermometer.

Alternatively, you could make a discussion on the spread of invasive species such as water hyacinth/ Emboch (*Eichhornia crassipes*) and the impacts caused on freshwater ecosystems (e.g., lake Tana) and propose possible solutions.

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 (Fig.6.14). 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.

Figure 6. 14 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 (Fig.6.15).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.

**Self Assessment 6.6**

1. What are the major physical and chemical factors that affect the distributions of plants estuaries ecosystem?
2. Discuss the major human impacts in the estuaries and the solutions
3. Why are planktons important?
4. Discuss the major human impacts in Streams and Rivers.
5. Discuss some of the limiting factors for organisms in lakes.

Figure 6. 15. Estuaries biome

## 6.1.6 Ecological succession

**Objectives**

At the end of this section, the student will be able to:

- *describe ecological succession*

*What is an 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** (Fig. 6.16).

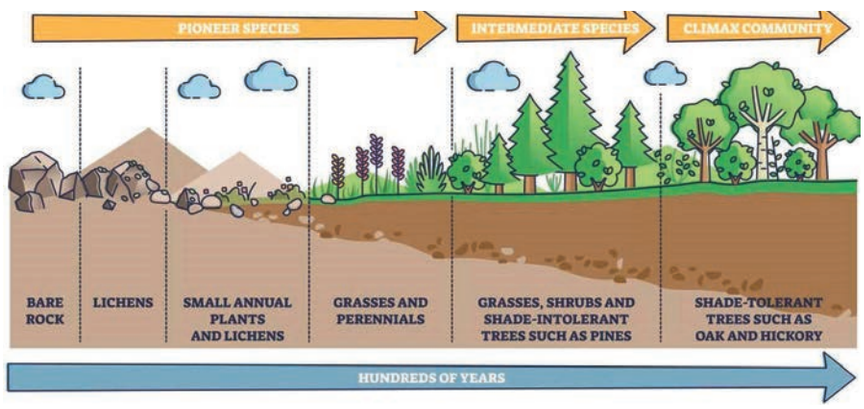



Figure 6.16 Primary successions

**Activity 6.13: Collaborative learning groups**

This section 6.1.6 presents the phenomenon of ecological succession. Discuss the concept of ecological succession. Tell the difference between primary and secondary successions. How might the early species facilitate the arrival of other species?

## Key Terms

**Climax community:** a stable community that undergoes little or no change

**Limiting factor:** any biotic or abiotic factor that restricts the existence, numbers, reproduction, or distribution of organisms

**Pioneer species:** The first organisms to grow on a new patch of cooled,hardened lava

**Primary succession:** colonization of barren land by pioneer organisms

**Secondary succession:** sequence of changes that take place after a community is disrupted by natural disasters or human actions

**Succession**: the orderly, natural changes that take place in the communities of an ecosystem

**Tolerance**: the ability of an organism to withstand changes in biotic and abiotic environm

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 photosynthesizers 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. Eventually, an area is colonized by plants that become the community's dominant form of vegetation (climax community). Producing such a community through primary succession may take hundreds or thousands of years. Early-arriving species and later-arriving ones may be linked by one of three key processes- facilitating inhibiting and tolerating. .

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 (Fig. 6. 17). 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.

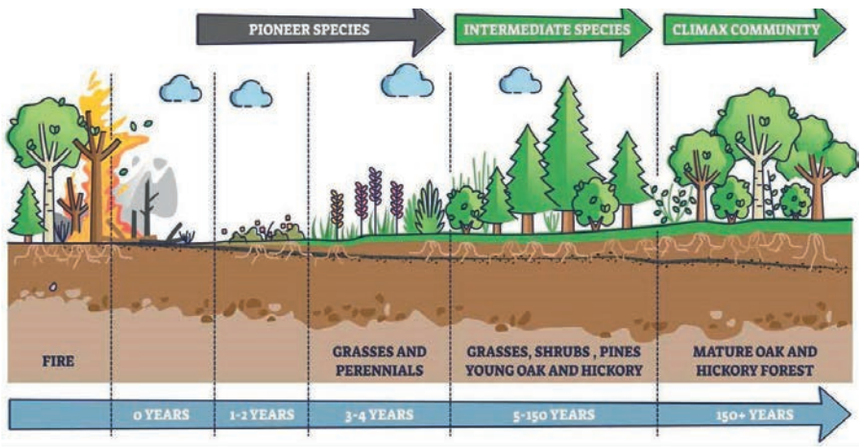



Figure 6.17. Secondary succession

### Self Assessment 6.7

1. After a flood destroys everything growing on the land, which type of succession is most likely?
2. What is succession?

## 6.2. Ecological relationships

**Objectives**

At the end of this section, the student will be able to:

- *discuss ecological relationships in ecosystems*

**Activity 6.14: Reflective discussion**

Interactions between species can help, harm, or have no effect on the individuals involved. Discuss the various types of inter-specific relationships. Explain how competition, predation, and mutualism differ in their effects on members of two interacting species.

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

**Competition(-/-)**

*What is a 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 (Fig. 6.18). 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.

Figure 6. 18 Intra-specific competitions between two lions

**Predation (+/-)**

*What is predation?*

**Predation** is interaction in which an individual of one species, the predator, kills and eats an individual of the other species, the prey(Fig.6.19). 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.

Figure 6. 19 Predation

**Herbivory** (+/-)

*What is 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 (Fig. 6.20). 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.

Figure 6. 20. Herbivory

**Parasitism (+/-)**

*What is 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 (Fig.6.21). 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.

Figure 6. 21. Parasitism

**Mutualism (+/+)**

*What are the effects of participating in a 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 (Fig.6.22). 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.

Figure 6. 22. Mutualism

**Activity 6.15: Field observation**

Make a field excursion around your village or school compound and investigate how the various ecological interactions influence the distribution organisms. Describe the type of ecological iteration (e.g., competition, predation, herbivory, parasitism, mutualism, commensalism etc.). Materials required includes notebook, pencil.

**Commensalism**(+/0).

*What is a commensalism?*

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 (Fig. 6. 23). 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.

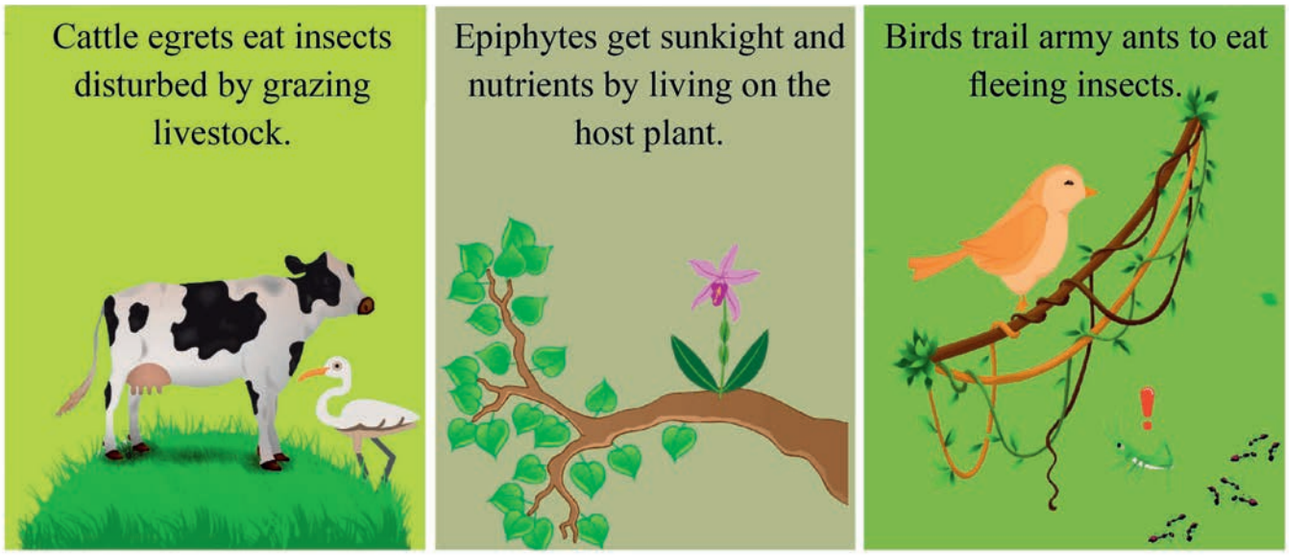



Figure 6. 23. Commensalism

**Self Assessment 6.8**

Match the following

| | A | | B |
|---|---|---|---|
| 1. | Two species interact and both benefit by the interaction | a. | Interspecific competition |
| 2. | Two species interact and one benefits while the other is neither helped nor harmed | b. | Commensalism |
| 3. | One free-living species feeds on another and usually kills it | c. | Mutualism |
| 4. | Two species access a resource | d. | Predation |
| 5. | One species feeds on another that it lives on or in | e. | Parasitism |

## Unit review

- Ecology is the study of relationships organisms to one another and to their surrounding environment.
- Abiotic factors are the non-living components of the ecosystem that influence the distributions of organisms in their environment. Examples of abiotic factors includes: energy, light, temperature, water, nutrients, salinity, etc.
- Most organisms are adapted to live within a relatively narrow range of temperatures and will not thrive if temperatures are colder or warmer. The growing season of plants, for example, is importantly influenced by temperature.
- All organisms require water. On land, water is often scarce, so patterns of rainfall have a major influence on life.
- Almost all ecosystems rely on energy captured by photosynthesis; the availability of sunlight influences the amount of life an ecosystem can support, particularly below the surface in marine communities.
- The physical consistency, pH, and mineral composition of the soil often severely limit terrestrial plant growth, particularly the availability of nitrogen and phosphorus.
- Biotic factors are the living components (e.g., predators, herbivores, parasite, decomposers, competing organisms etc.)of the ecosystem that influence the distributions of organisms in their environment.
- A population is a group of organisms that belongs to the same species.
- A community is all of the populations of different species in an ecosystem.
- An ecosystem is a unit containing the community of organisms and their environment, interacting together.
- The Earth has terrestrial biomes and aquatic biomes.
- Biomes located on land are called terrestrial biomes. Biomes located in bodies of water are known as aquatic biomes.
- Major terrestrial biomes are tropical forests, savannas, deserts, temperate grasslands, temperate forests, boreal forests, and tundra. The same biome can occur in different geographic locations with similar climates.
- Temperature and precipitation, and variations in both, are key abiotic factors that shape the composition of animal and plant communities in terrestrial biomes.
- A biome is a large group of ecosystems that shares the same type of climax community. All the ecosystems within the biome have similar climates and organisms.

- 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%.
- **succession:** the orderly, natural changes that take place in the communities.
- 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.**
- 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.
- Some key relationships in the life of an organism are its interactions with individuals of other species in the community. These **inter-specific interactions** include **competition, predation, herbivory, parasitism, mutualism,** and **commensalism**.

## Review Questions

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

| | **Column 1** | | **Column 2** |
|---|---|---|---|
| 1 | millipedes, centipedes, insects, slugs, and earthworms under a log | A | Abiotic factor |
| 2 | a tick on a cat | B | Parasitism |
| 3 | an owl eating a mouse | C | Biological community |
| 4 | rain | D | Habitat |
| 5 | a rain forest | E | Predator-prey relationship |
| 6 | cold temperatures and high winds that prevent tree growth in mountain areas | F | Limiting factors |
| 7 | the first organisms to grow on a new patch of cooled, hardened lava | G | Secondary succession |
| 8 | ability of mosquitoes to survive in very different conditions all over the world | H | Tolerance |
| 9 | an old forest that has not had any fire damage in over 200 years | I | Pioneer species |
| 10 | weeds and wildflowers beginning to grow in a field after a corn crop is harvested | J | Climax community |

**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?

6. Carefully look at the diagrams given below and answer the questions that follow

   i. Which diagram stands for biotic factors of an ecosystem?

   ii. Which diagram stands for abiotic factors of an ecosystem?

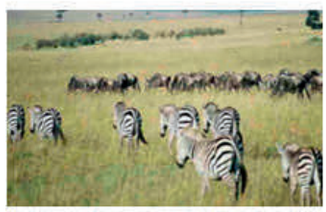
   iii. Which diagram represents: an ecosystem, community, individual, and population levels of ecology.

A

B

C

D



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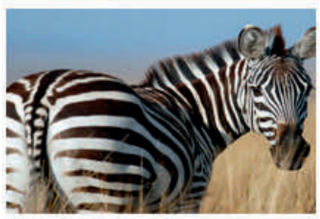
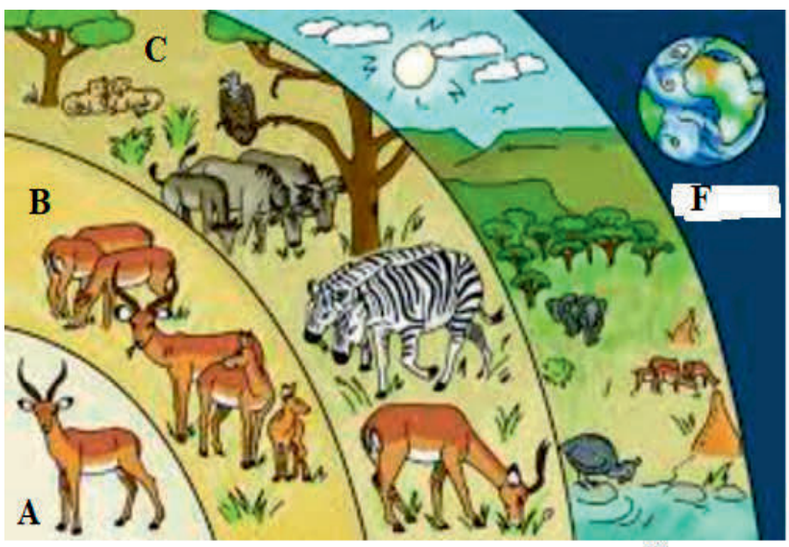


F

7. Carefully look at the diagram given below and identify the various ecological levels (individual, population, community, ecosystem and biosphere levels)

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