Biology

For Distance Education
Module 1
Grade 9

Federal Democratic Republic of Ethiopia
Ministry of Education

Biology

For Distance Education

Grade 9

FDRE
MOE

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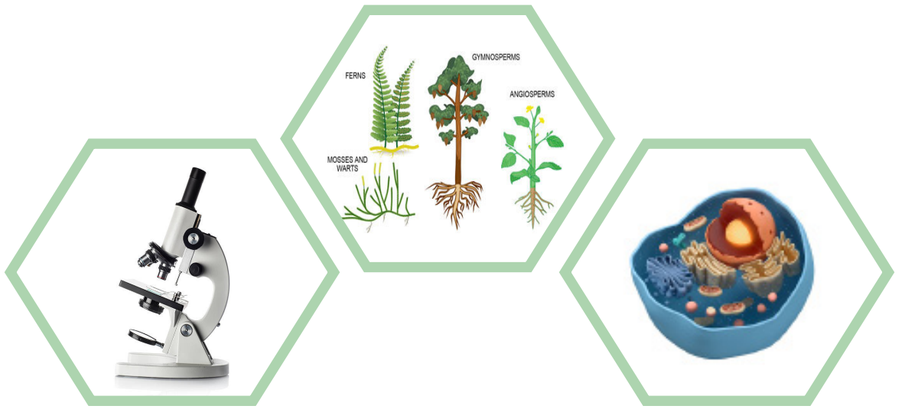

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Contents

MODULE 1 INTRODUCTION

Dear learner! This module consists three units, namely Introduction to Biology, Characteristics and classification of organisms, and the Cell.

The first unit is about introduction to Biology, the relation of Biology to other disciplines, and about scientific methods in biology laboratory and field tools by giving special attention to Microscope. In unit two, you will learn about Characteristics and classification of organisms. In third unit, you will learn about cell- the smallest unit of life, cell types, cell structures and cell function. Moreover, you will learn about the cell and its environment dealing about osmosis, diffusion and active transport. You will also learn about the level of Biological Organization at the end of this module.

Dear Learner! Be sure that you will take the responsibilities of a student and a teacher in facilitating your learning. As a student, you are responsible for mastering the lessons and completing the learning activities and assignments. As a teacher, you are responsible for checking your work carefully, noting areas in which you need to improve and motivate yourself to succeed.

Each unit is organized into sections that include introduction, learning outcomes, sub topics followed by checklist and self – test exercises. At the end of each unit, there are unit summary, feedback to activity and answer key for self – test exercises. Moreover, there are references, largely available as free book pdf on the internet, for each unit of the module for further reading.

Even though there are different specific learning strategies/learning methods for the different sections, the following general learning strategies are suggested, but not limited, to study this module:

- Rehearsal /Retrieval practices – Constructing mind or mental map, preparing short notes, checking course materials to fill gaps in memory
- Elaboration practices - paraphrasing, creating analogies, question and answering
- Self – Evaluation practices – using checklist, rereading /reviewing, generating self- test questions

- Self - regulating practices: allocate specific study time (prepare daily time table or weekly pattern or some other types of arrangement), designate defined, quiet and organized area to study, adjust learning rate, respect schedule and finish activities and exercises in time

In this module, you will find the following icons or graphic symbols with the description they represent throughout the module.

 This tells you there is an overview of the unit and what the unit is about.

 This tells you there is an in-text question to answer or think about in the text.

 This tells you to take note of or to remember an important point.

 This tells you there is a self-test for you to do

 This tells you there is an activity for you to do

√ This tells you there is a checklist.

 This tells you there is a written assignment

 This tells you that this is the key to the answers for the self-tests.

Dear distance learner, if you encounter difficulty in understanding some topics in the module, do not get frustrated or discouraged. Take it as a challenge. Do not give up! Keep in mind that you are self – learner practicing individual learning. Do not forget that other distance learners too may experience similar difficulties as you encountered.

When some topics are difficult to understand, first go through the module over and over again until you get things clearer. If you are not able to succeed, do

not hesitate to get the support of teachers in the nearby school or knowledgeable persons from other sectors or exchanging information with another distance learner.

As final advice, you should do all the activities and self- test exercises by yourself before proceeding to the feedback or answer key for self- test exercises.

General Objective of Module I

Dear learner! This module contains three units. After completing studying the units in this module, you will be able to:

- Explain the nature, principles, and importance of Biology.
- Manipulate common tools of a Biologist.
- Apply common laboratory safety rules
- Identify the characteristics of living things
- Classify living things based on taxonomic principles
- Tell the relevance of classification
- Appreciate renowned taxonomists of Ethiopia
- Describe what are cells
- Discuss the cell theory
- Compare the structure and function of plant and animal cells
- Prepare microscopic slides and observe under microscope
- Describe movements in plant and animal cells
- Discuss levels of cellular organization

Assessment Techniques

Dear learner! One or more of the following assessment methods can be used while are studying this module to see if you have done so successfully:

1) After each section in the module, there is a self-evaluation checklist to which you have to respond.
2) Self-testing exercise are provided after each lesson that you are required to complete. Do not rush to look at the answers provided at the end of the units when you are completing the self-test exercise.

Answer the questions first, and then review your answers on the answer sheet.

3) You complete the activities in your tutorial centers, which will support your module study with practical activities. You must answer questions following your practical activity. However, do not rush to the answers provided at the end of the unit. First test on yourself.
4) You will have "Assignment for Submission" at the end of the module. You are required to complete assignments questions and submit it to your tutorial center so that it can be corrected.
5) Try to respond to each every in-text and leading questions throughout your study session. Before moving on to the next section, these questions will assist you in reading additional materials – books, internet and other potential resources.
6) Final examination: Following successful completions the module, you will take a final examination at your tutorial center.

UNIT ONE: INTRODUCTION TO BIOLOGY

INTRODUCTION

 Dear learner! In this unit, you will learn about the meaning of biology and you will understand the subject of Biology. This unit has six sections: Section one and two deal about the meaning of Biology and its relation to other disciplines. In these sections, you will also learn about application of Biology in day-to-day life. In Section 3, you will study about the important procedures in Scientific methods. Section 4 addresses the different laboratory tools and their functions. In section five, you will study about part of a microscope and its function. The last section is about general laboratory safety rules.

Unit Outcomes

Upon successful completion of this unit, you will be able to:

- Explain the nature and importance of Biology.
- Manipulate common tools of a Biologist.
- Apply common laboratory safety rules.

UNIT CONTENTS

This unit includes the following contents organized in sections. These are

REQUIRED STUDY TIME

You are expected to spend 15 learning hours within one semester to learn this unit. Try to use the allocated study time properly and efficiently to cover the lessons included in this sub-unit.

LEARNING STRATEGIES

Dear learner! For your successful distance learning process, you can use different learning strategies wherever they are appropriate to the topics/ subtopics of your lesson. These learning strategies might be mind mapping, mentally rehearsing, short visits/onsite observation, using microscope in the nearby schools, hospitals and clinics, and research sites, comparing and contrasting, drawing and taking pictures of real plants, creating analogies, paraphrasing, summarizing (outlining and preparing flow chart summaries), taking short notes, underlining or highlighting key points.

Section 1.1. Definition of Biology

 **Overview**

Dear Learner! In this section, you will learn about the subject Biology that deals about living things. This section also deals about the characteristic of living things. In addition, you will also learn about the relation of Biology to other fields of natural Sciences.

Learning competencies

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

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

 What is biology?

☞ You might have tried to define Biology as the scientific study of life or living things.

Keywords

The word Biology comes from two Greek words **bios** means life, and **logos** meaning study.

Activity 1.1

What characteristics help you distinguish living things from non-living things?

Dear learner! How do you distinguish living things from nonliving things? What does "alive" mean?

- Dear learners! We recognize life mainly by common characteristics shared by living systems.
- Living things are composed of one or more cells, are complex and highly ordered, they can transmit genetic information to their offspring, need the energy to accomplish work, can maintain relatively constant internal conditions (homeostasis), can respond to stimuli, grow, reproduce, 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, thermometer etc.

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 concepts like conversion of radiant energy into organic molecules by photosynthesis are studied with the knowledge of chemistry and Physics.

Self-test exercise

I. Choose the correct answer for the following question.

1. Which one of the following indicates the relation between Biology and Chemistry?

a. Study of chemical bonding
b. study of molecules
c. study of acids and bases
d. all.

☑ Self-evaluation checklist

Direction: Put a tick (√) against each of the following tasks, you can perform. If you are not able to perform one of these tasks, you need to read the section once again.

I can

- Define Biology……□
- Explain the relation of Biology to other natural sciences……..□

Section 1.2. Why do we Study Biology?

Overview

Dear learner! Be clear that you understood the meaning of Biology and its relation to other natural sciences from your previous study. In this section, you will learn about the reason why we study Biology. You have heard that human beings have an inborn curiosity about the natural world that leads them to study about living organisms and their habitats. Therefore, studying biology helps` to understand how living things work, how they function and interact with the environment.

Learning competencies

By the end of this section, you will be able to:

- explain why biology is studied, and
- give examples of biological application.

Activity 1.2:

We hope you enjoy reading about application of Biology. If you do so, then you will go on to the next activity. Good Luck!

Explain how the knowledge of biology can be applied in the fields of agriculture, medicine, food preparation, preparation of beverage etc.

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.
- 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.

Recall

Biology has many applications in our day-to-day life. These are:

- 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 production: For instance, penicillin, are produced by mould fungi or bacteria.
- The production of industrial chemicals: These are citric acid or lactic acid which needs bacteria or fungi to bring about essential chemical changes.
- Sewage disposal: This depends on bacteria in the filter beds to form the basis of the food chain that purifies the effluent.

Self-test exercise

Match column A with column B

A	B
1. fertilizer	A. Baking Injera
2. Antibiotics	B. Increment of Plant growth
3. yeast	C. penicillin
4. D. make beer and wine	D. Fermentation which produce alcoholic drinks

☑ Self-evaluation checklist

Direction: Put a tick (√) against each of the following tasks you can perform. If you are not able to perform one of these tasks, you need to read once again.

1. Explain how Studying biology helps` to understand how living things work, they function and interact with the environment _____□
2. List some application of Biology which helps in the field of Agriculture and medicine_____ □

Section 1.3. The Scientific Method

Overview

Dear learner! You have already known the meaning of Biology which is the scientific study of living things. In this section, you will learn about the procedures for the scientific study. This section will emphasize on the meaning of hypothesis and formation of it in different experiments.

Learning competencies

By the end of this section, you will be able to:

- explain scientific method,
- Define hypothesis,
- practice formulation of hypothesis and
- practice scientific experiment and drawing a bar graph.

Biology is a science of inquiry.

 What comes to your mind when you hear about science?

Dear Learner! We hope you did well in the previous section. If you did so, then you should go on to the next section. Biologists are always curious about why things happen or how things happened by asking questions and seeking science-based responses known as the scientific method. The scientific method involves a series of steps that guide scientists through such scientific investigations.

Keywords

Hypothesis: is a proposed scientific explanation.

The general steps of the Scientific methods are:

Observation

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

Asking Questions

The observations usually lead the scientist to ask questions (inquiry). Dear learners! In the process of scientific method, it is obvious that after observation, there is asking questions like:

"What's that?" or "How does it work?" etc.

Forming of a hypothesis

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

Dear learners! It is important to understand that hypothesis is proposed in a way that enables to be tested by experiment. Dear learners! It is possible to formulate a hypothesis in our day to day life. For example:

You arrange to meet a friend, In order to do your assignment on Saturday afternoon, but when the appointed hour comes, she is not there. You wonder why. If you want to know her possible reason you should formulate possible hypothesis like:

She may forget the appointment.

She may be sick and couldn't come to the appointment place etc.

Testing the hypothesis

Hypothesis can be tested through experimentation. Dear learners! It is important to give a big attention for this procedure of scientific method. Any scientific experiment must have the ability to be duplicated (scientists can perform the same experiment and achieve the similar results).

Dear learners! If a hypothesis is not supported by experimental data, one can propose a new hypothesis. In the above example one of the two hypothesis is correct, if hypothesis one is not the correct reason for the absence of your friend, there should be another reason for her absence at the appointment place.

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.

Dear learners! It is important to understand that if the hypothesis is right, 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 to assist teachers and students in the field.

Example of hypothesis testing in everyday life. Dear learner! We hope you enjoyed reading the steps in scientific method above. I think it is very interesting and important for you to know about scientific procedures. Do you agree? Then, read the following example scientific procedure: Suppose you want to use your torch (hand lamp) to find a missing pen in your bedroom. When you switch the torch on, it is not working. The following flow chart will illustrate hypothesis testing for a torch that doesn't work.

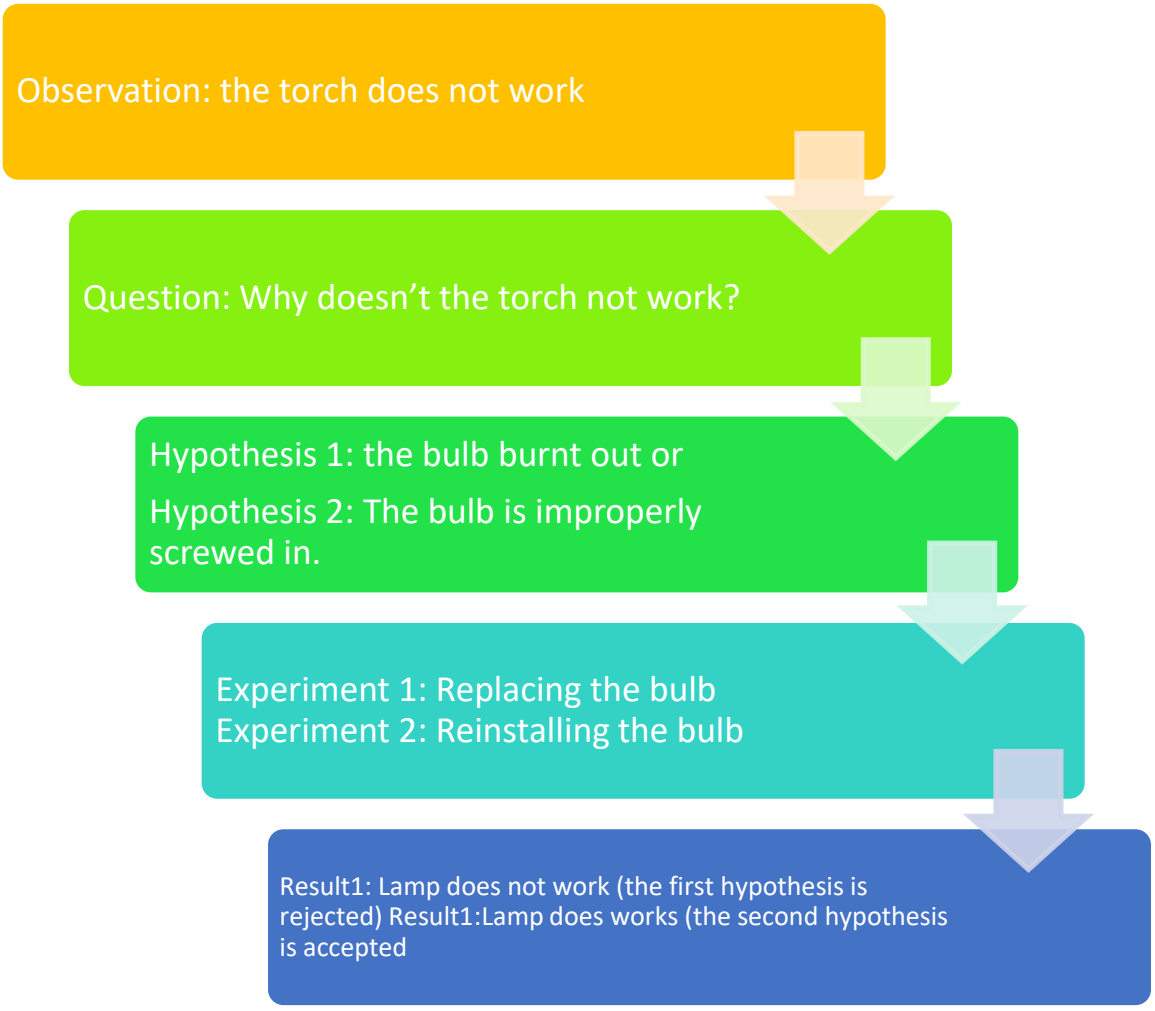

Figure 1.1. Application of the scientific method to common problems in our surroundings

Activity 1.3: Application of Scientific method

We think the following activity is interesting and important for you as a student.

Objective: To determine the importance of temperature for seed germination, in order to work on the following activity,

1. Prepare three pot
2. put some amount of soil and water in each pot
3. put bean or pea seed in each pot , then put
    - Pot one in room temperature.
    - Pot two in colder place like, in refrigerator
    - Pot three in hotter place like inside the kitche
4. Then, set your possible hypothesis for the differences in germination.
5. Measure the times of germination and length of the seedlings for the different groups
6. Draw a bar graph based on the results 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 by using a ruler).
7. Interpret and conclude the results

Self-Test Exercises

Answer the following questions.

1. What is a hypothesis?
2. What is the first step in scientific study?

☑ Self-evaluation checklist

Direction: Put a tick (√) against each of the following tasks, you can perform. If you are not able to perform one of these tasks, you need to read once again.

I can

- Explain the meaning of scientific method and list its procedures.....□
- Define hypothesis .....□
- practice formulation of hypothesis.....□
- Explain about testing the hypothesis.....□
- practice scientific experiment and drawing a bar gr.....□

Section 1.4. Tools of a Biologist

Overview

Dear learner! In this section, you will learn about the tools of Biologists. Biologists use different types of tools in the laboratory and for scientific investigations. Some of the tools are used for measuring, some are used for observation and some are used for culturing microorganisms.

Have you seen some of these tools in your previous studies or in laboratories? I hope you will remember some of them when you see their picture on the next pages.

Learning competencies

By the end of this section, you will be able to:

- identify the major tools of biologists, and
- describe the functions of a biologist tools.

Activity 1.4.

Have you heard or seen any laboratory materials found in Biology laboratory? List some of these materials.

Dear learner! In this section, you will see some of the laboratory and field tools of Biologists. We hope you will enjoy this section.

Section 1. 4.1. Laboratory tools of biologists

Dear learner! There are different types of laboratory materials which are important for the different experimental activity. We hope you enjoyed reading the note and observing the picture of these tools. We think it is very interesting and important for you.

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 a hand lens is to provide an enlarged image of the object placed under it.

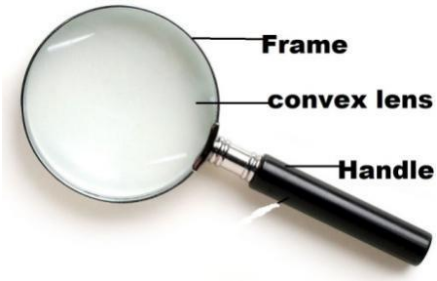

Figure 1.2 hand lens

Activity 1.5

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

Materials

- hand lens (you may borrow from nearby school laboratory)
- 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?

There is a need for providing high magnification tools such as microscope because a hand lens is not sufficient to observe the details in cells.

The Microscope

Dear learner! Did you remember the function of microscope in your grade seven general science lesson? I hope your remember it when you discussed about magnification. It is the most important tools of a biologist.

Dear learners! It is important to recall about a microscope in your grade seven science lesson. It 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.

Recall

The important functions of a microscope are 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.

Types of Microscopes

There are several types 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. Dear learner! There are two types of light microscopes. These are **simple light microscope** which consists of a single lens while a **compound light microscope** consists of two or more glass lenses.

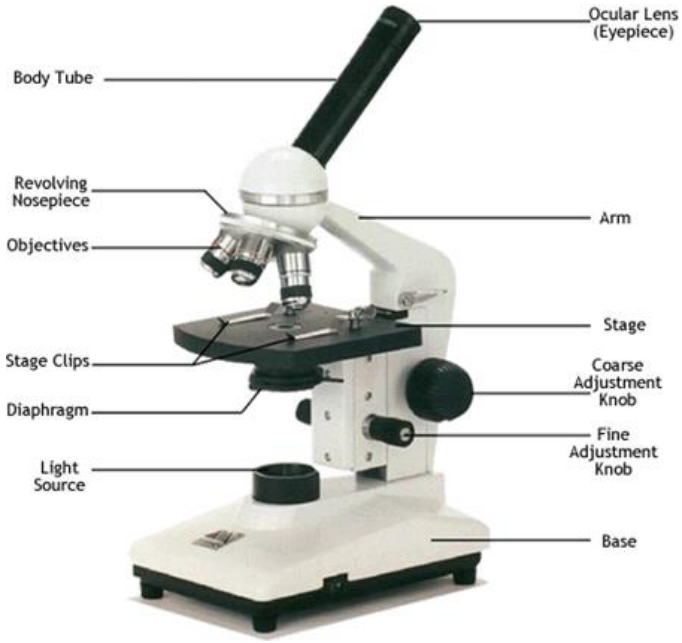

Figure 1.3. Light microscope

Activity 1.6

What type of lenses does a hand lens have?

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 2000 times. Each lens has a different magnifying power.

Dear learner! You have to understand that, a compound light microscope also divided into two:

A compound microscope with a single eye-piece is called monocular; the other one with two eye-pieces is said to be binocular.

Dear learner! We hope you enjoyed reading about light microscope. We think it is very interesting and important for you. In addition to light microscope, there is an electron microscope. These microscopes provide a higher magnification than light microscopes and are used for observing extremely small microorganisms.

Electron Microscopes use a beam of electrons (instead of a beam of light like a light microscope) and electromagnets (instead of glass lenses) to enlarge the image of an object.

Key Terms

Microscope: is 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.

Dear learner, There are materials which are necessary in order to use a microscope. These are Glass slides and coverslips.

Glass slides: The microscope slides are used to support the 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. It is put 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 a better view under the microscope.

Figure 1.4. Glass slide and cover slides

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.

Dear learner! We hope you get important information about microscope. If you did, then you should go on to the next important laboratory material called **autoclave** which is used to sterilize (kill microorganisms). 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 microorganisms has important function in medicine (Penicillin) and for food (beverage) preparation.

Wine and beer making uses culturing on a large scale, as it does in cheese making, biofuel 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.

Dear learner! Have you heard about the laboratory equipment used for the growth of different types of microorganism? The laboratory device used to maintain a specific environment for the growth of different types of microorganism is called **incubator**.

It is an instrument that maintains the temperature best suited for the growth of different types of microorganisms.

Figure 1.6. A Bacteriological incubator

Dear Learner! In the following table we are going to see the important materials or equipment in the laboratory.

 Figure 1.7. Petri dishes	**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 1.8. test tubes	**Culture tubes:** are available in a huge range of sizes, shapes, materials, and so on. They are used to culture microorganisms. Culture tubes may be used with solid (gel) culturing media or with liquid (broth) culturing media, and then placed in the autoclave for sterilization
 Figure 1.9. Flasks	**Flasks:** is an apparatus having a flat bottom and a long narrow neck, which allows easy mixing of the solution without spilling out the content .it is also used to gently heat the content inside with a gentle swirling motion of the flask. **It** is essentially a large-volume culture tube that is used only with broth media and flasks are used to produce large populations of microorganisms. They are available in a variety of shapes and sizes

	Figure 1. 10. Balance	**Balance:** is useful for making up solutions accurately, weighing specimens, and so on
	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.
	Figure 1.12. Tongs	**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 1.18. Figure 1.18	**Dissecting Tool Kit** It 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.
	Figure 1.14 dissecting pan	**Dissecting pan**: This equipment on which the specimen is kept while it is being dissected to study its internal organs.
	Figure 1.15 Crucible	**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 1.16. Beakers	**Beakers:** is a cylindrical glass container used for making up solutions, holding hot or cold water or ice baths, and so on.
	Figure 1.17 Hot plate	**Hotplate :**is useful for heating solutions, making up an agar culturing medium, and so on.
	Figure 1.18. Figure 1.18	**pH meter:** is used to measure the pH (acidity or basicity) of substances.
	Figure 1.19. Thermometer	**Thermometer:** is an instrument that measures the temperature of substances.
	Figure 1.20. Forceps	**Forceps** Forceps are used to hold or pick up small objects. They are available in a variety of shapes and sizes.

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

Figure 1.22. wash bottles

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 1.23. Bunsen burner

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.

Section 1.4.2. Field tools

Dear learner! We hope you did well in the laboratory tools? If you did, then you should go on to the field tools. Good Luck!

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. It is attached to a wooden or metal pole.

Figure 1.24. Insect net

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

Figure 1.25. Fish net

Self-Test Exercises

Match the function of biologists' tools listed in column A with their name listed in column B

A	B
1. useful for heating solutions	a. pH meter
2. A small square or circle shaped thin glass used to cover specimens	b. Incubator
3. used to support an specimens beingexamined under the microscope	c. Electron microscopes
4. used to sterilize microorganisms	d. Glass slides
5. used to measure the pH (acidity or basicity) of substances	e. Coverslips
6. used to maintain a specific environment for culturing	f. Autoclave
7. uses a beam of light to view specimens	g. Light microscope
8. uses a beam of electrons	h. Hot plate
	I. Incubator
	J. Thermometer

☑ Check List

Direction: Put a tick (√) against each of the following tasks you can perform. If you are not able to perform one of these tasks, you need to read once again.

I can:

- identify the major tools of biologists……□
- List some tools of biologist used in the laboratory and field work.....□
- Describe the functions of a biologist tools ……...□

Section 1.5. The light Microscope

Overview

Dear learner! We hope you have enjoyed reading about important tools of Biologists. As you have learned, the main important tool for a biologist is a microscope. In this section, you will learn about light microscope, its structure and function. Most microscopes have 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 have existed without the microscope, and good microscopes are essential for day-to-day activities for most biologists.

Learning competencies

By the end of this section, you will be able to:

- handle the microscope
- use the microscope

Dear learner! Have you ever seen a microscope? If you say yes, please draw a diagram in your mind.

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

Fill the following table by calculating the exact magnification.

Eye lens magnification	Objective lens magnification	Total lens magnification
X8		X800
X5	X40	
	X10	X100

Section 1.5.1 The parts and functions of the light microscope

Dear learners! In the previous section, you have studied important functions of a microscope. If you have done so, you should go on to the next section which is the structures and functions of a microscope.

In addition, microscopes are extremely expensive and that they are important to know how to handle them properly before you use them in the laboratory or in the field.

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. Dear learner! This section define the parts of a microscope and the functions they perform to enable the visualization of specimens.

Activity 1.8

1. List three parts of the microscope is used for supporting the microscope
2. List the parts of the microscope is used for magnification and viewing of the specimen images
3. list the parts of the microscope provide light to the specimen being observed

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

2. **Eyepiece tube**
- it is the eyepiece holder. It carries the eyepiece just above the objective lens. In some microscopes such as the binoculars, the eyepiece tube is flexible and can be rotated for maximum visualization.

3. **Objective lenses**
- are major lenses that further magnify the specimen at different intensities with multiple objective lenses. Mostly they have a magnification power of 4x to100X.

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

5. **Body tube**
- It connects the eyepiece to the objective lenses.

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

7. **The Adjustment knobs**
- these are knobs that are used to focus the microscope. There are two types of adjustment knobs. i.e fine adjustment knobs and coarse adjustment knobs.
- **Fine adjustment:** regulate the distance between object and objective, to achieve the necessary sharpness. The fine focus moves the stage only minimally
- **Coarse adjustment**: Brings specimen into general focus. Coarse adjustment also moves the stage to adjust the difference between the object and the objective. The function of the coarse focus is to capture the exact distance roughly and quickly.

8. **Stage**
- This is the section in which the specimen is placed for viewing.

9. Stage clip

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

10. Aperture

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

11. Microscopic illuminator

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

12. Condenser

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

13. Diaphragm

- It 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 is an adjustable apparatus, hence controlling the light intensity and the size of the beam of light that gets to the specimen.

14. Base

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

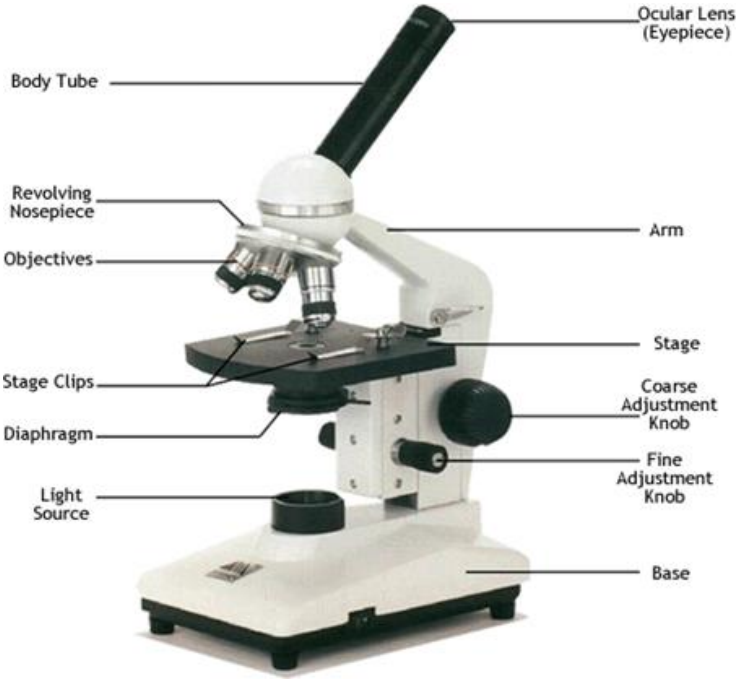

Figure 1.26. The parts of the light microscope

Section 1. 5.2. Handling and using a light microscope

Dear learner, in the previous section, you have understood the parts and functions of the light microscope. If you have understood, then you should go on to the next section about using and handling 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 slides other 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.

Self-Test Exercises

Match the parts and functions of a microscope under column A with their corresponding name under column B.

A	B
1. Found at the top and is used to look through the microscope	a. Eyepiece
2. The major lens of the microscope with multiple lenses	b. Coarse adjustment
3. Brings specimen into general focus	c. Stage
4. The section in which the specimen is placed for viewing	d. Objective lens
5. Found under the stage control the amount of light that reaches the specimen	e. Diaphragm

☑ Self-evaluation checklist

Direction: Put a tick (√) against each of the following tasks you can perform. If you are not able to perform one of these tasks, you need to read once again. I can

- List some procedures used to handle the microscope……
- Explain about structure and function of microscope……

Section 1.6. General Laboratory Safety Rules

Overview

Dear learner! 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.

Safety is very important in our daily to protect our self from accidents and injuries. I hope you always practice different safety conditions in your daily life. For example what safety rule will you practice if you want to drive a car or a motor cycle?

You will check the condition of the car or the motor cycle,
You will put a seatbelt protection while driving,
You will wearing helmet while driving motor cycle etc.

Dear learners! In the previous section, you have studied about the important laboratory tools. Using this laboratory tools and chemicals needs a special care before doing any activity. Therefore, you are expected to understand some laboratory procedures and safety rules. Accordingly, you will study about general laboratory safety.

Learning competencies

By the end of this section, you will be able to:

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

Dear learner! Laboratory safety procedures are 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 1.9

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

a) Why are goggles and laboratory coats used for?

b) Why is hair tied back?

c) List some safety rules.

Figure 1.28. Signs for general laboratory safety rules

Dear learner, we hope you enjoyed reading this passage. We think it is very interesting and important for you to know the laboratory procedures and rules.

Important general laboratory safety rules are:

1. **Following the instructions:** Please, read the laboratory procedure and be familiar with all the steps, from start to finish. It is very important to know how to use all of the lab equipment before you begin.
2. **Knowing the location of safety equipment:** It is mandatory to have a fire extinguisher and first-aid kit readily in the laboratory. It's important to know the location of the safety equipment and how to use it. It's a good idea to periodically check equipment to make sure it is in working order. Review lab safety signs and look for them before starting an experiment.
3. **Dressing for the laboratory:** It is important to wear protective cloths including a laboratory coat, safety goggles, gloves, hearing protection, long pants, a long-sleeve shirt, and leather shoes or boots that fully cover your feet(NO sandals).Wear a disposable respirator mask when you handle chemicals that are toxic. The dressing procedure should be based on the nature of the experiment.
4. **Never eat or drink in the laboratory:** Don't eat or drink in the science laboratory. It is forbidden to store food or beverages in the same refrigerator that contains experiments, chemicals, or cultures.
5. **Never taste or sniff chemicals:** Avoid tasting or smelling chemicals or biological cultures. Tasting or smelling some chemicals can be dangerous or even deadly. The best way to know what's in a container is to label it and read before use, so get in the habit of making a label for glassware before adding the chemical.
6. **Act responsibly in the laboratory:** Never randomly mixing chemicals to see what happens. It may result an explosion, fire, or release of toxic gases.
7. **Cleaning the experiment area in the laboratory and storing the waste properly:** Every laboratory session should begin and end with your glassware, chemicals, and laboratory equipment clean and stored properly.

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

9. **Know what to do with laboratory accidents:** If someone burn or if he exposed

to chemical immediately flood the burned area with cold tap water for several minutes to minimize the damage done by the burn.

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

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

Self-Test Exercise

1. List the ten important general laboratory safety rules.

☑ Self-evaluation checklist

Direction: Put a tick (√) against each of the following tasks you can perform. If you are not able to perform one of these tasks, you need to read once again. I can

- list some of the safety rules of laboratory
- explain about laboratory safety rules used in chemical handling

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 microorganisms. 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.

Unit review Questions

I. Choose the correct answer for the following questions.

1. Which of the following is true about a scientific method?
   a. A scientific method involves asking questions.
   b. A scientific method suggesting possible answers.
   c. A scientific method is testing for the validity of the answers through experimentation.
   d. All
2. In a scientific method, *forming of a hypothesis is found at ------Step*
   a. first b. second c. third d. fourth
3. Which of the following is not true about light microscope?
   a. A light microscope uses a beam of light to view specimens.
   b. simple light microscope consists of a single lens.
   c. compound light microscope consists of two or more glass lenses.
   d. A compound microscope with a single eye-piece is called binocular
4. What is the important function of autoclave?
   a. sterilizes contaminated materials b. culturing micro-organisms
   c. to measure samples d. all

II. Write short answer for the following questions.

1. What is electron microscope?
2. What will happen to the field of view in a microscope as you close the diaphragm? Explain your answer.
3. Why should you always focus a microscope by moving the objective lens away from the specimen?

Answer Key to Activities and Review questions

Section 1.1

1. D 2. D

Section 1.2

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

Section 1.3

1. is a proposed scientific explanation
2. Observation

Section 1.4

1. H 2. H 3. H 4. H 5. H 6. H 7. H 8. H

Section 1.5

1. A 2. A 3. A 4. A 5. A

Section 1.6

Important general laboratory safety rules are:

1. Following the instructions
2. Dressing for the laboratory
3. Never eat or drink in the laboratory
4. Never taste or sniff chemicals
5. Act responsibly in the laboratory
6. Cleaning the experiment area in the laboratory and storing the waste properly
7. Handling chemicals properly
8. Know what to do with laboratory accidents
9. All laboratory personnel should place emphasis on safety and chemical hygiene at all times

Feedback to Activities

Feedback to Activity 1.1

Living things have different characteristics that distinguish them from non-living things. The following are common properties of living things those found in your text book. Living things:

- are composed of one or more cells
- are complex and highly ordered
- can respond to stimuli, grow, reproduce, etc.
- transmit genetic information to their offspring
- need the energy to accomplish work
- can maintain relatively constant internal conditions (homeostasis)
- are capable of evolutionary adaptation to the environment .etc.

Feedback to Activity 1.2

You can use the examples of application mentioned in the text book such as:

- Wine-making, the brewing of beer, 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, which are produced by mold 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.
- Radiation can also be medically beneficial which is helping to treat cancer, studied by combination of two subjects Physics and Biology.
- Discovery of the structure of DNA by Watson and Crick in 1953 and subsequent achievements in DNA science led to the technologies of DNA manipulation that are transforming applied fields such as medicine, agriculture, and forensics Forensic analysis of. DNA samples from crime scenes.

Feedback to Activity 1.3

This activity helps you to practice how to formulate hypothesis. In the activity, you should do an experiment on seed germination. You should measure the growth of the seeding on each day, and draw a bar graph using X axis for measurement of time /hour of germination and, at Y axis, indicate the length of the germinated plants. This activity makes you practice scientific experiment and you can develop a skill to draw a bar graph.

Feedback to Activity 1.4

Write down the name of the tools you observe in Biology laboratory

Feedback to Activity 1.5

The dot gets bigger more than the original size because of the hand lens and after a while, the piece of paper is burning because of the converging of the radiation ray on the piece of paper.

Feedback to Activity 1.6

Hand lens has convex lens

Feedback to Activity 1.7

You should fill the table by calculating the total magnification using the formula:

Feedback to Activity 1.8

1. Head, arm and base
2. Eyepieces and objective lenses
3. Aperture, Microscopic illuminator, Condenser and Diaphragm

Feedback to Activity 1.9

Answer these questions before reading the notes in the textbooks.

I. Answers to unit Review Questions

I. Choose the correct answer for the following question...

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

II. Write short answer for the following questions.

1. Electron 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.

2. The diaphragm on the microscope is used to change the amount of light that is being allowed to enter through the slide. Closing the diaphragm will decrease the amount of illumination of the

Specimen but increases the amount of contrast. The light to the field is reduced as the diaphragm is closed. Smaller diameter and therefore lets in less light.

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

References

Jane, B. et al (2016). *Campbell Biology*. 11th Ed. Pearson higher education Ltd.

Mackean, D. G., & Hayward, D. (2014). *Cambridge IGCSE Biology*. 3rd Ed. Hodder Education.

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UNIT TWO: CHARACTERISTICS AND CLASSIFICATION OF ORGANISMS

INTRODUCTION

Dear learner! Welcome to unit two which deals with characteristics and classification of organisms. This chapter will re-introduce you to the field of taxonomy and to several key concepts that you may have covered in primary school science education. In this chapter, you will identify the characteristics of living things, classify living things based on taxonomic principles, discuss the relevance of classification, describe the system of Linnaean nomenclature and classify common Ethiopian animals and plants based taxonomic categories. Furthermore, you will define taxonomy, classification, identification, and nomenclature. You will also briefly discuss the characteristic features the three domains of life; the five-kingdom classification system and you will wind it up with discussion of the works of renowned Ethiopian Taxonomist.

Learning Outcomes

Upon successful completion of this unit, you will be able to:

- State the characteristics of living things
- Classify living things based on taxonomic principles
- Argue for or against the importance of classification
- Describe the system of Linnaean nomenclature
- Classify common Ethiopian animals and plants based on the taxonomic categories.
- List the characteristic features of the five kingdoms
- Appreciate the works of renowned taxonomists in Ethiopia

Unit Contents

This unit includes the following seven major contents organized in sections

Section 2.1. Characteristics of living things

Section 2.2. Taxonomy of living things

Section 2.2.1. Principles of classification

Section 2.2.2. Taxonomic hierarchies in biological classification

Section 2.3. Relevance of classification

Section 2.4. Linnaean system of nomenclature

Section 2.5. Common Ethiopian animals and plants

Section 2.6. The five-kingdom system of classification

Section 2.7. Renowned taxonomists in Ethiopia

Required learning time

You are expected to spend 18 learning hours within one semester to learn this unit. You should use the allocated study time properly and efficiently to cover the lessons included in this unit.

Learning activities

Please be sure that there are several learning activities placed throughout this unit, which will help you practice using the information you will learn. After attempting each activity in the module, try to check your answers against the answer keys set for each learning activities and make corrections to your work.

Learning strategies

For your successful distance learning process, you can use the following learning strategies wherever they are appropriate to the topics/subtopics of your lesson. These are mind mapping, mentally rehearsing, short visits/onsite observation, comparing and contrasting, drawing and taking pictures of orgasms, creating analogies, paraphrasing, summarizing (outlining and preparing flow chart summaries), taking short notes, underlining or highlighting key points, and if possible hands-on experiments.

Assessment

When you complete unit 2, you will submit your assignments, to the Distance Learning Unit either by mail or electronically through the learning management system (LMS). The staff will forward your work to your tutor/marker.

Section 2.1. Characteristics of Living Things

Dear learner! In subsection of this unit, you will learn about characteristics of living things. As you know from your previous studies, living things have some characteristic features that distinguish them from the non-living things. You may go back and revise your lessons from primary school sciences education to refresh your memory about the unique features of living things. Do you recall some of these features? If you remember some, list them on a piece of paper.

COMPETENCIES

After completion of this section, you will be able to:

- State the characteristics of living things

Activity 1

Dear learner, if your friend put 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? Write a short note on what actions you will take and submit to a tutorial center.

Dear leaner! You learned at primary school science lessons, that living things have variety of shapes and forms. Accordingly, biologists study life in many different ways. For example, they count how many times birds' wings beat per second. What makes something "alive"? Anyone could deduce that a running 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 waggle in a bowl. They certainly are not alive.

Activity 2

Dear learner, how are living things different from non-living? Sort out the things you observe in environment into living and non-living. Based on your observations, write down a maximum of 5 lines short report and present at a tutorial center.

What are the characteristics of living things?

Dear learner, here under, I will present you some of the properties that are shared by most living things. While reading this section, try to take a note and compare the features of living things you have written at the begging of this subsection.

1. **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'.
2. **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.
3. **All living organisms respond to stimuli:** organisms can detect or sense stimuli (change) in the internal or external environment and make appropriate responses.
4. **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.

5. **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.
6. **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.
7. **All living things display ordered complexity:** All living things are both complex and highly ordered. The levels of organization in biological systems begin with atoms and molecules and increase in complexity. Your body is composed of many different kinds of cells each containing many complex molecular structures. Many nonliving things may also be complex, but they do not exhibit this degree of ordered complexity.
8. **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.
9. **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 as shown Fig. 2.1 below:

Figure 2.1. Characteristics of living things

Exercise 1: Self-assessment questions

Part One: Say true if the statement is correct false if the statement is wrong.

1. Some organisms use energy from the sunlight to make their foods through the process of photosynthesis.
2. All living things are both complex and highly unordered.
3. Excretion is the regulation of an organism's internal conditions to maintain stability.
4. Reproduction is the process that makes more of the same kind of organism.
5. Growth is a permanent increase in size and mass due to an increase in cell number or cell size or both.

Part 2: Critical thinking questions

1. Producers and consumers differ in the way they use the energy from sunlight. Explain.
2. How are living things different from the non-living things?
3. What is the significance of adaptation for living things?

☑ Self-evaluation checklist

Put a tick ☑ against each of the following task(s) which you can perform. If you cannot perform any of these tasks, go back and read the lesson for that particular task.

I can

- List down the characteristics of living things _____ ☐

Section 2.2. Taxonomy of Living Things

Section 2.2.1. Principles of Classification

Dear learner! In the previous section, you have learned about characteristics of living things. Next, you will learn about principles of classification. Remember that the need to organize, classify, and name objects is basic to human nature. By organizing things into groups, naming

those groups, and then comparing the groups, we gain a better understanding of the things we are studying. Classifying things into groups is a useful process.

Competencies

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

- classify living things based on taxonomic principles.

Activity 3

Dear learner, section 2.2.1 explains how biologists organize the study of living things. This organization makes it easy to tell which organisms share characteristics and which are related to each other. Why is it important to group or classify things around us - cloths, books, bottles, tools, electronics, plants, animals, chairs, or tables? Do you remember times you or family members classifying things in your home? Write the advantages of being organized and submit your report it to a tutorial center.

Why do biologists classify living things?

Dear learner, organizing items not only makes them easier to find them back but can also make easier to understand. One tool a biologist uses to organize and understand living organisms is classification.

Classification is the process of grouping things based on their similarities and differences. 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. 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 - morphological, physiological, molecular, behavioral, and/or ecological characters.

Key Terms

Behavioral character: about the organism's activities or what organism does.

Ecological character: where the organisms live, their interaction among themselves and the environment.

Identification: identifying organisms using characteristic feature.

Molecular character: features like DNA, RNA or Protein.

Morphological character: structures such as teeth, muscle, bone, hair, root, stem, leaf, flowers, fruits, etc.

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

Physiological character: functions such as respiration, movements, breathing, digestion, blood circulation, photosynthesis, excretion, reproduction, etc.

Taxonomy: The science of identification, naming and classifying species.

Exercise 2: Self-assessment questions

Part One: Say true if the statement is correct false if the statement is wrong.

1. Classification is identifying organisms using characteristic feature.
2. Features like DNA, RNA or Protein are molecular characters.
3. Morphology is the science of identification, naming and classifying species.

Part Two: Critical thinking question

1. What features of the organisms' do biologists use to classify them?

☑ Self-evaluation checklist

Put a tick ☑against each of the following task(s), which you can perform. If you cannot perform any of these tasks, go back and read the lesson for that particular task

I can:

- Classify living things based on taxonomic principles_____ ☐

Section 2.2.2. Taxonomic Hierarchies in Biological Classification

Dear learner! Now, you are familiar with the principles of classification. You have also learned the common terms used by taxonomists. In this section, you will learn about taxonomic hierarchies in biological classification and their importance.

Competencies

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

- describe taxonomic hierarchies

Activity 4

Dear learners, why do biologists need to organize living things into hierarchies? Write the relevance of taxonomic hierarchies with your own words and submit to a tutorial center.

Dear learner, 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.

What are taxonomic hierarchies?

Dear learner, 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). Furthermore, taxonomists group all living things into three **domains**. 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. This system did not distinguish between the eukaryotes and prokaryotes, unicellular and multicellular organisms; and photosynthetic (green algae) and non-photosynthetic (fungi) organisms.

 What are the domains of life?

Dear learner, 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.

 Did you know the characteristic features of Archaea?

Dear learner! 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.

 Did you know the characteristic features of Bacteria?

Dear learner! 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 of chlorophyll for photosynthesis by bacteria but not by archaea, methane generation, and sensitivity to some antibiotics.

 Did you know the characteristic features of Eukarya?

Dear learner! Eukaryotes have relatively large and complex cells that contain a nucleus and other membrane-enclosed compartments. They are grouped into the domain **Eukarya**. The domain eukarya includes groups such **protista**, **fungi**, **plants** and **animals**. Have a great diversity of forms: there are unicellular, colonial and multicellular organisms.

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

Key Terms

Archaea: is a group of single-celled organisms that lack a nucleus but are more closely related to eukaryotes than to bacteria.

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: are cells with a true nucleus.

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.

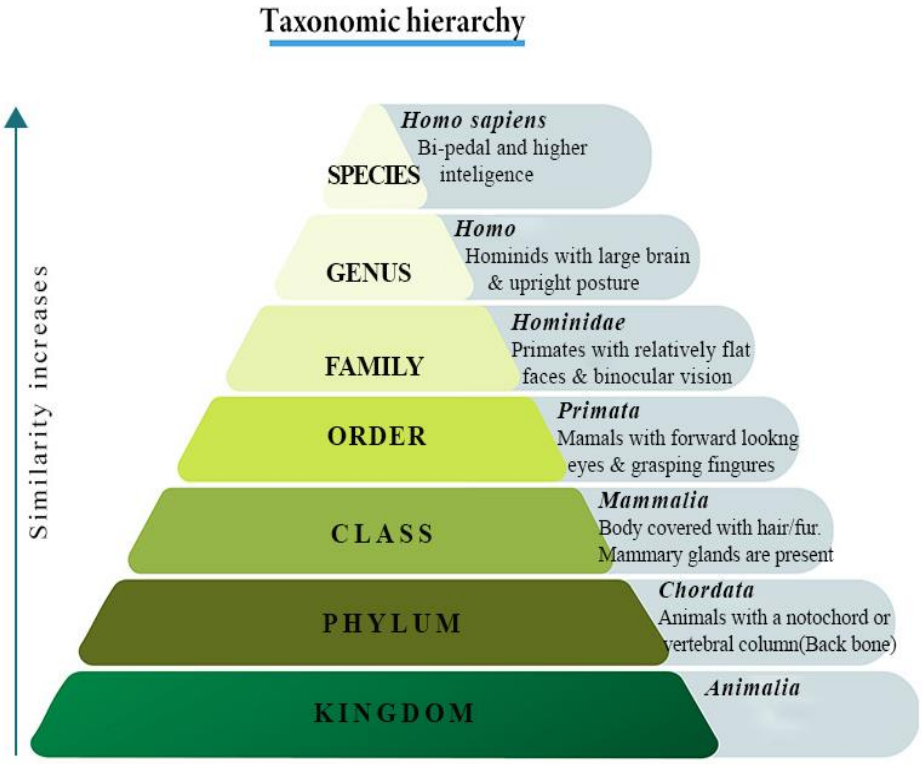

Figure 2.2. Taxonomic hierarchy

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.

Exercise 3: Self-Assessment questions

Part One: Match items under column A with the appropriate item under **column** B.

	A		B
1.	Is a taxon of similar genera	A.	Nomenclature
2.	Is a taxon of similar phyla	B.	Order
3.	Identifying organisms using characteristic feature	C.	Genus
4.	Grouping things based on their similarities	D.	Taxon
5.	A rank in a taxonomic hierarchy	E.	Class
6.	A unique type of organism	F.	Kingdoms
7.	Is the rank above kingdom	G.	Phylum (division)
8.	Is a taxon of similar species	H.	Identification
9.	Deals with the naming of organisms	I.	Family
10.	Is a taxon of similar species	J.	Classification
11.	Is a taxon of similar orders	K.	Species
12.	Is a taxon of similar families	L.	Domains

Part Two: Critical thinking question

1. What is taxonomic hierarchy?
2. List some of the taxonomic hierarchies that you know.
3. Name the three domains that are currently used in biology to classify the life forms on Earth. For each domain, state the characteristics that distinguish it from the other two domains.

☑ Self-evaluation checklist

Put a tick ☑against each of the following task(s), which you can perform. If you cannot perform any of these tasks, go back and read the lesson for that particular task

I can

- Describe taxonomic hierarchies _____ ☐

Section 2.3. Relevance of Classification

Dear learner! In the previous, you learnt about taxonomic hierarchies in biological classification and their importance. Have you ever imagined the importance of biological classification for your daily activities? Next, you will learn about relevance of classification. If you recall in the primary schools, you have learned that some plants are used for food, for medicine, construction, etc. Do you remember additional uses of plants and animals for human and nature?

Competencies

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

- describe the relevance of classification

Activity 5

Dear learner, have you ever asked yourself why human beings classify organisms? Visit a public library in your village, and write a short note on the importance of biological classification and submit to a tutorial center.

What is the relevance of biological classification?

Dear learner, the applications of classification are manifold - identification of harmful and beneficial organisms, reduce energy and time used to study organisms, help us understand the relationship between organisms, etc.

Dear learner! Taxonomy is 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.

Dear learner! Taxonomy can also give biologists a framework that allows them to study the relationships between organisms (extinct and extant species). 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.

Key Terms

Dinosaurs: A reptile like animals that used to live on the planet earth and which are extinct now.

Extant: Species of organisms for which their members are still living on the earth.

Extinct: Are species for which all the members have disappeared from the planet earth for example, **Dinosaurs or Dodo.**

Exercise 4: Self-assessment questions

Part One: Choose the correct answer among the given alterative

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 are
   D. All of the above
2. Which of these statements is not a reason why biologists classify the living world?
   A. To try to understand how life originated
   B. To make things sound complicated
   C. To simplify their study
   D. To bring order out of chaos or confusion

☑ **Self-evaluation checklist**

Put a tick ☑against each of the following task(s), which you can perform. If you cannot perform any of these tasks, go back and read the lesson for that particular task.

I can:

- Describe the relevance of classification_____ ☐

Section 2.4. Linnaean System of Nomenclature

Dear learner! In the previous section, you learnt about the relevance of classification. Next, you will learn about Linnaean system of nomenclature and their use in taxonomy. Yow will also learn how to give and write scientific names for organisms.

Competencies

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

- Describe the system of Linnaean nomenclature
- Explain how organisms are given scientific names.
- Write scientific names properly and give examples.

Activity 6

Dear learner, did you know Carl Linnaeus? Enumerate the major contributions of Carl Linnaeus to the Science of taxonomy.

How did Carl Linnaeus classify living organisms?

Dear learner! 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 a book, 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.

 What is a Binomial nomenclature?

Dear learner, 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, *Boqqolloo(Badallaa)* in Afan Oromo, *Baddelaa* 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 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, behavior and color makes it difficult to differentiate one species from the other. Again, the use of the scientific name avoids such confusion.

Dear learner, 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 specific epithet. 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 characteristic features of the organism**.** For example, the scientific names of Enset, false banana, and Banana, are *Ensete ventricosum* and *Musa acuminate*, respectively. Both belong to the same family (Musaceae).

Dear learner, 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.

Attention

UNIVERSAL RULES OF NOMENCLATURE ARE AS FOLLOWS

1. Biological names are generally in Latin and written in italics. They are Latinised or derived from Latin irrespective of their origin.
2. The first word in a biological name represents the genus while the second component denotes the specific epithet.
3. Both the words in a biological name, when handwritten, are separately underlined, or printed in italics to indicate their Latin origin.
4. The first word denoting the genus starts with a capital letter while the specific epithet starts with a small letter. It can be illustrated with the example of *Mangifera indica*.

Exercise 5: Self-assessment questions

Part One: Say true if the statement is correct false if the statement is wrong.

1. The first word in a biological name represents the genus while the second component denotes the specific epithet.
2. Carolus Linnaeus successfully classified over 4000 animals into mammals, birds, insects and worms.
3. The specific epithet sometimes describes a characteristic of the organism**.**
4. The scientific names are underlined when handwritten or italicized when printed.
5. Sapiens is the species name of human beings.

Part Two: Critical thinking question

1. Why do biologists use binomial system instead of local names?
2. What is a binomial nomenclature?
3. Using the rules nomenclature, write the scientific names of the following organisms: house fly, mouse, dogs, cat & goat.

☑ **Self-evaluation checklist**

Put a tick ☑ against each of the following task(s), which you can perform. If you cannot perform any of these tasks, go back and read the lesson for that particular task.

I can

- Describe the system of Linnaean nomenclature _____ ☐
- Explain how organisms are given scientific names_____ ☐
- Write scientific names properly and give examples_____ ☐

Section 2.5. Common Ethiopian Animals and Plants

Dear learner! Now, you are familiar with the Linnaean system of nomenclature and their use in taxonomy. In this section, you will learn about classification of common Ethiopian animals and plants based on their unique characteristics and dichotomous keys.

Competencies

At the end of this section, you 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

Activity 7

Dear learner, ask a biologist in your village the scientific and the local names common Ethiopian plants and animals' species. Prepare a short report and submit it to a tutorial center.

Dear learner, our country, Ethiopia is endowed with high biological diversity (biodiversity) due to its geographical location, topographical diversity and diverse climatic features. As might you know, Ethiopia is a hot spot for a diversity of wild plant and animal species with a high degree of endemicity. Furthermore, our country is a primary center 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 favored diversification of these resources. The scientific and common names of some plants and animals in Ethiopia are presented in table 1.

Table 2.1: Scientific names of some common plants and animals in Ethiopia

Common Name	**Taxon**						
	Kingdom	**Phylum/Division**	**Class**	**Order**	**Family**	**Genus**	**scientific names**
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	Angiosperm ata	Monocylodoneae	Zingiberales	Mussaseae	Ensete	*Ensete ventricosum*
Maize	Plantae	Angiosperm ata	Lilospida	Cyperales	Poacea	Zea	*Zea mays*
Noug	Plantae	Angiosperm ata	Eudicots	Asterales	Asteraceae	Guizotia	*Guizotia abyssinica*
Tef	Plantae	Angiosperm ata	Lilospida	Cyperales	Poacea	Eragrotes	*Eragrstos tef*
Wheat	Plantae	Angiosperm ata	Lilospida	Cyperales	Poacea	Triticum	*Triticum aestivum*

Dichotomous keys

Activity 8

Dear learner, you may have come across organisms that you did not recognize and could not classify. What tools do you use to identify these unknown organisms? Please write a short note about the procedure you use and present it at a tutorial center.

How do biologists use dichotomous keys?

Dear learner, dichotomous keys are tools 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.

Dear learner look 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. To start with look item 1, it 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.

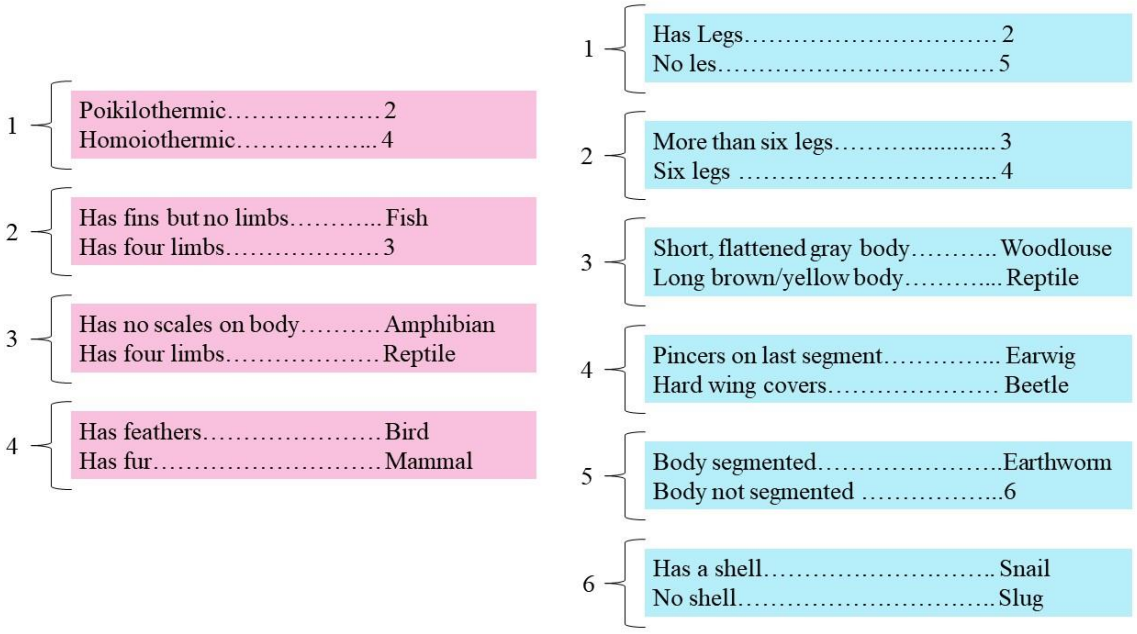

Figure 2.3. Vertebrate (left) and invertebrate (right) keys

Exercise 6: Self-assessment question

Part one: Critical thinking question

1. Dichotomous keys are useful tools for the identification of unfamiliar organisms, but their uses are not always easy. Explain.
2. Ask a biologist the names of twenty common Ethiopian animals and plants and write their scientific names (species names) along with their local names.

☑ Self-evaluation checklist

Put a tick ☑ against each of the following task(s) which you can perform. If you cannot perform any of these tasks, go back and read the lesson for that particular task.

I can

- 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_____ ☐

Section 2.6. The Five-Kingdom System of Classification

Dear learner! Previously, you learnt about classification of common Ethiopian animals and plants. Next, you will learn about the five-kingdom system of classification. You will learn how to group living things into the five kingdoms. You also study the characteristic features of each kingdom by giving examples.

Competencies

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

- Tell the basis of Whittaker for the classification

Activity 9

Dear learner! What is the largest category of organisms recognized by taxonomists? How many such categories are there? Most taxonomists used to favor the adoption of two categories. What are these two categories?

Why did we come up with the five kingdoms?

Dear learner! 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 - **plants and animals**. 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 as it is shown Fig. 2.4. It is still not easy to fit all organisms into the five-kingdom scheme. For example, many **protista** with chlorophyll (the protophyta) show important

resemblances to some members of the algae, but the algae are classified into the plant kingdom.

Attention: Viruses

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.**

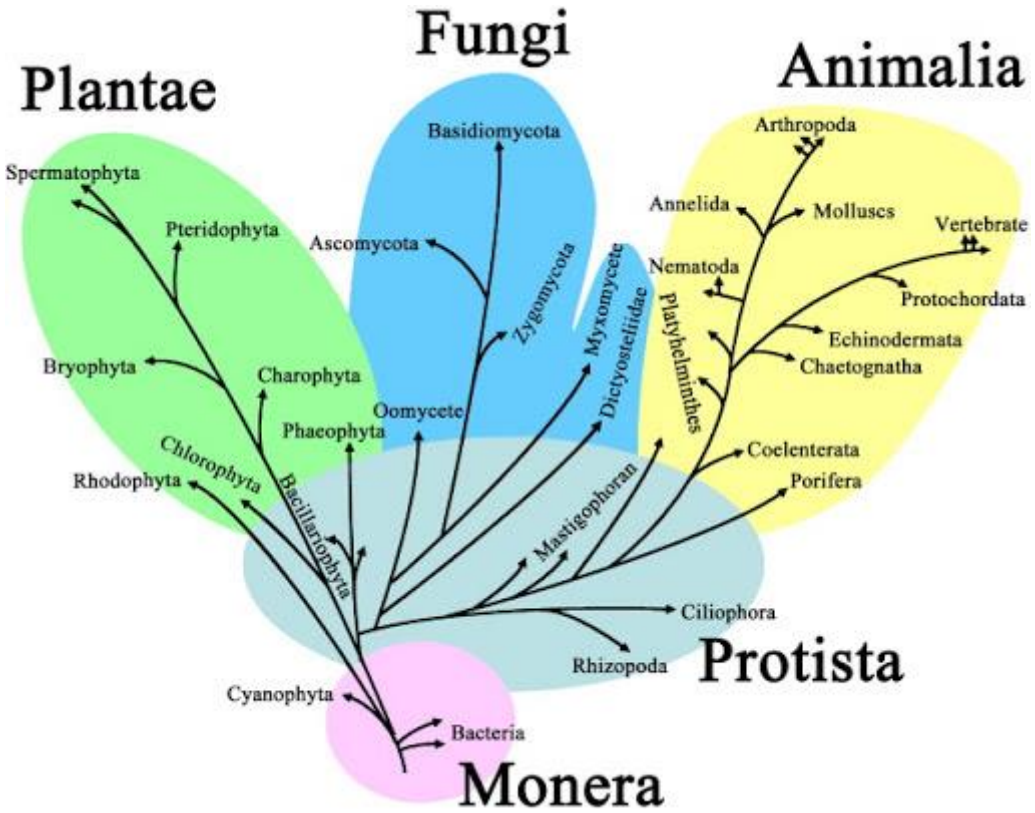

Figure 2. 4. The five kingdoms of life

Activity 10

Dear learner! Why do you that think it is difficult for taxonomists to develop a rigid classification scheme? Do you think the Whittaker's **five-kingdom** scheme has resolved the classification questions taxonomists are trying to answer for millennia?

Procedure:

1. Give a role to your study partners.
2. One of your partners supports the idea that Whittaker's **five-kingdom** scheme has solved the classification problems.
3. The other partner is against the idea that Whittaker's **five-kingdom** scheme has solved the classification problems.
4. You act as an audience.
5. Let each of your partners present their position each in five minutes, and
6. You ask questions both of your partners.

Exercise 7: Self-assessment questions

Part one: Critical thinking questions

1. Viruses are not considered as a living thing. Explain
2. Do you agree with the classification of algae as a plant? Explain.
3. Do you suggest an alternative category or group for organisms' such as algae and the likes?
4. What are the main criteria used by Whittaker for the classification of the five kingdoms?

☑ Self-evaluation checklist

Put a tick ☑ against each of the following task(s) which you can perform. If you cannot perform any of these tasks, go back and read the lesson for that particular task. I can

- Tell the basis of Whittaker for the classification _____ ☐

Section 2.6.1. Kingdom Monera

Dear learner! In the previous section, you learnt about the five-kingdom system of classification. You learned how to group living things into kingdom. Next, you will learn about the kingdom Monera and the unique features of the members of the kingdom. You will learn the how to group monera into archaebacteria and eubacteria. You also study the characteristic features of the major groups of kingdom monera.

Competencies

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

- Describe the kingdom Monera and give example of organisms
- Describe importance of Monera

Activity 11

Dear learner! 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 many 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. Write the major distinguishing features of kingdom Monera and bring to the tutorial center.

What are Monera?

Dear learner! Monera includes eubacteria and archaebacteria. Eubacteria (true bacteria) have strong cell walls. They exist in various shapes and forms (Figs 2.5 and 2.6). Some eubacteria are heterotrophs; others can make their (autotrophs). Some autotrophic bacteria make their own food the way plants do; they are **photosynthetic**. Others make energy by chemical reactions; **chemosynthetic**. The eubacteria live in most habitats, except the most

extreme. Some eubacteria cause diseases, like strep throat and pneumonia. Most eubacteria, however, are harmless and helpful.

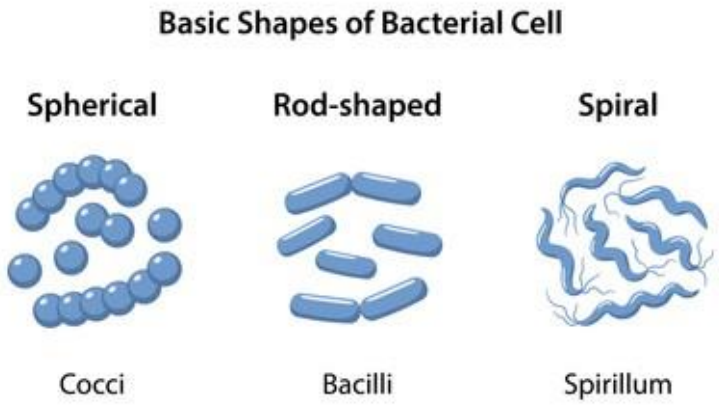

Figure 2.5. Examples major groups of Monera

Dear learner! 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 as shown in Fig 2.6 below.

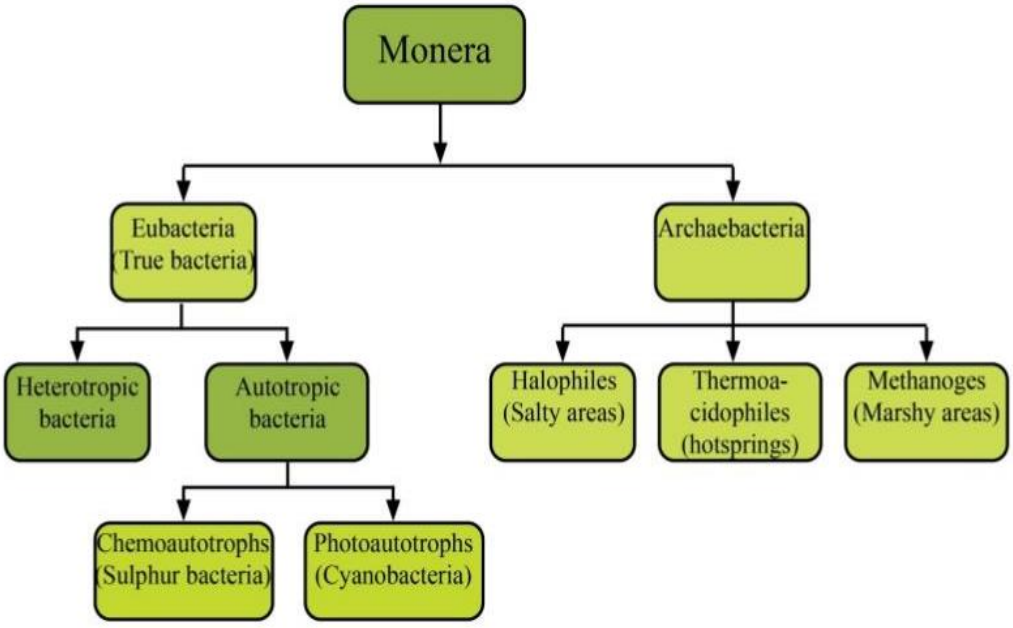

Figure 2.6. Some representative of taxa of kingdom monera

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

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

Attention

IMPORTANCE OF BACTERIA

Dear learner! Imagine that 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 12

Dear earner! 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

Exercise 8: Self-assessment question

Part One: Match items under column A with the appropriate item under **column** B.

A		B	
1.	Salt loving bacteria	A.	Archaebacteria
2.	Synthesis food using chemical reaction	B.	Photosynthetic
3.	Live in marshy area	C.	Chemosynthetic
4.	Live in extreme environments	D.	Methanogens
5.	Synthesis food using light energy	E.	Halophiles

Part Two: Critical thinking questions

1. Write the major distinguishing features between archaebacteria and bacteria.
2. If someone tells you that bacteria are harmful, how will you respond to it?
3. Write the major shape types of bacteria.

☑ Self-evaluation checklist

Put a tick ☑ against each of the following task(s) which you can perform. If you cannot perform any of these tasks, go back and read the lesson for that particular task.

I can:

- Describe the kingdom Monera and give example of organisms ☐
- Describe importance of Monera_____ ☐

Section 2.6.2. Kingdom Protista

Dear learner! In the previous section, you learned about the kingdom Monera and the unique features of the members of the kingdom. You also learned the how to group monera into archaebacteria and eubacteria. You also studied the characteristic features of the major groups of kingdom monera. In this subsection, you will learn about the kingdom **Protista** and the unique features of the members of the kingdom. You will learn the how to group **Protista** into the major groups. You also study the characteristic features of the major groups of kingdom **Protista**.

Competencies

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

- Describe the kingdom Protista and give examples of organisms
- Describe importance of Protista

Activity 13

Dear Learner! 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 section 2.6.2 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 and develop a short note that you will submit at a tutorial center.

What are protists?

Dear learner, imagine that there is no such thing as a typical protist. Kingdom protista contains the most diverse organisms of all the kingdoms shown in Figs. 2.7 and 2.8 below. 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.

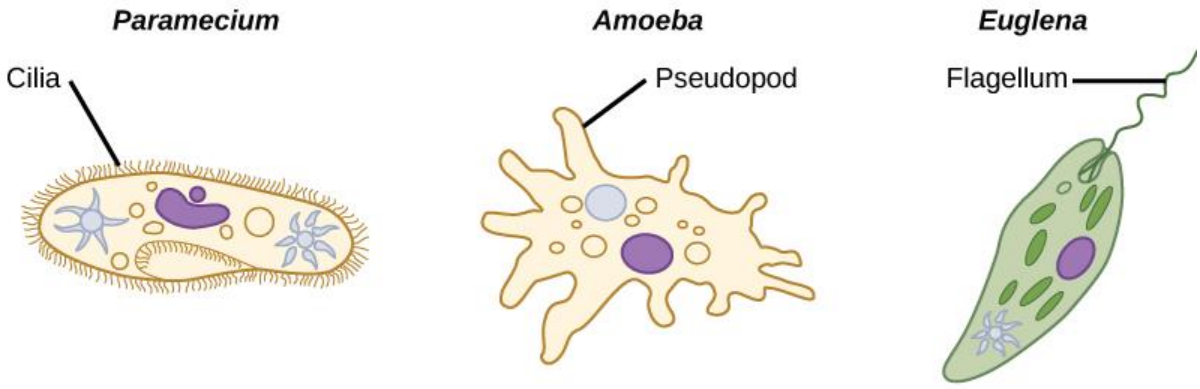

Figure 2.7. Examples major groups of protists

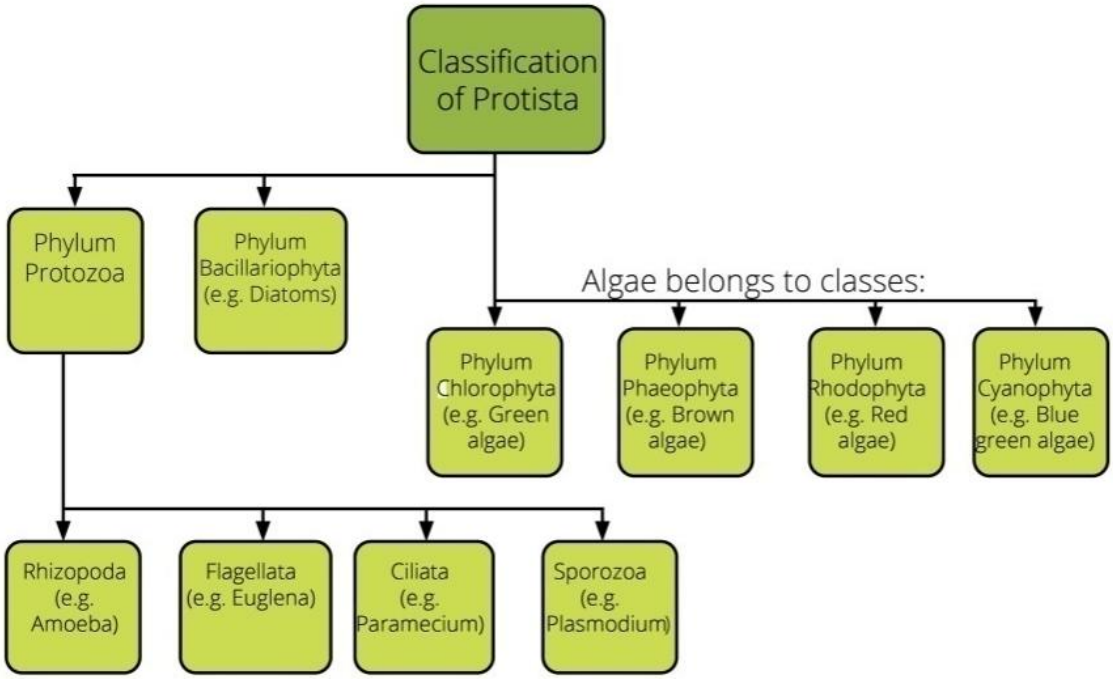

Figure 2.8. Some representative taxa of kingdom Protista

Activity 14

Dear learner, 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. Write the additional applications of Diatomite and submit to your tutorial center.

Exercise 9: Self-assessment questions

Part One: Write true if the statement is correct and writes false if the statement is wrong.

1. Some Protista seem to be like fungi and have the same kind of cell walls that fungi have.
2. Kingdom Protista contains the most diverse organisms of all the kingdoms.
3. Plasmodium, paramecium and ameba belong to the kingdom Protista.
4. Protozoans seem to be like animals except that they only have one cell.

Part Two: Critical thinking questions

1. Compare and contrast algae with plants.
2. What are the characteristic features of Protista?
3. What is the single common feature all Protista possess?

☑ Self-evaluation checklist

Put a tick ☑against each of the following task(s) which you can perform. If you cannot perform any of these tasks, go back and read the lesson for that particular task.

I can

- Describe the kingdom Protista and give examples of organisms ☐
- Describe importance of Protista _____ ☐

Section 2.6.3. Kingdom Fungi

Dear learner! Now, you are familiar with the kingdom **Protista** and the unique features of the members of the kingdom. You also learnt how to group **Protista** into the major groups. You also studied the characteristic features of the major groups of kingdom **Protista**. In this subsection, you will learn about the kingdom **Fungi** and the unique features of the members of the kingdom. You will learn how to group **Fungi** into the major groups. You also study the mode of reproduction, nutrition, ecology, cell structure and importance of kingdom **Fungi**.

Competencies

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

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

Activity 15

Dear learner, so far, you have studied bacteria, and protists. In section 2.6. 3, 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. If possible, take a picture of those places. What do those places have in common? Were they hot, dry, cool, or damp? Did the mushrooms appear suddenly or grow slowly over time? Prepare a brief note on your observation/experience and present at a tutorial center.

What are fungi?

Dear learner! Fungi are eukaryotic organisms that include microorganisms 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

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

Dear learner! 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.

Dear learner! 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.

Dear learner! Fungi can reproduce either by vegetative means (fragmentation, fission and budding), asexual reproduction through spores formation and sexually. The various spores are produced in distinct structures called fruiting bodies

Dear learner! Yeast (saccharomyces service) is a very important fungus used for making injera rise and allows us to make alcohol (Tej, Tella, Beer, etc).

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.

Attention

IMPORTANCE OF FUNGI

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.

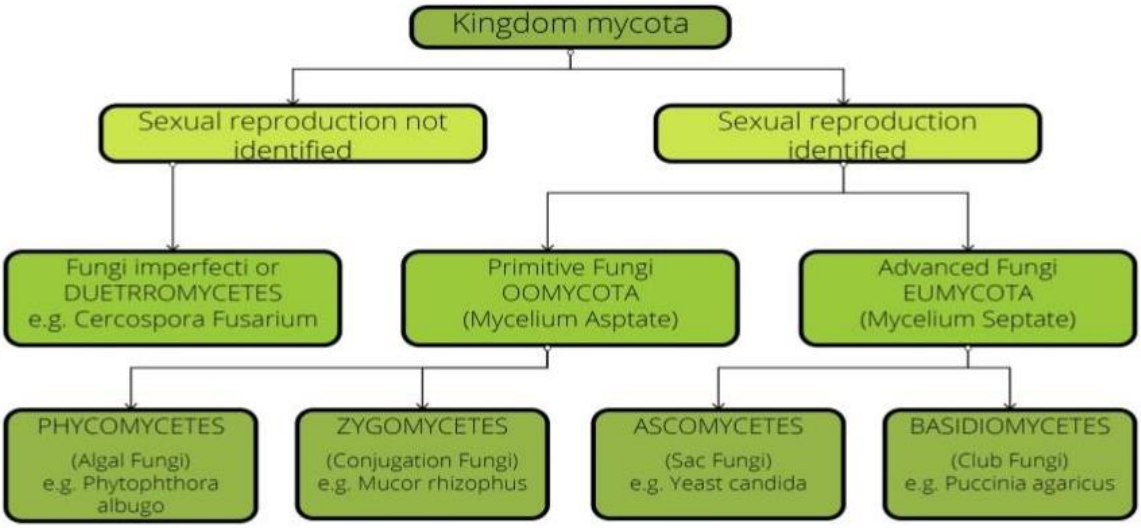

Figure 2.10. Some representative taxa of kingdom fungi

Exercise 10: Self-assessment questions

Part One: Match items under column A with the appropriate item under column B.

	A		B
1.	Break down and absorb nutrients from nonliving organic material	A.	Mutualism
2.	Symbiotic relationship in which both species benefit.	B.	Symbiosis
3.	Symbiotic relationship in which one organism benefits at the expense of another	C.	Decomposers
4.	Association with algae as lichens and with roots of higher plants	D.	Parasitism
5.	Permanent, close association between two or more organisms of different species	E.	Mycorrhiza

Part Two: Critical thinking questions

1. How do fungi digest their food?
2. Write the characteristic features of fungi.
3. Distinguish between useful and harmful fungi by giving examples

☑ **Self-evaluation checklist**

Put a tick ☑against each of the following tasks which you can perform. If you cannot perform any of these tasks, go back and read the lesson for that particular task.

I can:

- Describe the kingdom fungi and give example of organisms ____ ☐
- Discuss the importance of fungi _____ ☐

Section 2.6.4. Kingdom Plantae

Dear learner! In the previous section, you have learned about the kingdom **Fungi** and the unique features of the members of the kingdom. You also have learned the how to group **Fungi** into the major groups. You have also studied the mode of reproduction, nutrition, ecology, cell structure and importance of kingdom **Fungi**. Next, you will learn about the kingdom **Plantae** and the unique features of the members of the kingdom. You will learn the how to group **Plantae** into the major groups – vascular and non-vascular; seed and seedless plants; flowering and non-flowering plants. You also study the mode of reproduction, nutrition, ecology, cell structure and importance of kingdom **Plantae**.

Competencies

At the end of this section, you 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

Activity 16

Dear learner, think of all the things that plants provide for us. For example, they are an important source of food. They also provide oxygen through photosynthesis. Some plants are valuable sources of medicine. Write some other goods and services that plants provide to us and develop a brief note about your experience; submit at a tutorial center.

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 shown in figures 2.11 and 2.12 below:

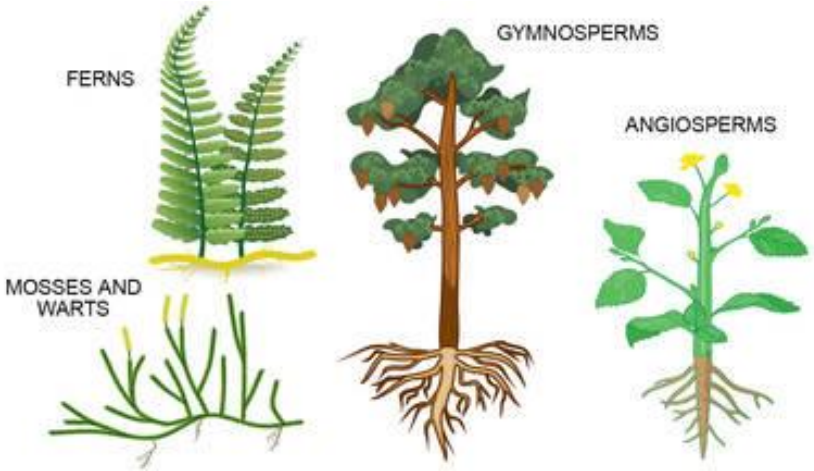

Figure 2.11. Examples major groups of plants

Activity 17

Dear learner! Try to name or think of at least five different plants. You might think of flowers, bushes, shrubs, ferns, trees, and grasses to mention 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 groups based on shared characteristics. If you were to place plants into groups, what characteristics would you use? Hint: Look at figure 2.12 to find useful features to classify plants. Write a short report on your classification and present it at a tutorial center.

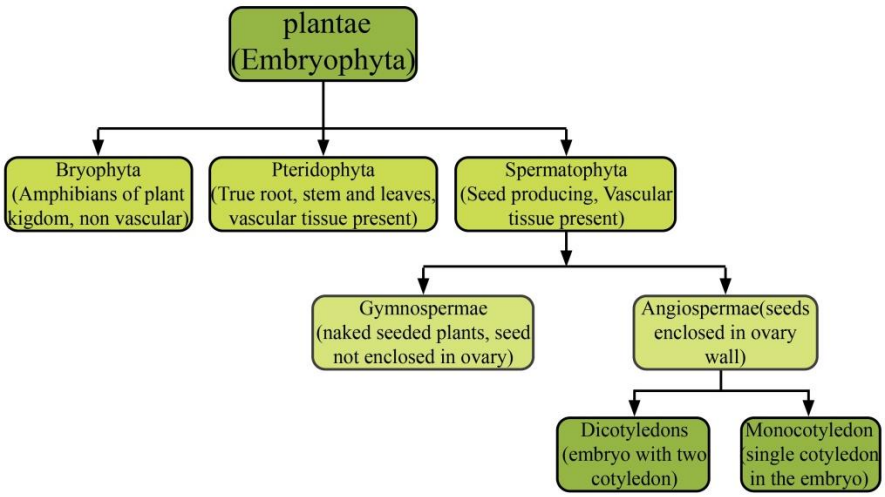

Figure 2.12. Classification of the plant kingdom

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 hornworts.

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.

Activity 18

Dear learner! Ask a biologist about the economic, medicinal and ecological values of plants (e.g., food, medicinal, ornamental, horticultural, cultural, spiritual, aesthetic, music, arts, etc.). Develop a brief note on the various uses of plants and submit to a tutorial center.

Exercise 11: Self-assessment questions

Part One: Say true if the statement is correct and say false if the statement is wrong.

1. Plants have chloroplast and chlorophyll pigment, which is required for photosynthesis.
2. The predominate mode of reproduction plants is sexual reproduction.
3. Bryophytes are the only group that makes flowers and fruits.
4. Monocots are gymnosperm which includes plants such as grasses that have one seed leaf and parallel veins.
5. Vascular plants have specialized tissues that transport water and sugar within the plant body.
6. Dicots are plants which have two seed leaves and branching leaf veins.
7. Plants with true root, stems, leaves and vascular tissue are termed Pteridophytes.

Part Two: Critical thinking question

1. Why do we call bryophytes the amphibian of the plant kingdom?
2. Write the characteristic features of plants.

☑ Self-evaluation checklist

Put a tick ☑against each of the following task(s) which you can perform. If you cannot perform any of these tasks, go back and read the lesson for that particular task.

I can:

- Describe the kingdom Plantae and give example of organisms____ ☐
- Describe characteristic features of major divisions of plants _____ ☐
- Give examples of flowering plants_____ ☐

Section 2.6.5. Kingdom Animalia

Dear learner! Now, you are familiar with the kingdom **Plantae** and the unique features of the members of the kingdom. You have also learned the how to group **Plantae** into the major groups – vascular and non-vascular, seed and seedless plants, flowering and non-flowering plants. You have also studied

the mode of reproduction, nutrition, ecology, cell structure and importance of kingdom **Plantae**. Next, you will learn about the kingdom **Animalia** and the unique features of the members of the kingdom. You will learn the how to group **Animalia** into the major groups – invertebrates and vertebrates. You will classify invertebrates into major phyla (e.g., sponges, flat worms, round worms, annelida, Mollusca, Arthropoda (e.g., Insects, Arachnids, Crustacea and Myriapods) and vertebrates into major classes (e.g., fish, amphibians, reptiles, birds, & mammals). You also study the mode of reproduction, nutrition, ecology, cell structure and importance of members of kingdom **Animalia**.

Competencies

At the end of this section, you 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

Activity 19

Dear learner, think about all the animals you are familiar with. They may be pets, domestic animals, wild animals, and captive animals such as in a circus or zoo. This section explains what most animals have in common. Enumerate the characteristics you know about that most animals share and bring to your tutorial center.

What is an Animal?

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

- Animals differ from both plants and fungi in their mode of nutrition. Unlike plants, animals are not photosynthetic. Animals consume food obtained from other organisms (i.e. they are heterotrophs). But unlike fungi, most

animals do not feed by absorption; instead, animals ingest their food and then use enzymes to digest it within their bodies.

- In contrast to plants and fungi, however, animals lack the structural support of cell walls. Instead, animal cells are held together by structural proteins, the most abundant being collagen, which is found only in animals.
- Many animals have two types of specialized cells not seen in other multicellular organisms: muscle cells and nerve cells. In most animals, these cells are organized into muscle tissue and nervous tissue, respectively, and are responsible for moving the body and conducting nerve impulses.
- 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) as shown in Fig. 2.13 -2.15 below.

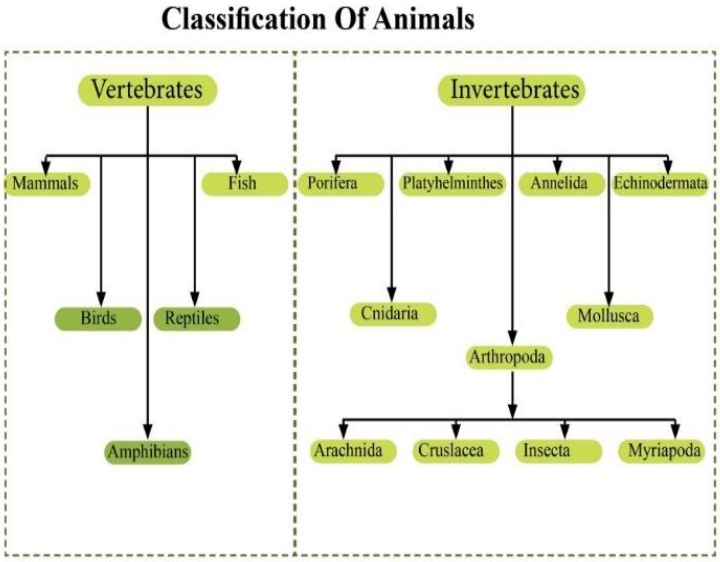

Figure 2.13. Major groups of animals

Activity 20

Dear learner! What are the two largest categories of animals recognized by biologists? Make a field visit in your village and try to classify the animals you see/know into invertebrates or vertebrates. (Hint: you could use a dichotomous key). Prepare a brief summary of your classification.

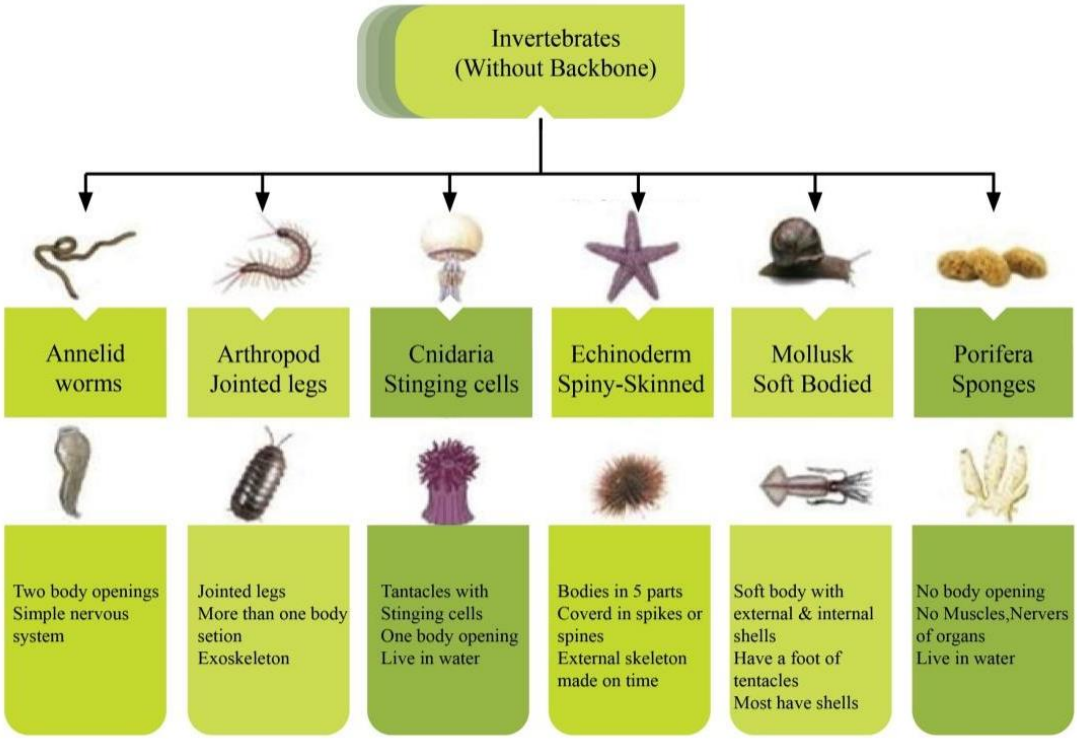

Figure 2.14. Major groups of invertebrates

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.

Activity 21

Dear learner! Ask local people about medically or agriculturally important insect (e.g., grasshopper, tsetse fly, mosquito, honey bee, etc.) and write its importance (Hint: economic, pollination, pest, aesthetic; music, arts, cultural, spiritual, vector, etc.). Develop a brief report about survey and present it during the tutorial session.

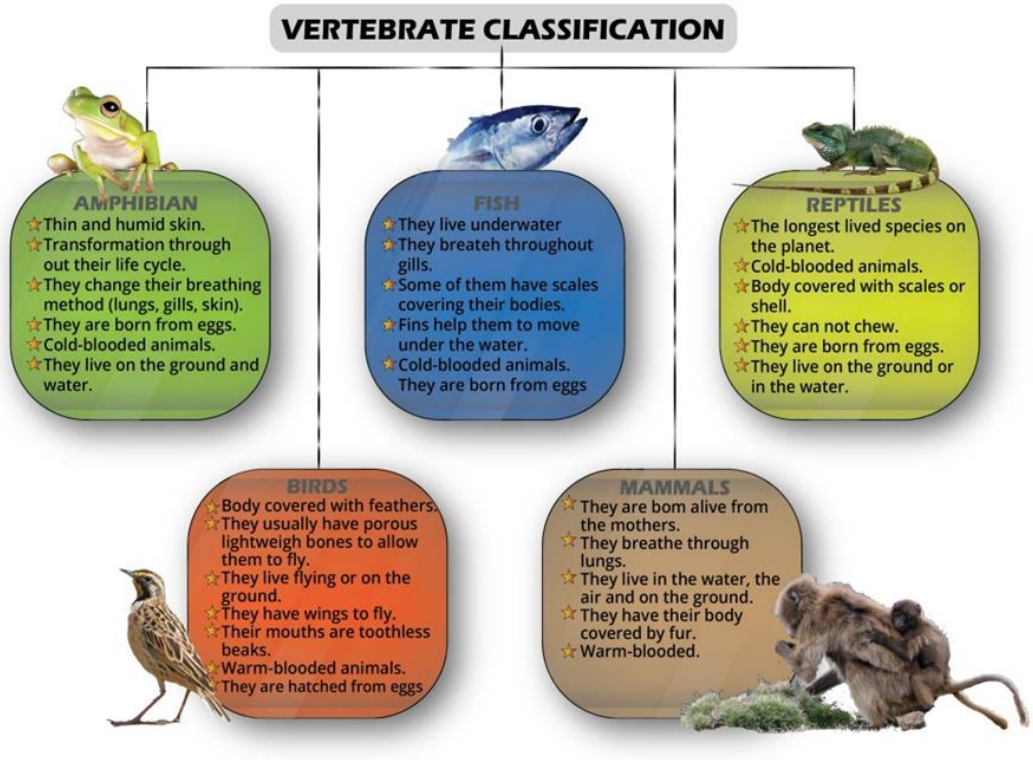

Figure 2.15. Major groups of vertebrates

Activity 22

Dear learner! Ask local people in your village about a common fish, mammal or bird species at your area. Then, write its economic, medicinal, aesthetic, cultural, spiritual, and/or ecological value. Prepare a short report that you will submit during the tutorial session.

Exercise 12: Self-assessment questions

Part One: Match items under column A with the appropriate item under column B.

	A		B
1	Body covered with feather	A	Mammals
2	Thin and humid skin	B	Reptiles
3.	Body covered with fur and breath with lung	C	Fish
4	Body covered with scale or shell	D	Amphibians
5	They breath using gills	E	Birds

Part Two: Critical thinking questions

1. How are animals differing from plants and fungi?
2. Enumerate the characteristic features of animals.
3. How are invertebrate different from vertebrates?

☑ **Self-evaluation checklist**

Put a tick ☑ against each of the following tasks, which you can perform. If you cannot perform any of these tasks, go back and read the lesson for that particular task.

I can:

- List the characteristic feature of the animal kingdom_____ ☐
- Describe characteristic features of invertebrates and vertebrates ☐
- List the common class of animals _____ ☐

Section 2.7. Renowned Taxonomists in Ethiopia

 Dear learner! Previously, you have learned about the kingdom **Animalia** and the unique features of the members of the kingdom. You have also learned how to group **Animalia** into the major groups – invertebrates and vertebrates. You classified invertebrates into major phyla(e.g., sponges, flat worms, round worms, annelida, Mollusca, Arthropoda (e.g., Insects, Arachnids, Crustacea and Myriapods) and vertebrates into major classes (e.g., fish, amphibians, reptiles, birds, & mammals). You studied the mode of reproduction, nutrition, ecology, cell structure and importance of members of kingdom **Animalia**. Next, you will learn about renowned Taxonomists in Ethiopia. You will learn the major contributions made by a renowned taxonomist to the sciences of taxonomy in general and to our country in particular.

Competencies

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

- Appreciate the works of renowned taxonomists in Ethiopia.

Activity 23

Dear learner! Do you know any renowned Ethiopian taxonomist? If you know one, please write the name and the contribution of the renowned Ethiopian taxonomist. Prepare short note on the contribution of the taxonomist to science taxonomy and the society and submit it at your tutorial center.

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

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

☑ **Self-evaluation checklist**

Put a tick ☑against each of the following task(s), which you can perform. If you cannot perform any of these tasks, go back and read the lesson for that particular task.

I can:

- Appreciate the works of renowned taxonomists in Ethiopia_____ ☐

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 protista
- 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 multicelled and colonial species. Life cycles vary like nutrition; some species are autotrophs, others are heterotrophs.
- Fungi are heterotrophs that secrete digestive enzymes to 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.

Unit Review Questions

Part One: Write true if the statement is correct or false if the statement is wrong.

1. Linnaeus' developed a six-Kingdom system of classification.
2. Fungi can reproduce either by vegetative, asexual reproduction through spores formation and sexually.
3. Archaea have identical cell walls from bacteria.
4. Many animals have two types of specialized cells not seen in other multicellular organisms.
5. Identification is the process of grouping things based on their similarities.
6. Unicellular algae are the basis of aquatic food chains and produce much of the oxygen in Earth's atmosphere.
7. Angiosperms are seed plant that make flowers or fruits
8. Some autotrophic bacteria make their own food the way plants do and they are chemosynthetic.
9. Ethiopia is not a primary center for *Eragrostis tef* and *Guizotia abyssinica*.
10. The Greek philosopher Plato (384-322 BC) developed the first widely accepted biological classification systems.

Part Two: Choose the best answer from the give alternatives, and write the letter of your answer on your exercise book.

1. Fungal infections are most common in _____
   A. Reptiles B. mammals C. Insects D. Plants
2. _____is the transmission of DNA to offspring.
   A. Development B. Photosynthesis C. Reproduction D. Respiration
3. Bacteria, Archaea, and Eukarya are three_____
   A. Domains B. Classes C. Genera D. Orders
4. Organisms require_____ and _____to maintain themselves, grow, and reproduce.
   A. DNA; energy B. DNA; cells C. food; sunlight D nutrients; energy
5. A process by which an organism produces offspring is called _____
   A. Adaptation B. Homeostasis C. Reproduction D. Excretion
6. Bacteria that serve as decomposers are_____
   A. Photosynthetic B. Chemoheterotrophs C. Photoheterotrophs
   D. Chemoautorophs

7. All fungi_____

A. Are multicelled B. Are heterotrophs

C. Form flagellated spores D. All of the above

8. Most fungi obtain nutrients from _____

A. Respiration B. Nonliving organic matter

C. Living plants and animals D. Photosynthesis

Part Three: Critical thinking questions

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

Answer Key to Activities and Review questions

Feedback to Activity 2

- You may tell car, computer, books, exercise books, pen, cloths, rocks, mobile phone, house, etc.as **non-living** and cows, goats, sheep, plants, insects, fish, donkey, horse, lion, cats, dog, flowers, birds as **living things**.

Feedback to Exercise 1

Part One: Say true if the statement is correct false if the statement is wrong.

1. True 2. False 3. False 4. True 5. True

Part Two: Critical thinking questions

1. **Answer**: All living things are made up of one or more cells; all living organisms respond to stimuli; all living things can grow; all living things can

excrete; all living things display ordered complexity and all living things maintain homeostasis.

2. **Answer**: 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.

Feedback to Activity 3

- The degree of being organised may vary from person to person. Some students may say no but other may say yes!
- However, to be organised is a useful characteristic a person.
- Therefore, as a student it is advisable to organise your belongings such as books and clothes into groups to easily get them back when you need them.
- Organizing things into groups is also good in various life activities such libraries, supermarkets, stores, pharmacies, museum and laboratories.

Feedback to Exercise 2: Self-test questions

Part One: Say true if the statement is correct false if the statement is wrong.

1. False 2. True 3. False

Part Two: Critical thinking question

2. **Answer:** Biologists use morphological, physiological, molecular, behavioral, and/or ecological characters to classify organisms into groups.

Feedback to Activity 4

- Biologists need to organize living things in hierarchies, since it helps to simplify the study living things and makes the study organized or systemized.

Feedback to Exercise 3: Self-test questions

Part One: Match items under column A with the appropriate item under **column** B.

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

Part Two: Critical thinking questions

1. **Answer:** Taxonomic hierarchy is the process of arranging various organisms into successive levels of the biological classification either in a decreasing or an increasing order.

2. Answer: Below is a taxonomic hierarchy using **maize (corn)** as an example.

Classification of Corn

Domain	**Eukarya** Organisms that have nuclei and other membrane-enclosed organelles
Kingdom	**Plantae** Terrestrial, multicellular, photosynthetic organisms
Phylum	**Anthophyta** Vascular plants with flowers, fruits, and seeds
Class	**Monocotyledones** Monocots: Flowering plants with one seed leaf (cotyledon) and flower parts in threes
Order	**Commelinales** Monocots with reduced flower parts, elongated leaves, and dry 1-seeded fruits
Family	**Poaceae** Grasses with hollow stems; fruit is a grain; and abundant endosperm in seed
Genus	***Zea*** Tall annual grass with separate female and male flowers
Species	***Zea mays*** Only one species in genus—corn

3.Answer: Eukarya, Archaea & Bacteria (see the table & picture below)

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

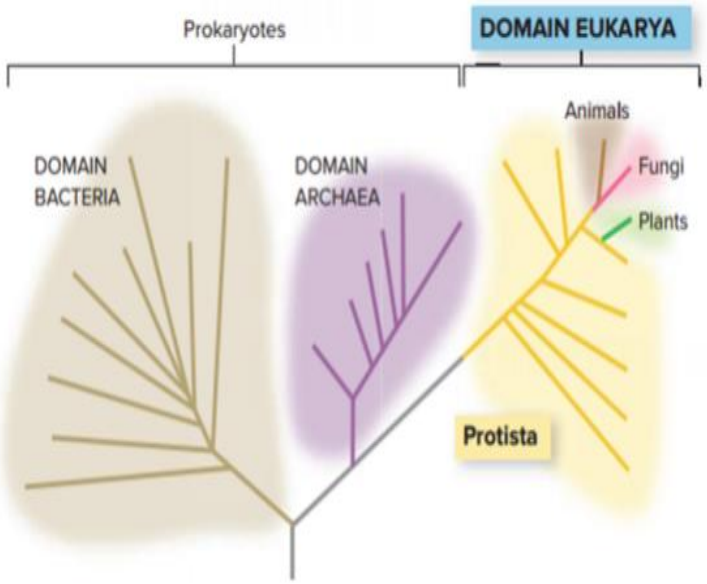

Figure 2.1. Three domain of life

Feedback to Activity 5

1. It make the study organisms organised and systematize. We classify organisms based on their similarities and differences. For example, all animals with backbone are classified into vertebrate (e.g., fish, amphibians, reptiles, birds, and mammals) and without backbone into invertebrates (e.g., sponges, rotifer, nematodes, segmented worms, molluscs, and arthropods). Alternatively, plants could be classified as vascular plants versus non-vascular plants, seed plants versus non-seed plants, flowering plants versus non-flowering plants, or monocots versus dicots.
2. The purposes of classifying organisms are manifold but the first and foremost reason is to make the study of organism simpler and organized.

Feedback to Exercise 4: self- test question

Part One: Choose the correct answer among the given alterative

1. D **2.** B

Feedback to Exercise 5: Self-test questions

Part One: Say true if the statement is correct false if the statement is wrong.

1. True 2. False **3.** True 4. True 5. False

Part Two: Critical thinking questions

1. **Answer:** Biologists use Binomial system because it makes communication simple among scientists across the globe. Different languages have different names for the same species which creates a communication barrier for scientists from different parts of the world.
2. **Answer: 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 (e.g., *Ensete ventricosum, Zea mays, Panthera leo,etc.)*. The first letter of name of the genus is a capitalized and the

specific epithet always starts with a small letter; is underlined when handwritten or italicized when printed.

3. **Answer:** *Musca domestica*, *Mus musculus*, *Canis familiaris*, *Felis catus* & *Capra hircus*

Feedback to Activity 8

- 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 (**see the diagram below**).

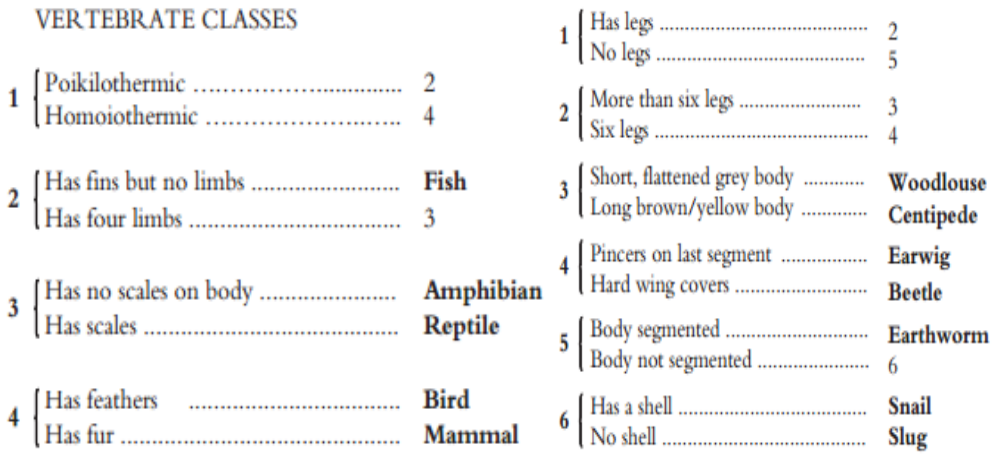

Figure 2. 2. A dichotomous key for vertebrate classes (Left) A dichotomous key for some invertebrates (Right)

Feedback to Exercise 6: Self-test question

Part one: Critical thinking question

1. **Answer**: Dichotomous keys are handy tools but their use is not simple because the features may not always be easy to see and you have to make use of less fundamental characteristics.

2. Answer:

No.	Common names	Scientific names (species name)
1	Elephant	*Loxodonta africana*
2	Ethiopian Wolf	*Canis simensis*
3	Gelada	*Theropithecus gelada*
4	Lion	*Panthera leo*
5	Walia	*Capra walie*
6	Ostrich	*Struthio camelus*
7	Watled Ibis	*Bostrychia carunculata*
8	Enset	*Ensete ventricosum*
9	Maize	*Zea mays*
10	Noug	*Guizotia abyssinica*
11	Tef	*Eragrstos tef*
12	Wheat	*Triticum aestivum*
13	Ethiopian Mastered	*Brassica carinata*
14	Barely	*Horduem vulgare*
15	Banana	*Musa acuminate*
16	Finger Millet	*Eleusine coracana*
17	Sorghum	*Sorghum bicolor*
18	Chickpea	*Cicer arietinum*
19	Faba Bean	*Vicia faba*
20	Lentil	*Lens culinaris*

Feedback to Activity 9

- Earliest naturalists such as Linnaeus recognized two groups - **plants and animals**.
- How many such groups should there be? The answer varies based on the systems of classification applied. It could be two (**plants and animals**); three (**plants, animals and Protista**); four (**monera, Protista, animals and plants**), five (**plants, animals, fungi, protista and monera**).
- Most biologists used to favor the adoption of two groups. What are these two groups? The answer is **plants and animals** (**see the figure below**).

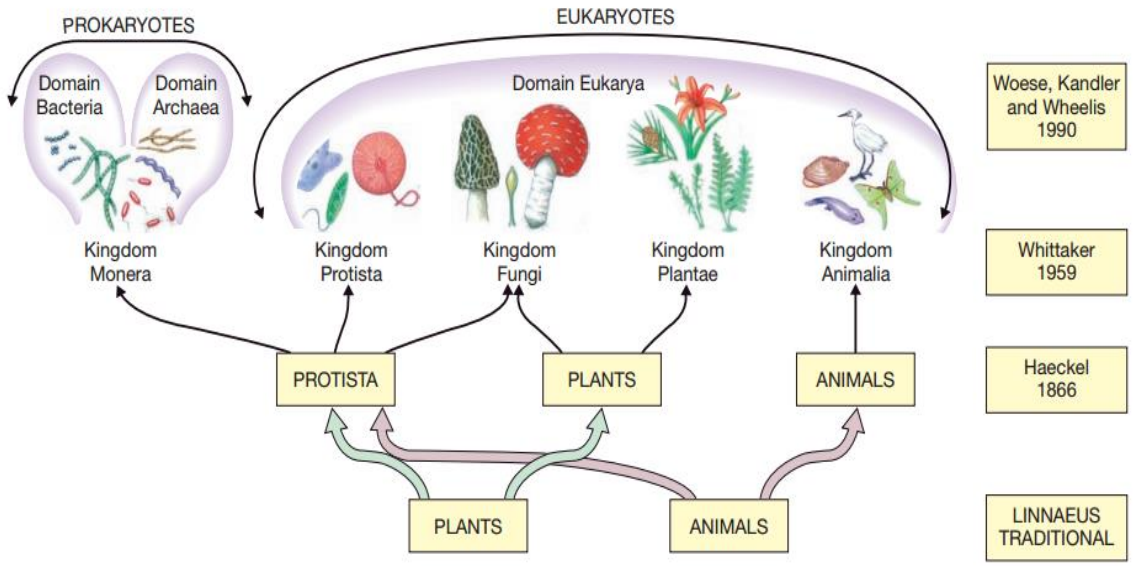

Figure 2.3. The historical developments of the kingdoms of life.

Feedback to Activity 10: Role-play (you could work with your study partners)

Always, there are organisms that do not fit to the classification systems, for example, in the two-kingdom system of classification (plants and animals) the Protista do not fit to; in the thee-kingdom system of classification (plants, animals and Protista) the fungi do not fit to; in the five -kingdom system of classification (plants, animals, fungi, protests and monera); the Protista is a complex group. **Therefore, it was difficult to develop rigid classification scheme**.

Do you think the **Whittaker five-kingdom** scheme has solved the classification problems biologists are trying to answer for millennia?

The answer is no, there are a number organism that do not fit into the Whittaker five-kingdom scheme. That is why the six-kingdom system was introduced which includes **Bacteria, Archaea, Protista, Fungi, Plantae and Animalia (see the figure below).**

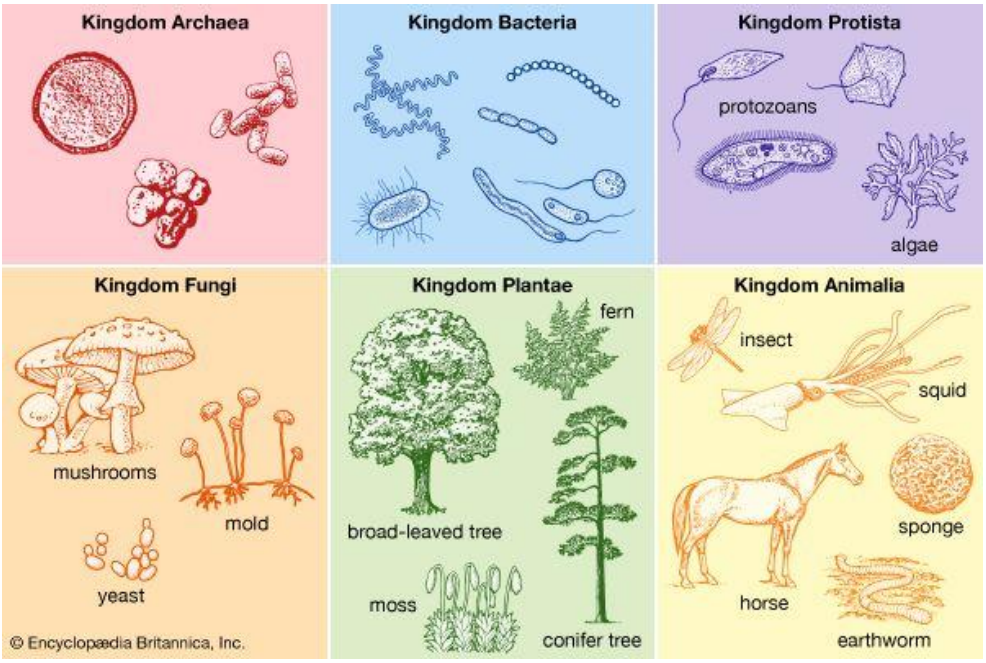

Figure 2.4. The six kingdoms of life

Feedback to Exercise 7: Self-test

Part one: Critical thinking questions

1. **Answer:** Viruses are not considered to be living organisms because they lack key characteristics of living things. They need the help of living cells to replicate themselves.
2. **Answer:** Yes or no. Yes, because algae fulfil some properties of plants. No, there are characteristics of plants that algae do not fulfil.
3. **Answer:** Yes, kingdom Protista is suggested to include organisms such as algae and the like.
4. **Answer:** The main criteria used by Whittaker include cell structure, body organization, and mode of nutrition, reproduction and phylogenetic relationships.

Feedback to Activity 12

Useful

- ✓ Provide nitrogen in a usable form for plants,
- ✓ Flavor food,
- ✓ Oxygen is a byproduct of making food

Harmful

- ✓ Endospores germinate in human lungs,
- ✓ Cause infection in humans,
- ✓ Create toxins

Feedback to Exercise 8: Self-test

Part One: Match items under column A with the appropriate item under **column** B.

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

Part Two: Critical thinking question

1. **Answer**: Archae and bacteria differ in the chemical composition of cell wall. Archaebacteria live in extreme environments.
2. **Answer:** Except some species of bacteria almost all species are useful (see Activity 12)
   - **Beneficial effects**: agriculture, industries, waste water treatment, biological control of insects.
   - **Harmful effects**: food spoilage, water pollution, reduction of soil fertility, diseases.
   - **Pathogens**: *Mycobacteria tuberculosis, Mycobacteria leper*, *Vibrio cholera*, Salmonella, Shigela, *Chlamydia trachomatis*
   - **Useful**:, *Lactococcus lactis*, *Lactobacillus bulgaricus*
   - **Genetic engineering**: Agrobacteria sp.
3. **Answer:** The shape morphologies of bacteria are**: Cocci, bacilli & spirillum**

Feedback to Activity 14

Diatoms are single cell eukaryotic microalgae, which present in nearly every water habitat make them ideal tools for a wide range of applications such as oil exploration, forensic examination, environmental indication, biosilica pattern generation, toxicity testing and eutrophication of aqueous ecosystems.

Feedback to Exercise 9: Self-test questions

Part One: Say true if the statement is correct false if the statement is wrong.

1. False 2. True 3. True 4. True

Part Two: Critical thinking questions

1. Answer: Algae are photosynthetic like plants but unlike plants they do not have roots, stems or leaves.

2. Answer: a brief summary to the characteristic features of protist are given below:

- There is no such thing as a typical protist.
- Kingdom protista contains the most diverse organisms of all the kingdoms
- There are single-celled (unicellular) protists as well as many-celled (multicellular) protists.
- Some are microscopic, others are very large. Some can make their own food, some cannot. Protists have only one thing in common—they are all eukaryotes.

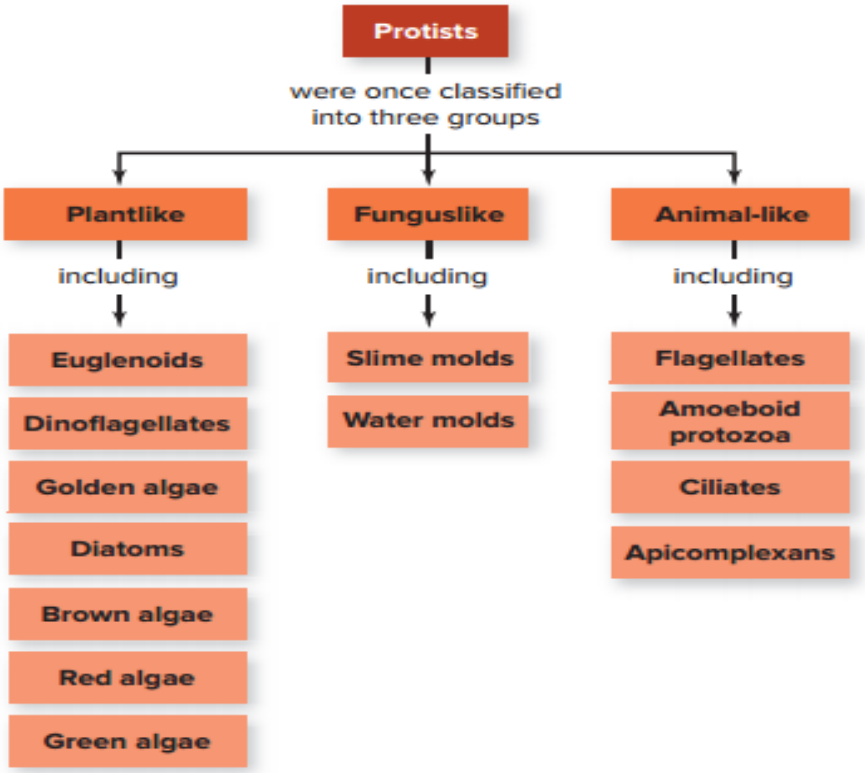

Figure 2.5. The major groups of Protista

3.Answer: Protists have only one thing in common—they are all **eukaryotes**.

Feedback to Activity 15

- Fungi are everywhere. They are in your backyard, in air and water, on damp walls, on food, and sometimes even on your body. Some fungi are large, bright, and colorful. **Most grow best in moist, warm environments. Usually grow fast.**

Feedback to Exercise 10: Self-test question

Part One: Match items under column A with the appropriate item under **column** B.

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

Part Two: Critical thinking questions

1. **Answer:** Fungi secrete enzymes to their surroundings to digest their food and absorb the nutrients.
2. **Answer:** a brief summary to the characteristic features of fungi are given below:

- Except for unicellular yeasts, fungi are filamentous multicellular organisms (**see the picture elbow**).
- 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.

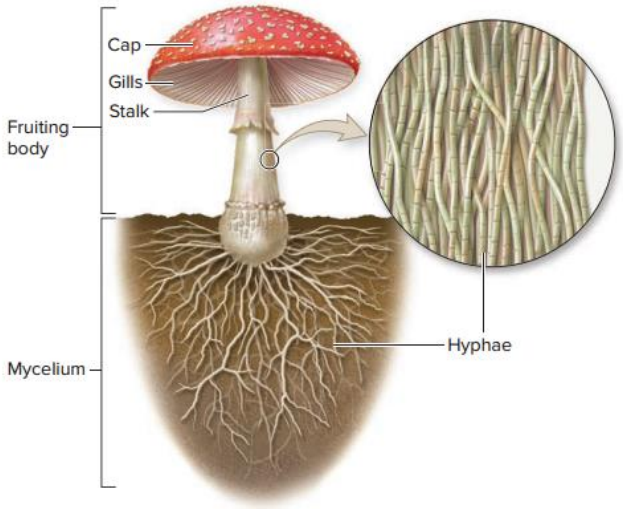

Figure 2.6. Morphological features of a typical fungus

3. **Answer: Pathogenic (e.g.,** Candida albicans cause rush and Tinea pedis cause athlete's foot) & useful (yeast).

Feedback to Activity 17

Vascular and non-vascular plants

1. Non-vascular plants (no specialized conducting tissue): Bryophyta – Liverworts and Mosses

	Bryophytes	Seedless Vascular Plants	Gymnosperms	Angiosperms
Gametophyte (haploid generation)				
Size relative to sporophyte?	Varies	Small	Microscopic	Microscopic
Depends on sporophyte for nutrition?	No	No	Yes	Yes
Sporophyte (diploid generation)				
Size relative to gametophyte?	Varies	Large	Large	Large
Depends on gametophyte for nutrition?	Yes	No	No	No

Figure 2.7. Non-vascular Plants

2. Vascular plants (well developed xylem and phloem tissue): pteridophayte (also known as the Filicinophyta - the ferns) and spermatophyte (Gymnospermae (also known as the Coniferophyta) – the conifers; Angiospermae (also known as the Angiospermophyta) – the true flowering plants)

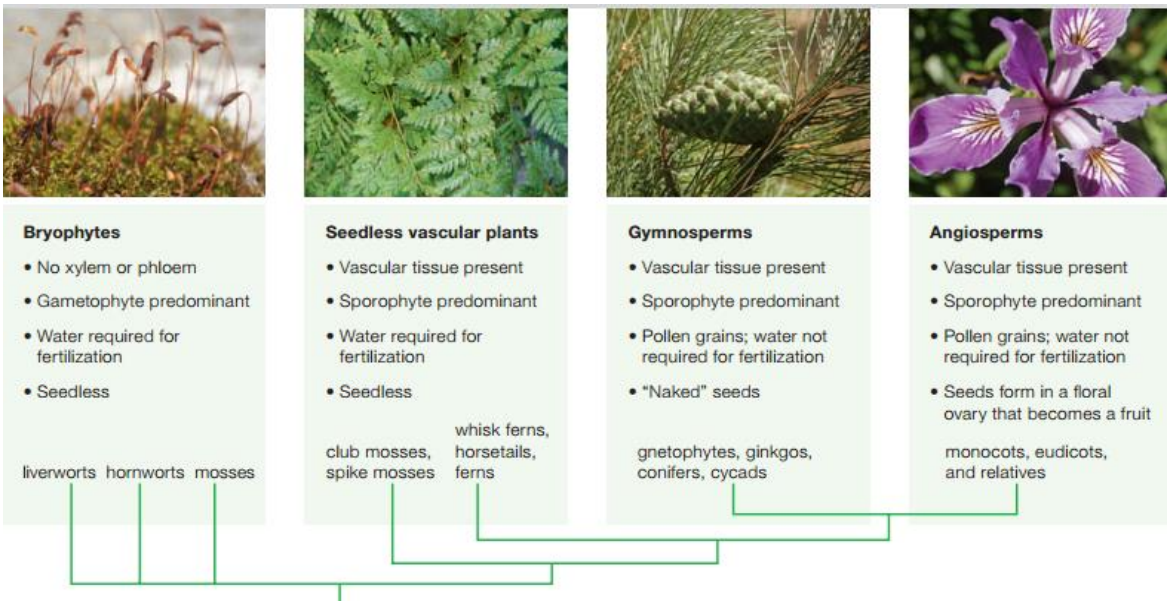

Figure 2.8. Vascular plants

Feedback to Activity 18

Example of important plants

1. Food (cereal, vegetables, fruits): tef, wheat, maize, carrot, barley, oranges, banana, oats, apple, sorghum, millets, rice, tomato, papaya, lemon,etc.)
2. Medicinal: (e.g., endod, Enset, Aloe vera, Shiferaw, Hegenia, etc.)
3. Ornamental(e.g., Enset, Pin tree)
4. Fiber tissue: (e.g., Enset)
5. Weeds: (e.g., water hythcin)
6. Construction (e.g., Podocarpus, wanza, eucalyptus tree)
7. Ecological importance
8. Animal Habitats
9. Horticulture: tomato, potato, paper

Feedback to Exercise 11: Self-test questions

Part One: Say true if the statement is correct false if the statement is wrong.

1. True 2. True 3. False 4.False 5.True 6.True 7. True

Part Two: Critical thinking questions

1. **Answer:** We call bryophytes amphibians of the plant kingdom because the live both on the land and water bodies like amphibians (e.g., frogs).
2. **Answer:** a brief summary to the characteristic features of plants are given below:

- Plants make their own food through the process of photosynthesis. Plants have chloroplast and chlorophyll pigment, which is required for photosynthesis. Photosynthesis also provides oxygen in the atmosphere.
- They do not move from place to place; they are stationary.
- Their cells contain a rigid cell wall made up of cellulose.
- They reproduce asexually by vegetative propagation or sexually.

Feedback to Activity 20:

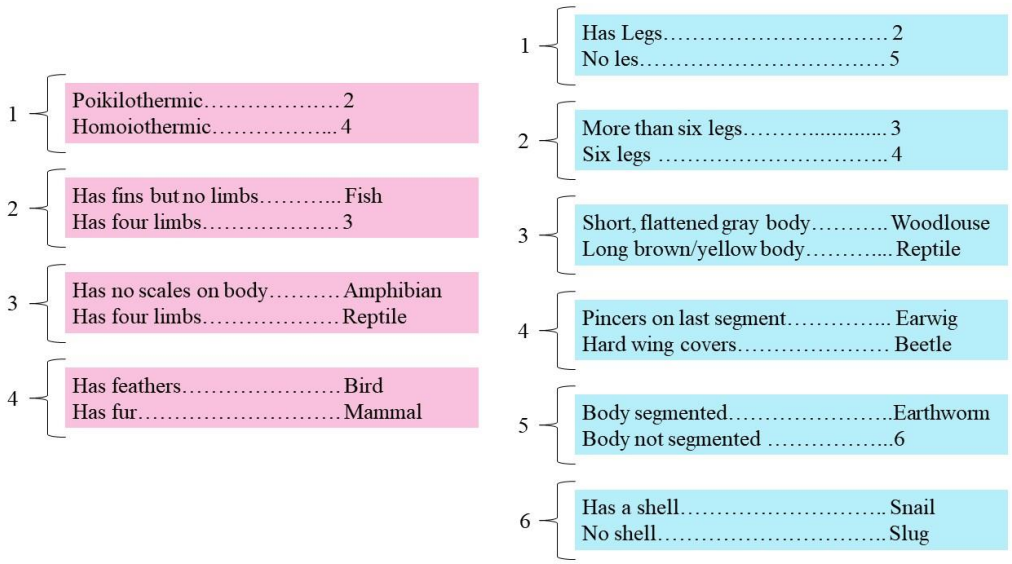

Figure 2.9. Vertebrate (left) and Invertebrate (right) keys

- **Invertebrates:** Porifera (sponges), Coelenterata (cidaria), Platyhelminthes (flatworms), Nematoda (roundworms or nemathelminthes), Annelida (segmented worms), Mollusca (soft-bodied animals), Echinodermata (spiny-skinned animals), and Arthropoda (joint-footed animals), etc.).

- **Vertebrates:** the fish, the amphibians, the reptiles, the birds, and the mammals, etc.).

Phylum	Mouth/anus	Symmetry	Skeleton	Other external recognition features
Porifera – fan sponges, cup sponges, tube sponges, glass sponges	No mouth or anus	None	Internal spicules (sketetal needles)	Many pores over the surface through which water is drawn in for filter feeding. Very varied shapes
Cnidaria – hydras, jellyfish, corals, sea anemones	Mouth only	Radial	Soft, but hard corals secrete $CaCO_3$	Tentacles arranged in rings around the mouth, with stinging cells. Polyps or medusae (jellyfish)
Platyhelminthes – flatworms, flukes, tapeworms	Mouth only	Bilateral	Soft, with no skeleton	Flat and thin bodies in the shape of a ribbon. No blood system or system for gas exchange
Mollusca – bivalves, gastropods, snails, chitons, squid, octopus	Mouth and anus	Bilateral	Most have shell made of $CaCO_3$	A fold in the body wall called the mantle secretes the shell. A hard rasping radula is used for feeding
Annelida – marine bristleworms, oligochaetes, leeches	Mouth and anus	Bilateral	Internal cavity with fluid under pressure	Bodies made up of many ring-shaped segments, often with bristles. Blood vessels often visible
Arthropoda – insects, arachnids, crustaceans, myriapods	Mouth and anus	Bilateral	External skeleton made of plates of chitin	Segmented bodies and legs or other appendages with joints between the sections

<table>
<tr><th>Bony ray-finned fish</th><th>Amphibians</th><th>Reptiles</th><th>Birds</th><th>Mammals</th></tr>
<tr><td>Scales which are bony plates in the skin</td><td>Soft moist skin permeable to water and gases</td><td>Impermeable skin covered in scales of keratin</td><td>Skin with feathers made of keratin</td><td>Skin has follicles with hair made of keratin</td></tr>
<tr><td>Gills covered by an operculum, with one gill slit</td><td>Simple lungs with small folds and moist skin for gas exchange</td><td>Lungs with extensive folding to increase the surface area</td><td>Lungs with para-bronchial tubes, ventilated using air sacs</td><td>Lungs with alveoli, ventilated using ribs and a diaphragm</td></tr>
<tr><td>No limbs</td><td colspan="4">Tetrapods with pentadactyl limbs</td></tr>
<tr><td>Fins supported by rays</td><td>Four legs when adult</td><td>Four legs (in most species)</td><td>Two legs and two wings</td><td>Four legs in most (or two legs and two wings/arms)</td></tr>
<tr><td colspan="2">Eggs and sperm released for external fertilization</td><td colspan="3">Sperm passed into the female for internal fertilization</td></tr>
<tr><td>Remain in water throughout their life cycle</td><td>Larval stage that lives in water and adult that usually lives on land</td><td>Female lays eggs with soft shells</td><td>Female lays eggs with hard shells</td><td>Most give birth to live young and all feed young with milk from mammary glands</td></tr>
<tr><td>Swim bladder containing gas for buoyancy</td><td>Eggs coated in protective jelly</td><td>Teeth all of one type, with no living parts</td><td>Beak but no teeth</td><td>Teeth of different types with a living core</td></tr>
<tr><td colspan="3">Do not maintain constant body temperature</td><td colspan="2">Maintain constant body temperature</td></tr>
</table>

Feedback to Activity 21

Example of important insects

1. Insect pests: grasshopper, caterpillar, aphids, etc.
2. Vectors: tsetse fly, mosquitoes,
3. Pollinators: butter fly, honey bee, etc.
4. Apiculture: honey bee
5. Silvi-culture: silk worm

Feedback to Activity 22

Example of important vertebrates

1. Fish (Nile tilapia, cat fish): food, ecological, medicinal, aesthetic, cultural, sport hunting.
2. Birds (poultry, ostrich): food, ecological, medicinal, aesthetic, cultural, sport hunting
3. Mammals (cow, horse, donkey, hyena, lion, game mammals, etc.): food, ecological, medicinal, aesthetic, cultural, aesthetic, cultural, sport hunting

Feedback to Exercise 12: self-test questions

Part One: Match items under column A with the appropriate item under **column** B.

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

Part Two: Critical thinking questions

1. **Answer:** Animals are eukaryotic like plants and fungi. However, unlike plant and fungal cells animal cells lack cell wall. Like fungi animals are heterotrophic. Animals ingest or eat their food whereas fungi digest their food outside their body and absorb nutrients. Unlike plants animals are usually mobile.
2. **Answer:** a brief summary to the characteristic features of animals are given below:
    - 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.

3. **Answer:** Invertebrates (animals without backbone) and vertebrates (animal's backbone) (see **the picture below**).

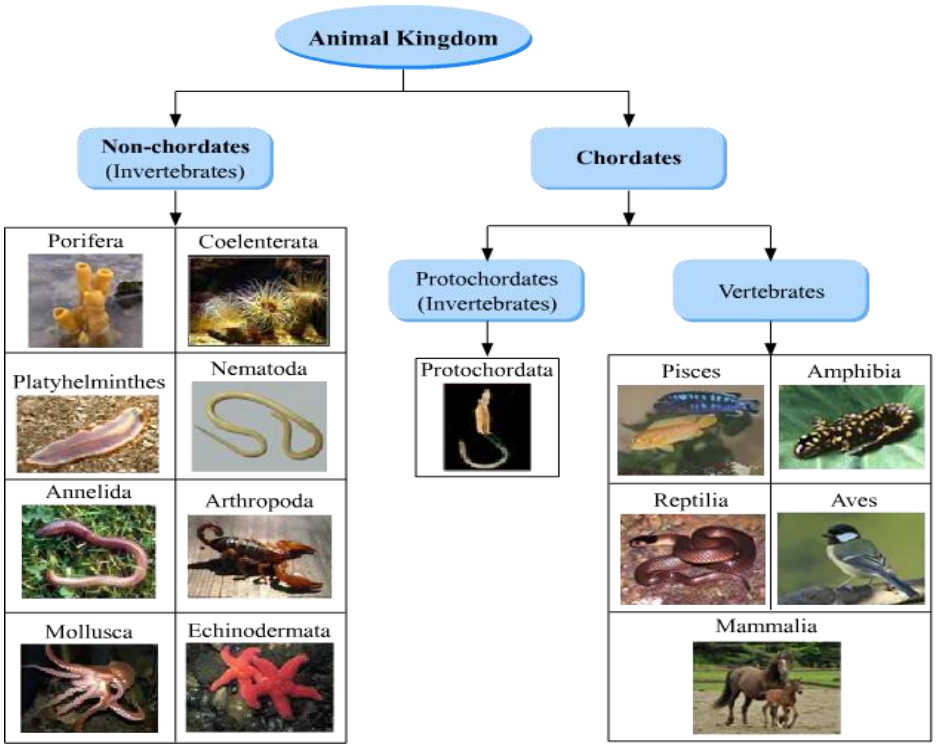

Figure 2.10. Major classes of Animals

FEEDBACK TO THE UNIT REVIEW QUESTION

Part One: Say true if the statement is correct false if the statement is wrong

1. False	2. True	3.Flase	4.True	5.False
6.True	7.True	8.False	9.False	10.False

Part Two: Choose the best answer among the give alternatives

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

Part Tree: Critical thinking questions

1. Fungi decompose materials, thus releasing nutrients that producers can take up and use. Fungi form mutually beneficial partnerships with plants and green algae. Some ants farm fungus as a source of food. Some fungi are pathogens that invade the tissues of plants and animals.
2. Ecological and economic importance of insects are: pollinators, food sources, removal of wastes and remains, crops pests, disease vectors, parasites & pathogens, etc.
3. Both groups have cell wall & no a nucleus. Both reproduce by binary fission.
4. Food sources (e.g., wheat, rice, tef, potato, tomato, maize, Soybeans, lentils, peas, peanuts, etc.), medicine, source of fabrics (e.g., linen, ramie, hemp, burlap, and cotton), fire wood, construction, ecological, etc).
5. Viruses cause many diseases, most short-lived and relatively mild, but some that are deadly.
6. Fish, amphibians, reptiles, birds and mammals.
7. Bacteria benefit other organisms by putting oxygen into the air, fixing nitrogen, and acting as decomposers. Some bacteria are human pathogens.

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Mackean, D. G., & Hayward, D. (2014). *Cambridge IGCSE Biology*. 3rd Ed. Hodder Education.

Starr, C., Taggart, R., Evers, C., & Starr, L. (2015). *Biology: The unity and diversity of life*. Cengage Learning.

UNIT THREE: CELL

INTRODUCTION

 Dear learner! In the previous unit, you have studied about the characteristics and taxonomy of living things. If you have done well in the previous unit, then you should go to the next unit. In this unit, you will learn about the smallest unit of living things known as cell. In connection to cell, you will study about scientists who have played a fundamental role in the study of the cell theory. In addition, you will study about structure and types of the cell. This unit also deals with cell and its environment which includes osmosis and diffusion. Finally, you will come up with study level of biological organization.

This unit has eight sections: Section 1 and two deal with the meaning of cell and cell theory. These two sections deal with the contributions of Robert Hooke, Anton van Leeuwenhoek, Theodor Schwann and Matthias Schleiden to the development of the cell theory. In Section 3, you will study about structure and function of cell wall, Cell membrane, cytoplasm and other organelles. Section 4 discusses the difference between eukaryotic and prokaryotic cells. Section 5 discusses about comparing and contrasting of the plant and animal cells. Section 7 treats about movement of substances across animal and plant cells by osmosis, diffusion and active transport. The last section treats about levels of biological organization.

Unit Learning Outcomes

Upon successful completion of this unit, you will be able to:

- Describe what are cells
- Discuss the cell theory
- Compare the structure and function of plant and animal cells
- Prepare microscopic slides and observe under microscope
- Describe movements in plant and animal cells
- Discuss levels of cellular organization

Unit Contents

The Required Study Time

You are expected to spend 18 hours of the semester to learn this unit. You should use the allocated study time properly and efficiently to cover the lessons included in this unit.

Learning Activities

Please be sure that there are several learning activities placed throughout this module, which will help you practice using the information you will learn. After attempting each activity in the module, try to check your answers against the answer keys set for each learning activities and make corrections to your work.

Learning Strategies

Dear learner! For your successful distance learning process, you can use the following learning strategies wherever they are appropriate to the topics/ subtopics of your lesson. These are mind mapping, mentally rehearsing, short visits/onsite observation, watching microscope in the nearby schools, hospitals and clinics, and research sites, comparing and contrasting, drawing and taking pictures of real plants, creating analogies, paraphrasing, summarizing (outlining and preparing flow chart summaries), taking short notes, underlining or highlighting key points.

Section 3.1. What is a cell?

Dear learner! In this section, you will study about the meaning of the cell.

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

Learning competencies

By the end of this section, you will be able to:

- Explain that living things are composed of cells
- Identify unicellular organisms from multicellular organisms

Dear learner, it is very important to know that most of the unicellular organisms are invisible with naked eyes, therefore scientists use a microscope to observe such cells. However, there are some unicellular cells, which can be seen with naked eyes. I hope you can give one example of such cell.

Dear learner! Do you know that Chicken egg is an example of unicellular cell, which can be seen with naked eyes? 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 you take 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. We hope you enjoyed reading this passage. We think it is very interesting and important for the learners, because it deals about how our body cell works cooperatively. What do you think? Then you should go on to the next section.

Attention

Most cells are very small and are, therefore, visible only with a microscope but an ostrich egg is a single cell 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.

Self-test exercise

1. What is a cell?
2. List some unicellular and multicellular organisms.

☑ Self-evaluation checklist

Direction: Put a tick (√) against each of the following tasks you can perform. If you are not able to perform any of these tasks, you need to read once again. I can:

- Explain that living things are composed of cells _____ □
- Distinguish Unicellular from Multicellular organisms _____ □

Section 3.2. Cell theory

Overview

Dear learner! In this section, you will learn about scientists who played a role in the discovery of 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. Other early Dutch Microbiologist Anton van Leeuwenhoek (163-1723) used his lenses

in building numerous microscopes, some with magnifications approaching 300X.

Learning competencies

By the end of this section, you will be able to:

- describe cell theory
- name scientists who played roles in the discovery of the cell theory

Robert Hooke examined thin slices of plant material cork. He was surprised by the regular appearance of the structure, which are 'pore like' regular structures that Hooke called 'cells'. Each cell appeared to be an empty box surrounded by a wall. Hooke had discovered and described a cell, without realizing that it is the fundamental unit of all living things.

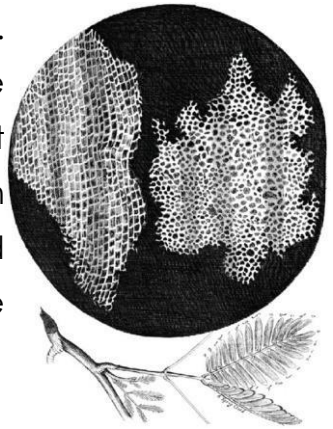


Figure 3.1. Drawing of cork cells published by Hooke

Recall

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.

Dear learner! We hope you enjoyed reading this section. This section deals about important scientists who have a big role in the discovery of cell and cell theory.

In 1674 Anton van Leeuwenhoek (1632-1723) likely observed protozoa for the first time and several years' later he observed bacteria. Those "very little animalcules" he was able to isolate from different sources, such as rainwater, pond and well water, and the human mouth and intestine.

Leeuwenhoek is universally acknowledged as the father of microbiology because, he discovered microorganisms like protists and bacteria.

More than 150 years later, German scientists, Matthias Schleiden and Theodor Schwann were the first to explain the basic views of what we now call cell theory. In 1838, German botanist Matthias Schleiden, a botanist stated that all plants are made up of cells.

A year later in 1839, another German zoologist Theodor Schwann reported that all animals are made up of 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.

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

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

Self -test exercise

1. List the names of scientists who played a role in the discovery of the cell theory.
2. State the three-cell theory.
3. What are the common features of all cells?

☑ **Self-evaluation checklist**

Direction: Put a tick (√) against each of the following tasks you can perform. If you are not able to perform any of these tasks, you need to read once again. I can

- State the cell theory……□
- List name of the scientists who played a role in the discovery of the cell theory……□

Section 3.3. Cell structure and function

Overview

Dear learner! In this section, you will learn about the main structure and organelles of the cell. Cells have different structures which have different functions. The organization of cells varies between different organisms.

Learning competencies

By the end of this section, you 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.

Activity 3.1

Read books and/or search the internet and complete the following table based on your search

Function	Cell Structure
A rigid structure of a plant cell that provides support and gives shape to the cell	Cell membrane
The darker area of the nucleolus where new ribosomes are made	Nucleolus
The place where protein is synthesized	Ribosome
The part which allow materials to be transported throughout the cell	Endoplasmic Reticulum
Its functions is in the collection, packaging, and distribution of molecules within the cell or even outside the cell.	Golgi apparatus

Dear learner! In multicellular organisms, some cells have the same shape and same function but other cells have different shapes and different functions.

What do you think about the human muscle and nerve cells?

It is very interesting and important for you to compare the shape and function of the above two cells. It is obvious that the human nerve and muscle cells have different shape and different function.

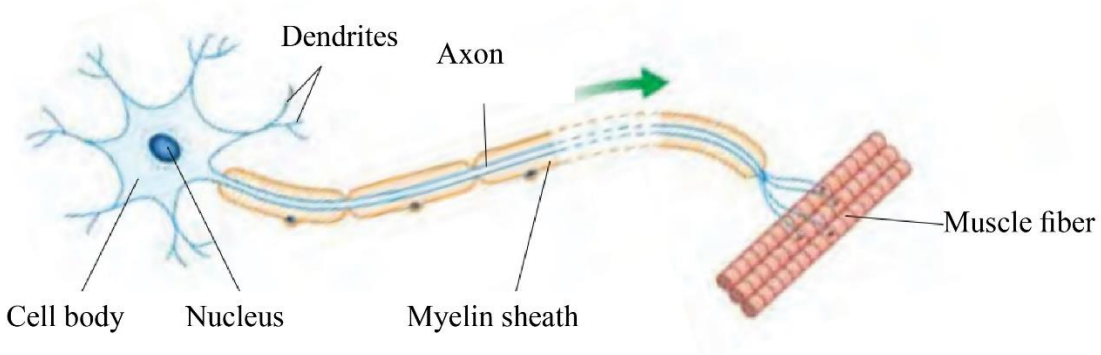


Figure 3.2 Nerve cell

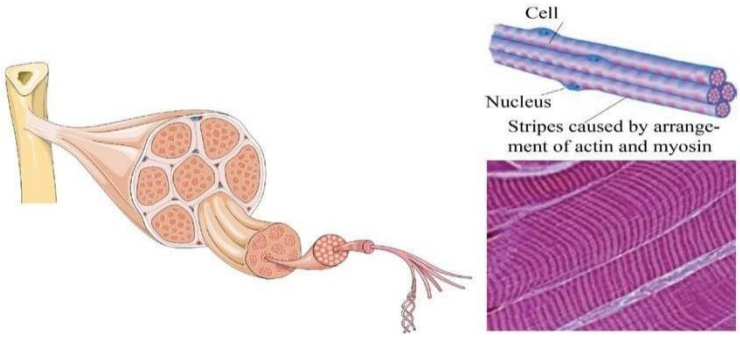


Figure 3.3 Muscle cells

Activity 3.2:

What makes nerve cell different from muscle cell? Discuss it based on its structure and function

Dear learner! It is important to know that cells look like one another in certain important ways. One important similarity between plant and animal cells is the presence of common cell structures like:

(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.

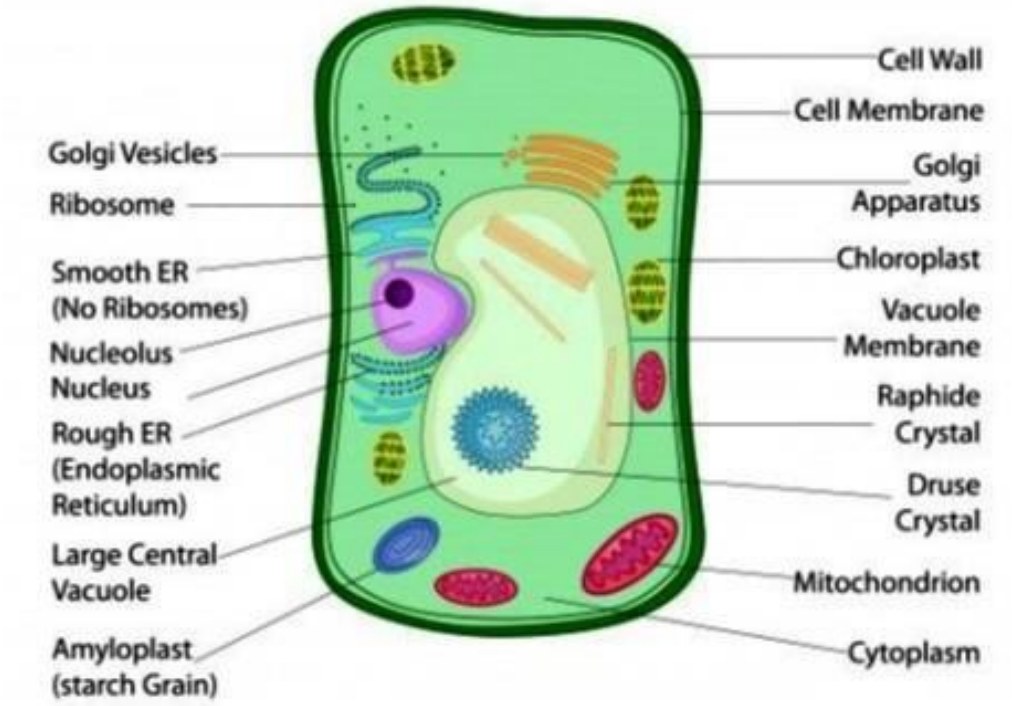


Figure 3.4 Structure of typical plant cell

Dear learner! The next section deals about the important structure and function of cells. These structures are common in plant and animal cells. In this section we are going to start from cell wall which is the important structure found externally in plant, bacteria fungi and some Protista.

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.

Activity 3.3

What are the function of a cell wall and cell membrane?

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.

Dear learners! The function of the Cell membrane is like a guard of the cell.

What is the role of any guard at the entrance of some organization?

I hope you said, he controls who or what enters and leaves.

The cell membrane also 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

Dear learners! Cytoplasm is a thick fluid-filled region in the cell containing cell organelles. It is the whole part of the cell.

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

Nucleus

Nucleus is the largest organelle surrounded by the double-membrane. Inside a nucleus, there are thread- like structures called Chromosomes that contain a very long molecule of DNA (Deoxyribonucleic acid).

The nucleus determines what the cell will be, for example, a blood cell, a liver cell, a muscle cell or a nerve cell. The nucleus also controls cell division. Within a nucleus there is a darker area called the nucleolus, this is the site where new ribosomes are made.

Activity 3.4 assignment

Using the internet or books as a source of the information, explain the important function of DNA with in the cell.

Ribosomes

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

Endoplasmic Reticulum

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

Dear learners it is very important to understand the difference between these two types of ribosomes. They are different because of their function and by the absence and presence of ribosomes

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.

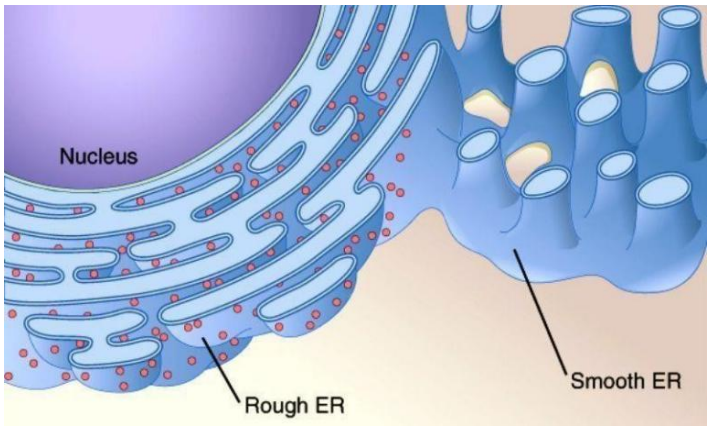


Figure 3.5. The Rough and Smooth Endoplasmic Reticulum

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.

Vesicles

Vesicles are a small stack-like collection of the membranous sac. They store and transport and ship materials where they need to go.

Dear learners! It is very interesting to understand that how cell structures work cooperatively. 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.

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.

Dear learner! There is an interesting relationship between three organelles rough and smooth endoplasmic reticulum, Golgi apparatus and vesicles. 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.

We hope you enjoyed reading the above activity of rough and smooth endoplasmic reticulum, Golgi apparatus and vesicles.
We think it is very interesting and important for you to see how the above three organelles work cooperatively .What do you think?

Activity 3.5

1. What are the main structural differences between smooth and rough endoplasmic reticulum rough?
2. Explain how the Golgi apparatus, vesicles and rough endoplasmic reticulum work cooperatively in material transportation.

Mitochondria Dear learner! It is very important to know about Mitochondria the 'powerhouse' of the cell since they are the sites of respiration. It is the organelle from where the cell gets energy.

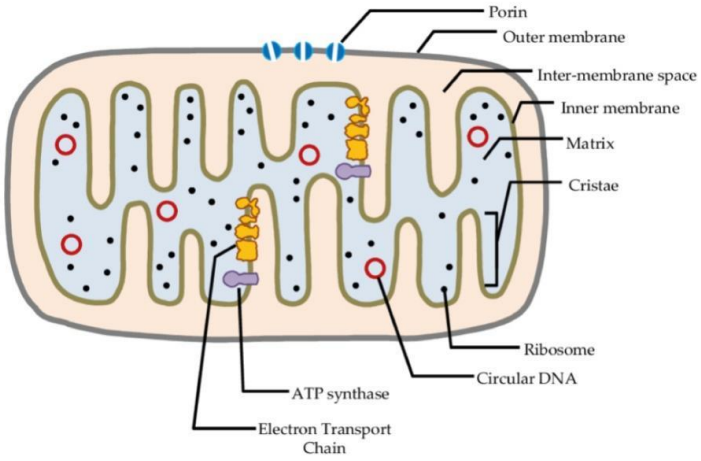


Figure 3.6: Mitochondria

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.

Activity 3.6

What type of cell would you expect to have more mitochondria?

Lysosomes

Dear learner! Lysosomes are little membrane-bound packages and it contain digestive enzymes which can be used to digest bacteria or other cells taken into the cell. It is also breakdown unwanted or damaged organelles within the cell.

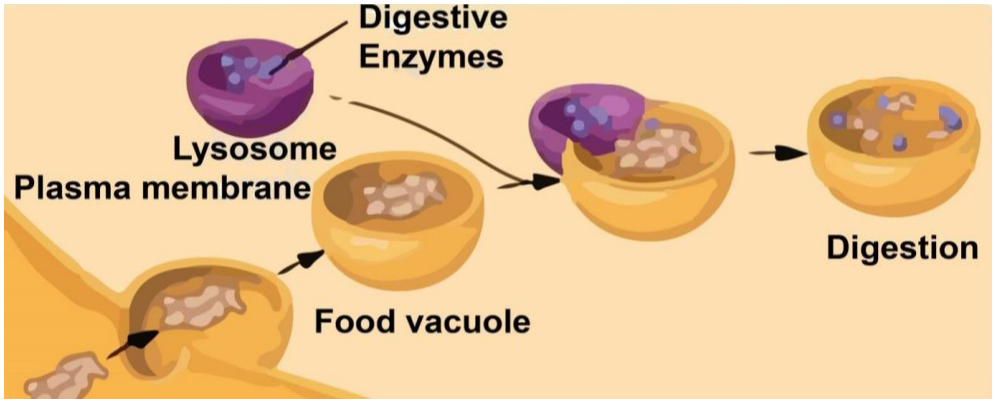


Figure 3. 7: lysosome

Vacuoles

Dear learner, vacuoles 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. Dear learner! Vacuoles perform a variety of functions in different kinds of cells. Food vacuole found in some animals to digest food.

In addition, amoebas and many other unicellular eukaryotes have food vacuole in order to eat smaller organisms or food particles, by a process called phagocytosis. Some unicellular organisms there is a contractile vacuole which is function is to expel excess water.

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 *phage in* which means to eat, and *kytos* is vessel referring here to the cell.

Chloroplasts

Dear learner! We hope you learned about photosynthesis in your previous grade. Here we have important organelle of the cell found in green plants. It is called Chloroplasts. Chloroplasts occur in the cell of green plants, mostly in the cells of the leaves. They are the site for photosynthesis.

Dear learner! For the process of Photosynthesis, sunlight energy is very important. Therefore, Chloroplasts contain a green pigment called chlorophyll that can trap the sunlight energy for the synthesis of carbohydrates.

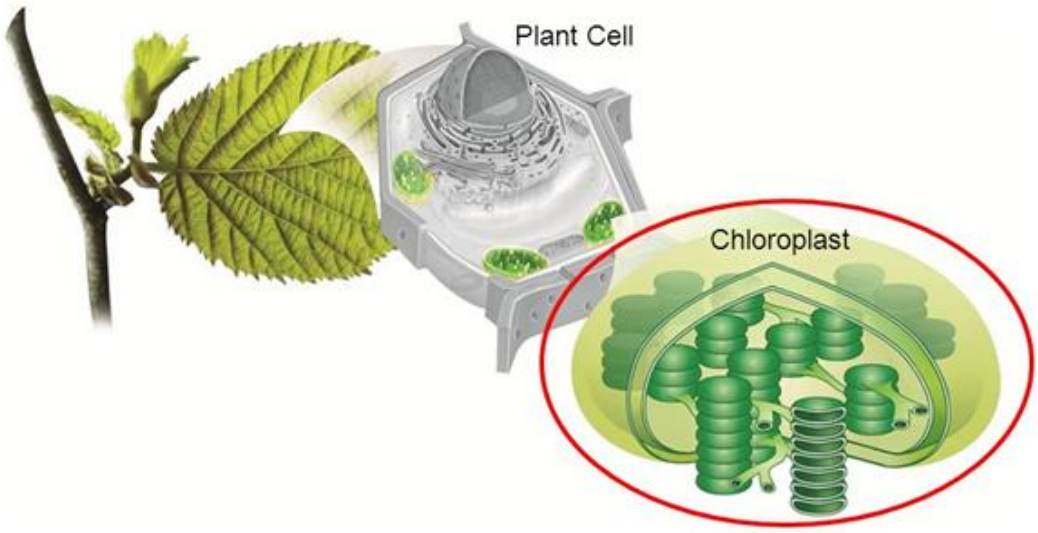


Figure 3.8: Chloroplast trapping sunlight energy to synthesize sugar

Activity 3.7: Individual assignment

What are the functions of food vacuole and contractile vacuole in unicellular organisms?

Centrioles and microtubules

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

Cilia and flagella

Dear learners! The next cell organelles of unicellular organisms are important for movement of that organism. 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.

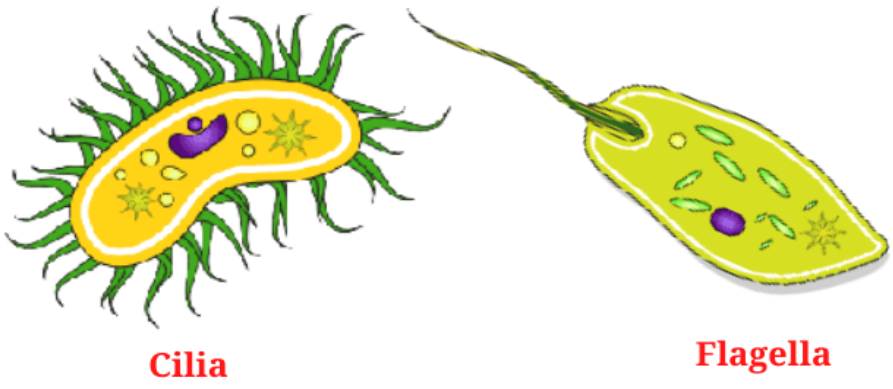


Figure 3. 9. Cilia and Flagella

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.

Self-test exercise

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. Power house of the cell	d. Lysosome
5. Photosynthesis	e. Chloroplast

II. Answer the following questions

1. What are the common organelles of unicellular organisms which are important for locomotion?

☑ **Self-evaluation checklist**

Direction: Put a tick (√) against each of the following tasks you can perform.

If you are not able to perform may one of these tasks, you need to read once again.

I can:

- 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 ……□
- List the main structure of a cell……..□

Section 3.4. Types of cells

Overview

Dear learner! We hope you have studied well the important structures of the cell. If you have done, then you should go on to the next section which is about the two types of cells which are grouped based on cell structure and cellular organization. These are Prokaryotic cells and Eukaryotic cells.

Prokaryotes are different from eukaryotic cells because of the absence of a nucleus and other membrane-bounded organelles. Eukaryotes have a nucleus and other membrane-bound organelles.

Learning Competences

By the end of this section, you will be able to:

- Describe the difference between prokaryotes and eukaryotic cells
- Give examples of the two types of cell

Activity 3.8

Give two examples of Eukaryotic cell.

Attention

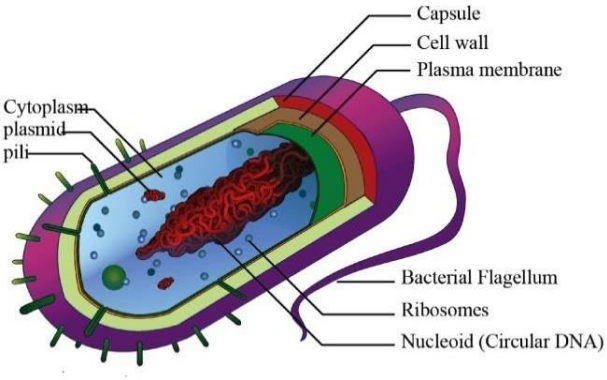
The term eukaryotic is derived from the Greek *eu,* true, and *karyon*, kernel, referring to the nucleus. Thus Eukaryotic cells are cells with a "true nucleus".

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.

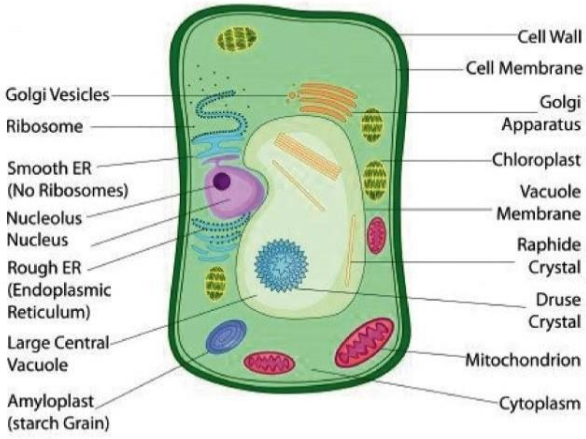
Eukaryotic cells are usually between 10 and 100 micro meters (µm) wide, while prokaryotes are between 1 to10 µm in size.

Dear learner! We hope you identified well Prokaryotes are different from eukaryotic cells. If you did, then you should go on to the next point about the difference between eukaryotic and prokaryotic cells section.

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 organisms are unicellular but eukaryotic organisms are usually multicellular.



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



B. Structure of a typical eukaryotic cell (Example, plant cell)

Dear learners! Please see the following table to see the difference between eukaryotic and prokaryotic 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

Self-test exercise

What makes prokaryotes different from eukaryotes? List at least three characteristics.

☑Self-evaluation checklist

Direction: Put a tick (√) against each of the following tasks you can perform. If you are not able to perform any of these tasks, you need to read once again. I can:

- Distinguish prokaryotic cell from eukaryotic cell ……..…□
- List example of prokaryotic and eukaryotic cell……..……...□

Section 3.5. Animal and plant cell

Overview

Dear learner! We hope you have studied well about prokaryotic and eukaryotic cell. If you have done, then you should go on to the next section which is about animal and plant cell which are belonged to eukaryotic cell. Animal and plant cells have certain structure 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.

Learning competencies

By the end of this section, you will be able to:

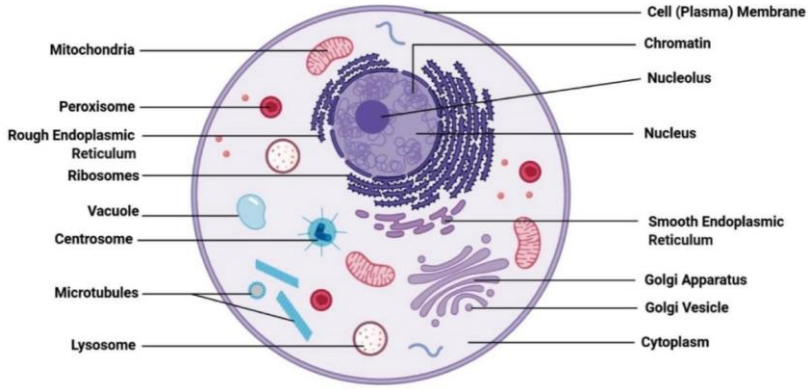
- List the structures of plant and animal cells, and
- Describe the differences in structure between plant and animal cells.

Dear learner! It is very interesting and important for you to understand the difference between plant and animal cells. Plant cells are usually larger and are more easily visible under a light microscope than animal cells. The plant

vacuole is surrounded by a membrane and contains fluid. The fluid in the vacuole is a solution of pigments, enzymes, sugars and other organic compounds (including some waste products), mineral salts, oxygen and carbon dioxide.

Vacuoles help to regulate the osmotic properties of cells (the flow of water inwards and outwards). Chloroplasts are found in the green parts of the plant, mainly in the leaves.

A



B

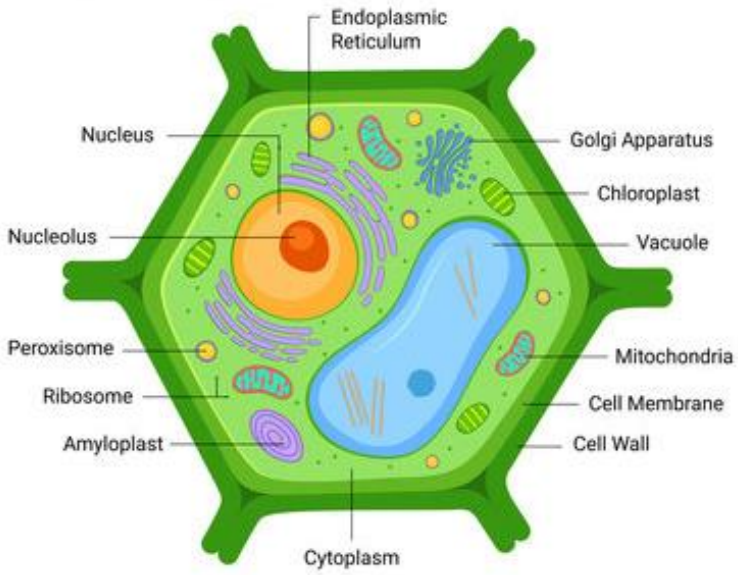


Figure .3.11. A. Animal cell as seen with an electron microscope

C. Plant cells as seen with an electron microscope

Self-test exercise

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

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

☑ Self-evaluation checklist

Direction: Put a tick (√) against each of the following tasks you can perform. If you are not able to perform any of these tasks, you need to read once again. I can:

- Distinguish plant cell from animal cell……□
- List some structures of the cell which are only found in animal cell……□
- List some structures of the cell which are only found in plant cell……□

Section 3.6 The cell and its Environment

Overview

Dear learner! In this section, you will study about the exchanging of materials between the cell and its environment.

You already knew the cell structures and their function. One of the important

structure of the cell is cell membrane. The cell membrane is a selectively (semi)permeable structure, that controls the entering of necessary substances and the removal of unnecessary ones.

Learning competencies

By the end of this section, you 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

Attention

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

Activity 3.9

1. What is the importance of semi permeability of the cell membrane?

Dear learner! 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. Therefore, there must be a means of material transportation into the cell and also out of the cell.

We think it is very interesting and important for you to understand how materials transport into the cell and out of the cell. Materials can pass through the cell membrane either passively by diffusion and osmosis or actively by active transport.

Section 3.6.1. Passive transport

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

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

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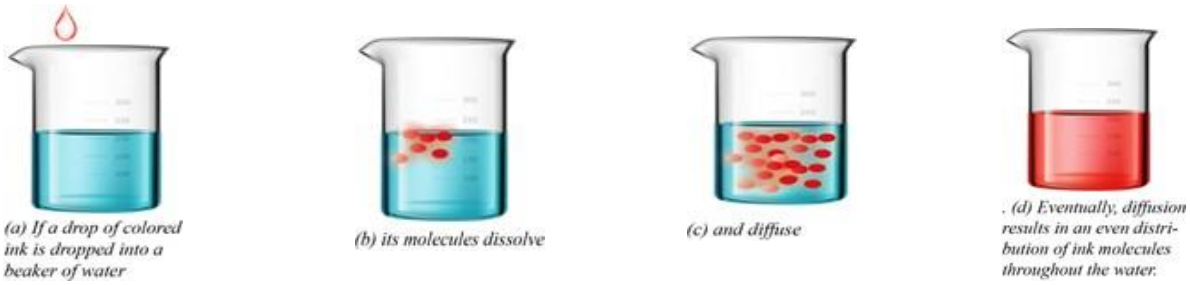

Figure 3.12. Diffusion of molecules.

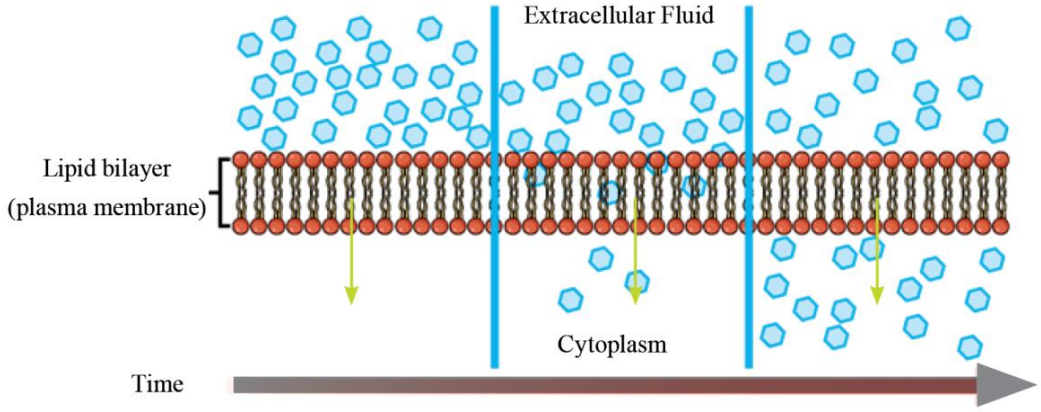

Figure 3.13 Diffusion through a semi-permeable membrane of cell

Activity 1.10

What will happen in the following situations?

1. When you sprayed perfume in one part of your home?
2. When you put one drop of ink inside a glass of water?

Factors influencing the rate of diffusion:

Dear learner! There are different factors which are influencing the rate of diffusion. These factors are:

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.

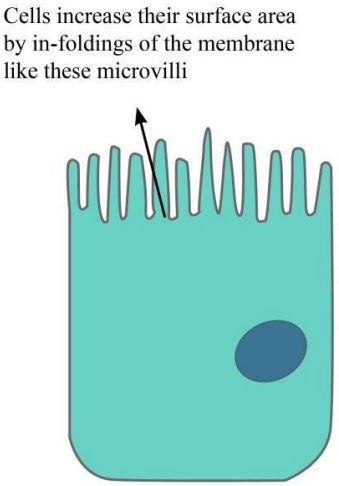

Figure .3.14 Microvilli on the surface of small intestine

Activity 3.11

Pea or bean seeds swell when they are soaked in water. Explain.

Osmosis

Dear learner! We hope you did well in the case of diffusion. If you did, then you should go on to the next section about osmosis.

Osmosis is the movement of water from a region of high concentration of water molecules (lower solute concentration) to a region of lower concentration of water molecules (higher solute concentration).

The movement of water is affected by the concentration of substances (solutes) dissolved in the water. Basically, water moves from areas where there is more water to areas where less water is.

Activity 3.12
Think about osmosis in terms of the solvent. Why do you think water moves away from the area with the greatest concentration of solvent?

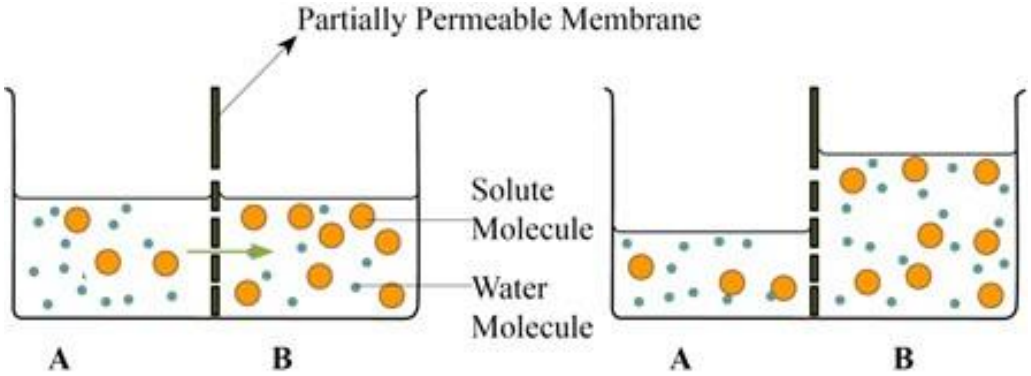

Figure 3.15 Osmosis

A). 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.

Dear learner! 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).

The solution found in the cell surrounding can be hypertonic, hypotonic and isotonic solutions.

The Hypertonic solution is a solution with a high concentration of solute and a low concentration of water.

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

Isotonic solution is when the cell and its surroundings have equal solute and water. 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 3.13

Why do People put salt for preservation of meat in the rural area where refrigerator is not available.

Osmosis in Plant cells

Dear learner! We hope you enjoyed reading the previous lesson about osmosis. We think it is very interesting for the learner to know the importance of osmosis in plant cells. Osmosis in plants is very important to bring strength and rigidity to the plant cell.

Dear learner! 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.

A 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.

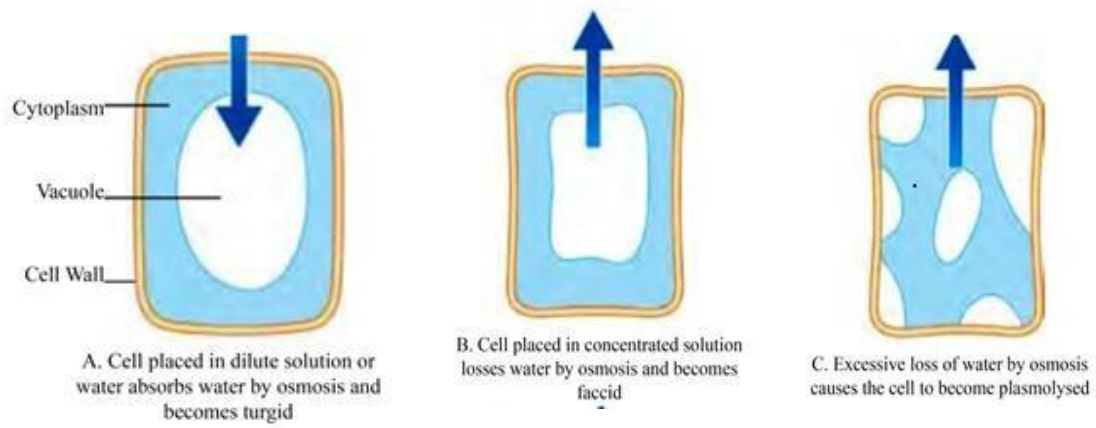

Fig. 3.16 water concentration of the solution surrounding the plant cell

In Fig. 3.16, figure, A shows that if the water concentration of the solution surrounding the plant cell is too high, the cell swells and turgid.

Figure B shows that if it is the concentration water in both is the same. Figure C shows that if the solution surrounding the cell is too high, the plant cell plasmolysed.

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

Dear learner! We hope you enjoyed the previous lesson about osmosis in plant cell. We think it is very interesting and important for the learners 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 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.

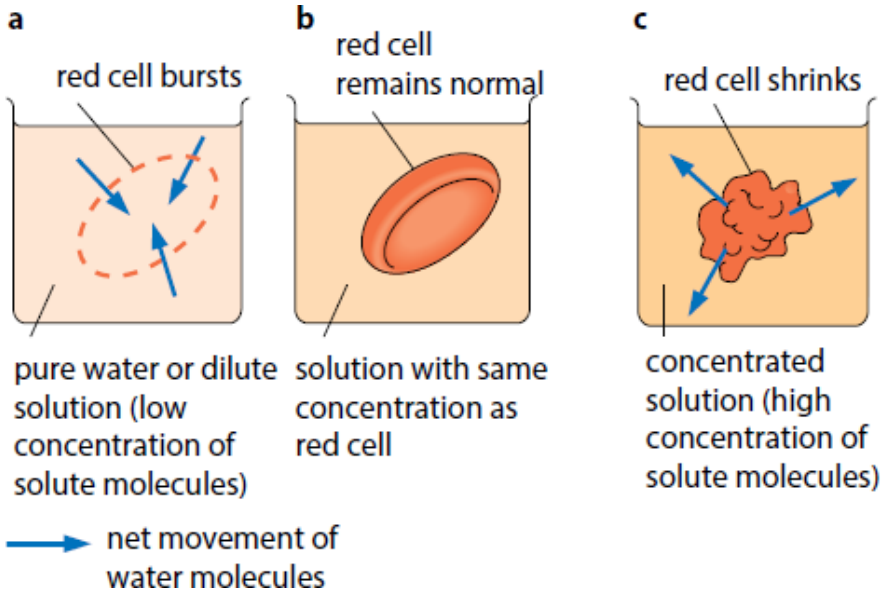

Fig. 3.18. (A) Shows that if the water concentration of the solution surrounding the red blood cell is too high, the water moves to the cell and the cell swells and bursts.

(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.

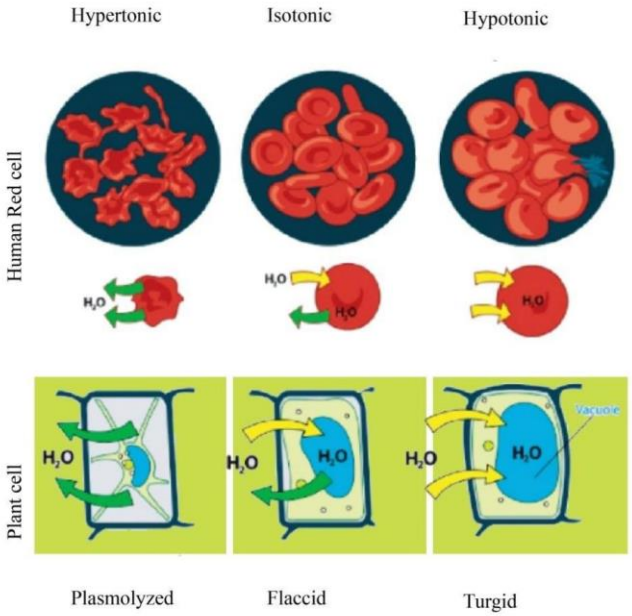

Fig. 3.19 Osmosis in plants and animal cell

Activity 3.14

1. If we apply too much chemical fertilizers in the soil? What could happen if we cultivate the crop plant in such type of soil? Why?

Activity 3.15

1. How do freshwater animals regulate the entrance of water into their body? Explain it by comparing with their environment.

Osmosis in Ameba

Dear learner! In section 3.3 you have learned about the function of contractile vacuoles which is found in some unicellular protozoans such as amoeba.

Contractile vacuole controls the intracellular water balance by accumulating and expelling excess water out of the cell. This is 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.

Section 3.6.2. Active transport

Dear learner! Active transport is the movement of particles through a cell membrane from a region of lower concentration to a region of higher concentration. It is the movement of particles against a concentration gradient, using the energy.

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.

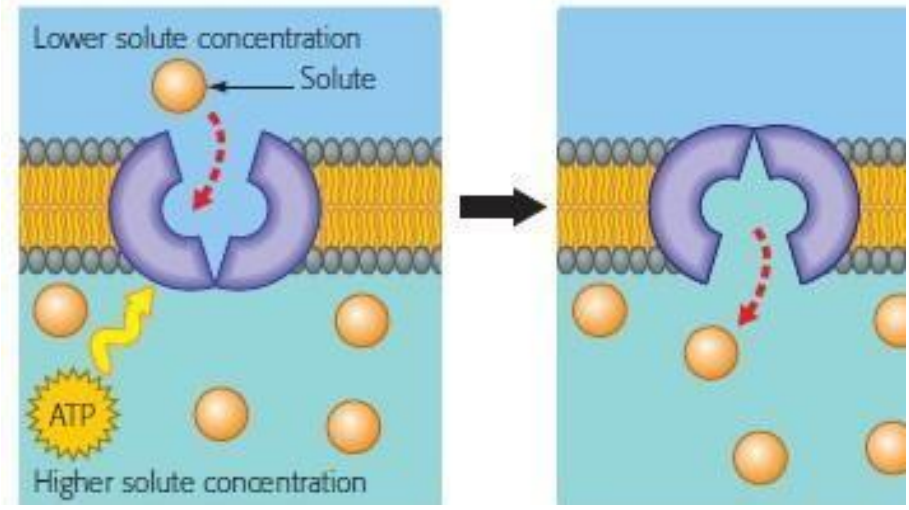

Figure 3.20 Active transport

Self-test exercises

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

	Diffusion	Osmosis	Active transport
It is the movement of substances llike O2			
It is movement of water			
Movement of ions like K^+			
Energy is required			

ii. Answer the following questions:

1. What is the different between passive and active transport?
2. Define diffusion and osmosis.
3. What are the factors that influence the rate of diffusion? and explain how surface area affect diffusion in body cell
4. Give some examples of application of diffusion and osmosis in day-to-day life.

☑ Self-evaluation checklist

Direction: Put a tick (√) against each of the following tasks you can perform. If you are not able to perform any of these tasks, you need to read once again.

I can

- Define the term diffusion and osmosis…….....□
- Describe the importance of diffusion and osmosis for the transport of gases and solutes ……□
- Describe the importance of active transport ……..…..□

Section 3.7. Levels of Biological Organization

Overview

Dear learner! In this section, you will study the level of organization.

Life forms a hierarchy of organization from atoms to complex multicellular organisms. Atoms are joined together to form molecules, which are assembled into more complex structures such as organelles. These in turn form subsystems that provide different functions. Cells can be organized into tissues, then into organs and organ systems such as the nervous system. This organization then extends beyond individual organisms to populations, communities, ecosystems, and finally the biosphere.

Learning competencies

By the end of this section you will be able to:

- Define the terms tissue, organ and organ system, and
- List some examples of human systems.

Activity 3.16:

In which hierarchical level does organelles are found?

Dear learner! The organization of the biological world is hierarchical—that is, each level builds on the level below it; we think it is very interesting and important for the learners to understand the cellular level and organism level of biological organization.

The cellular level. At the cellular level, **atoms,** the fundamental elements of matter, are joined by chemical bond into clusters called **molecules.**

Complex biological molecules are assembled into tiny structures called **organelles** within membrane-bounded units we call **cells.**

The organism levels. 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, 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 3.17:

1. Suppose one system in the organism, such as nervous or digestive system, failed to work properly. How would the organism be affected? Explain.

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

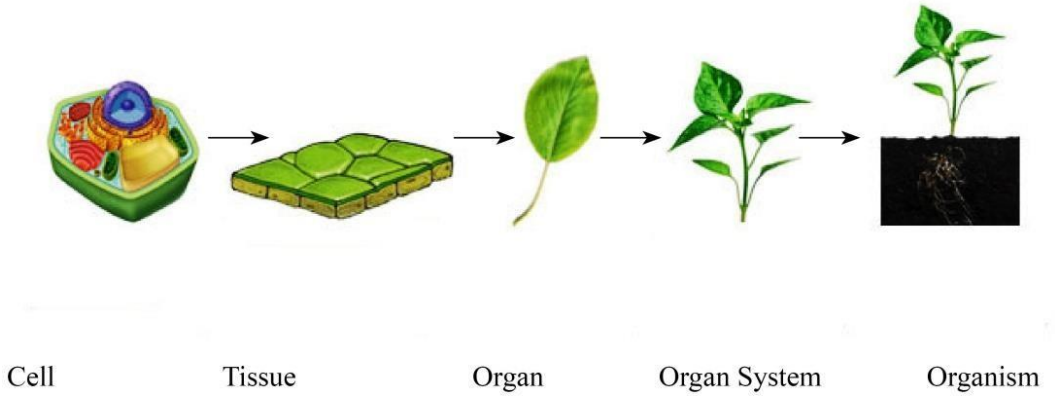

Figure. 3.21 Level of organization in plants

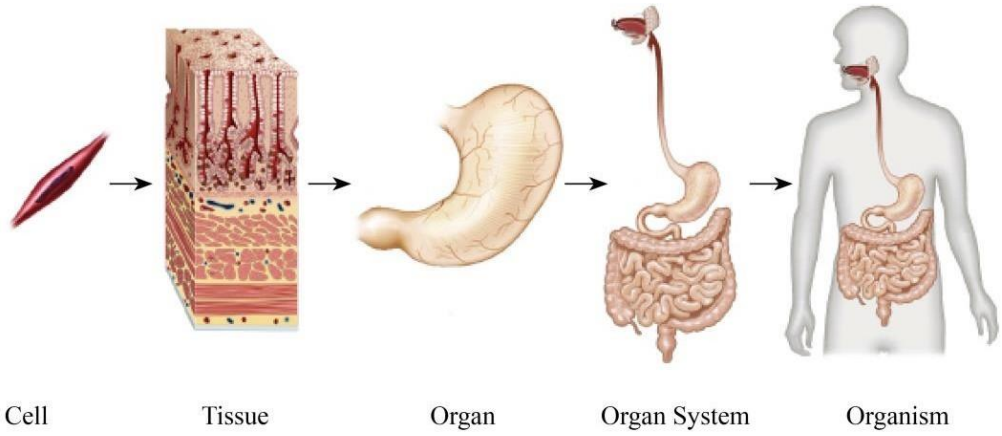

Figure. 3.22 Level of organization in Animals

Activity 3.18:

Give examples of some organ in the human body and discuss the tissue from which they are composed of.

Self-test exercises

1. 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

☑ Self-evaluation checklist

Direction: Put a tick (√) against each of the following tasks you can perform.

If you are not able to perform any of these tasks, you need to read once again.

I can

- Define the terms tissue, organ and organ system……..□
- List some examples of human systems ……..□

UNIT SUMMARY

The Cell Theory

- 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 shares simple structural features.
- All eukaryotic cells have a centrally located nucleus, a semifluid cytoplasm, and an enclosing plasma membrane.

Cell structures and function

- 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 controls all activities of the cell. With in 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 with in 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 Golgia pparatus refines certain ER products and packagesthemintransportvesiclestargetedforotherorganellesorexportfromt he 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.
- Microtubulesareanimportantcomponentofthecytoskeleton,anorganelletha

t 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. Thisorganizationthenextendsbeyondindividualorganismstopopulations, communities, ecosystems, and finally the biosphere.

Unit review questions

Match the following column 'A' with column 'B'

A	B
1. When the cell is surrounded by Hypertonic solution	**A.** Water moves out of the cell, causing the cell to shrink or plasmolysed
2. When the cell is surrounded by Hypotonic solution:	B. Water moves into the cell and pressure are applied to the plasma membrane causing turgidity of the cell
3. when the cell is surrounded by Isotonic solution	C. When the cell and the surroundings have equal solute and water

1. In which direction does the transport of water occur when a cell containing 5% glucose is placed in gar water that contains 10 % glucose?

A. From the cell to gar water B. From gar water to cell

2. If you look into a microscope and view an unknown cell. What structure might you see that would tell you that the cell is plant cell?

A. Cytoplasm B nucleus C. a plasma membrane D. cell wall.

II. Fill in the blank space with appropriate words

1. The largest organelle which contains DNA and control all activity of the cell_____
2. A smaller cellular structure that is used to synthesize proteins_____
3. _____is the site of respiration
4. _____is the site of Photosynthesis
5. The structure used to break down unwanted substance in the cell is_____

✍Written assignment

Answer the following questions.

1. Name three structures in plant cells and animal cells have in common.
2. Assume that you are observing plant cell under the microscope and the

plant cell looks turgid, what type of environment or solution is found around this plant cell.

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

Cell structure s	Cheek cell (animal)	Onion cell (plant)
Mitochondria		
Cell wall		
Chlorophyll		
Centriole		
Cytoplasm		

Answer Key to Activities and Review questions

Section 3.1

1. Cell is the smallest and the basic unit of living things
2. Multicellular: Plants and animals
   Unicellular: bacteria protozoa

Section 3.2

1. Robert Hooke, Anton van Leeuwenhoek, Matthias Schleiden, Theodor Schwann and Rudolf Virchow
2. The cell theory states that:
   - Living organisms are composed of one or more cells.
   - Cells are the smallest unit of life
   - Cells arise only by the division of a pre-existing cell.

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

- Every living cell is surrounded by a membrane, which separates the cell contents from everything else outside.

- Cells contain genetic material which stores all of the instructions needed for the cell's activities.
- Many of these activities are chemical reactions, catalyzed by enzymes produced inside the cell.
- Cells have their own energy release system that powers all of the cell's activities, so cells can be thought of as the smallest living structures – nothing smaller can survive.

Section 3.3

i. Matching

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

II. Short answer

1. Cilia and flagella

Section 3.4

Prokaryotes are different from eukaryotes because:

1. They have no membrane-bound organelles
2. Relatively small

Features	Animal Cell	Plant Cell
cell wall	Absent	Present
Cell membrane	Present	Present
Nucleous	Present	Present
Chloroplast	Absent	Present
Vacuole	Small	Large
Mitochondria	Present	Present
Smooth and rough endoplasmic reticulum	Present	Present
Golgi bodies	Present	Present
Ribosomes	Present	Present

3. All have cell wall

Section 3.5

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

Section 3.6

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

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

II. Short answer questions

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

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

6. **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 to a region of their lower concentration.

7. **Concentration gradient, Temperature, mass of molecule distance travel and surface area.**

8. 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 and explain how they affect diffusion

9. Spraying perfume etc.

Section 3.7

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

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

Feedback to Activity 3.1

Activity 3.1: Self-test

Function	Cell Structure
A rigid structure of a plant cell that provides support and gives shape to the cell	Cell membrane
The darker area of the nucleolus where new ribosomes are made	Nucleolus
The place where protein is synthesized	Ribosome
The part which allows materials to be transported throughout the cell	Endoplasmic Reticulum
Its functions are in the collection, packaging, and distribution of molecules within the cell or even outside the cell.	Golgi apparatus

Feedback to Activity 3.2

The two cells have differences in their shape and their function, such as, nerve cell in human body is very long and extends throughout the body to reach the different muscle cell.

Feedback to Activity 3.3

Cell wall is a rigid structure of a plant cell that provides structural support and gives shape to the cell. 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.

Feedback to Activity 3.4

DNA is the genetic material that organisms inherit from their parents. It is double stranded helical macromolecule consisting of nucleotide monomers with deoxyribose sugar, a phosphate group, and the nitrogenous bases adenine (A), cytosine (C), guanine (G), and thymine (T).

Feedback to Activity 3.5

1. The Rough Endoplasmic Reticulum has a dotted appearance of its surface. These dotted structures on it are the ribosomes. But the smooth Endoplasmic Reticulum is without ribosomes.

2. The Golgi apparatus, vesicles and rough endoplasmic reticulum have a cooperative work in material transport of the cell; for example, proteins can be made by rough endoplasmic reticulum. This protein made by the rough endoplasmic reticulum may be placed inside a transport vesicle which is attached on golgi bodies. The golgi apparatus with the vesicles functions in the collection, packaging, and distribution of molecules within the cell or even outside the cell.

Feedback to Activity 3.6

Metabolically very active cells like muscle cells contain thousands of

mitochondria, because they need more energy for their metabolic action.

Feedback to Activity 3.7.

Unicellular eukaryotes like amoebas have food vacuole in order to eat smaller organisms or food particles. Other unicellular protists have contractile vacuoles that pump excess water out of the cell.

Feedback to Activity 3.8

Animal and plant cell

Feedback to Activity 3.9

The semi permeability of cell membrane is used to control the entering of necessary substances and the removal of unnecessary ones.

Feedback to Activity 3.10

1. Diffusion of the odor of the perfume from high to low concentration.
2. Diffusion of ink color in glass of water from high to low concentration.

Feedback to Activity 3.11

Swelling of pea and bean seeds when they are soaked in water, this seed swells because it takes water.

Feedback to Activity 3.12

When osmosis explained in terms of the solvent (water), water moves from the area of higher concentration (Hypotonic) toward the area with the lower concentration of solvent (Hypertonic).

Feedback to 3.13 Activity

Osmosis is important in our society in the preservation of meat in the rural area where refrigerator is not available. Here, many people live in a rural area preserve meat by mixing the cut meat with salt; here water moves from meat (high concentration of water) to the salt (low concentration of water but high concentration of salt).

Feedback to 3.14

When we apply chemical fertilizers to the soil, the fertilizers dissolve in the soil water. Too much fertilizer can lower the osmotic potential of the soil water. This can draw water out of the plant root hair cells by osmosis, leading to wilting and death of crop plants. Why?

This is because high amount of fertilizer makes the soil to reduce its water concentration. This is because of the addition of solutes as fertilizer in the soil. Now, the movement of water is from high concentration (the plant) to low concentration (the soil). Therefore, the plant becomes wilt because it loses its water content by osmosis.

Feedback to 3.15

Fresh water animals these animals must have a way to balance the uptake and loss of water. The control of water balance is called osmoregulation. For example, a freshwater fish has kidneys and gills that work constantly to prevent an excessive buildup of water in the body.

Feedback to Activity 3.16

In the cellular level.

Feedback to Activity 3.17

If the systems in organism is affected, such as if digestive system affected by any condition it may leads to illness of the organism.

Activity 3.18

For example, the stomach is an organ that contains tissues made from epithelial tissue, gland tissue and muscle tissue.

Answer to unit review questions

Matching

1. a 2. B 3, c

Fill in the blanks

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

Choose the best answer

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

Short answer questions

1. The red blood cell burst by receiving more water.
2. Cell wall, chloroplast and large vacuole
3. Centrioles and lysosomes
4. The cell surrounding environment is hypertonic (contain more solute than the cell)

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

cell structures	cheek cell (animal)	onion cell (plant)
Nucleus	X	X
cell wall		X
Chloroplasts		X
large vacuole		X
Cytoplasm	X	X

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