Federal Republic of Somalia
Ministry of Education, Culture and Higher Education

Biology
Secondary
Form one

Student Book

Federal Republic of Somalia
Ministry of Education, Culture and Higher Education

Biology

Secondary

Form one

2020

Madbacadda Beder
0616459001 / 0616459002
Muqdisho - Soomaaliya

Manhajka Cusub ee Qaranka
Daabacaadda 1aad
2020

Waxaa Daabacday:
Madbacadda Beder
616459001 | 616459002
Muqdisho -Soomaaliya

Jamhuuriyadda Federaalka Soomaaliya
Wasaaradda Waxbarashada, Hiddaha iyo Tacliinta Sare
Xafiiska Wasiirka

جمهورية الصومـــال الفيدرالية
وزارة التربية والثقافة والتعليم العالي
مكتب الوزير

Federal Republic of Somalia
Ministry of Education, Culture & Higher Education
Office of the Minister

MAHADNAQ IYO ORAAHDA WASIIRKA

Alle ayey mahad u sugnaatay, Wasaaradda Waxbarashada Hiddaha iyo Tacliinta sare (WWH&TS) waxa ay muddo dheer ku taameysay in ay soo saarto manhaj ka tarjumaya ummadda Soomaaliyeed, kaas oo la jaan qaadi kara casriga cusub, kuna dhisan aragti midayneysa ummadda Soomaaliyeed, una horseedaysa midnimo iyo horumar.

Waxaa sharaf u ah **WWH&TS** in ay soo saarto manhajkan cusub oo tayadiisu sareyso, kana qeyb qaadanaya horumarinta maskaxda ubadkeena iyo garaadka fekerkooda si ku dhisan cilmi.

Manhajkan cusub waxa uu daaweyn doonaa fikradaha kala duwan ee ummadda Soomaaliyeed kala geeyay, oo ay sababtiisu tahay kala duwanaanshaha manaahijta dugsiyada kala duwan loo dhigo, waxa uuna keeni doonaa in la helo ummad Soomaaliyeed oo hal ujeeddo iyo hal fikir leh.

Manhajkan waxa uu ku dhisan yahay feker Soomaalinimo, si loo gaaro arrinkaas waxa lagu caddeeyey manhajkaan waxa la bari doono ardayga Soomaaliyeed, habka barashada, dhigista iyo ciddii dhigi leheydba, kaas oo lasiin doono tababar ku filan iyo bare kaaliye haga baraha.

Waxaana rajeyneynaa inuu noqodo kii ka saari lahaa ubadka Soomaaliyeed kala qoqobnaanta una horseedi lahaa midnimada iyo horumarka.

Ugu danbeyn, WWH&TS waxay mahad iyo bogaadin u jeedinaysaa Madbacadda Beder oo maalgelisay qorista iyo soo saarista manhajkan.

A. Goodah B.

Mudane, Xil. Cabdullaahi Goodax Barre
Wasiirka Wasaaradda

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Mahadnaq

Marka hore waxa aan u mahad naqeynaa Alle (SW), oo noo fududeeyey howshan baaxadda leh, intaa kaddib, Wasaaradda Waxbarashada, Hiddaha iyo Tacliinta Sare iyo Xafiiska Horumarinta Manaahijta ee Wasaaraddu waxa ay mahad ballaaran u celinayaan dhammaan dhinacyadii iyo shaqsiyaadkii ka qayb qaatay manhajka cusub ee waxbarshada dalka, iyo soo saaridda buuggan, gaar ahaan:

- Madbacadda Beder oo gacan ka geysatay daabacaadda iyo maalgalinta mashruucan
- Guddiga dib u eegista ee Xafiiska Manaahijta oo si hufan u turxaan bixiyay buugga
- Qorayaasha buugga oo waqti badan geliyay
- Khubarada maadada oo dajiyay casharrada
- La taliyeyaasha oo soo jeediyay talooyin wax ku ool ah
- Khubarada kale ee xagga farsamada iyo isku xirka casharrada naga caawiyay
- Khubarada naqshadeynta oo xagga sawirrada iyo naqshadeynta naga caawiyay

Ugu dambayntii, waxaan u rajayneynaa in uu buuggani noqon doono mid faa'iido u leh ardayda iyo barayaashaba, uuna door muuqda ka ciyaari doono horumarinta waxbarashada dalka.

Mahadsanidiin

Xafiiska Horumarinta Manaahijta
WWH &TS
Mudisho - Soomaaliya
2020

Introduction

Summary of the Somali National Curriculum

Education is the key to development. However, it has to be of high quality and deliver relevant outcome to the society. Education is important as it helps the country and its people to develop.

The new curriculum will help reform the education system and ensure that its graduates fit in this 21st century. Similarly, it prospers, supports and motivates students to live a peaceful, happy and healthy life fully supported with core Islamic values. This curriculum also helps students to develop and achieve their ambitions. This will prepare them for a creative and productive working life as well as being active citizens in a changing world of tomorrow. We look forward to develop an education system which meets all needs for all Somalis.

The Ministry of Education intends that all students learn to acquire the following values:

Appreciate and apply Islamic values, develop a strong sense of patriotism and love for their country and the community, appreciate their own cultural heritage, uphold ascetic values that appreciate the beauty and its expression in nature and the arts. The ministry also intends to instil self-discipline-appropriate behavior, time keeping, respect, value the rights of all people irrespective of gender and ability, value integrity in themselves and others including respect for property and life. This will nurture all round students with skills and knowledge that will enable them adapt and contribute to the changing society both economically and socially.

Learning and Teaching Approaches

In delivering this new curriculum in the classroom, teachers will use a variety of instructional strategies that actively engage all learners in the learning process. In this regard, teachers will employ learning and teaching approaches that promote:

1. Active learning: Learners meaningfully engage in activities that contribute towards the attainment of learning outcomes.
2. Experiential learning: Learning through action, learning by doing, learning through experience, and learning through discovery.
3. Skills development: Acquisition of a wide range of skills such as critical thinking, creativity and problem solving among other skills.

Assessment approaches

The school curriculum regards assessment as an integral part of the teaching and learning process. This curriculum places greater emphasis on assessment for learning rather than of learning. In this regard, the role of assessment will be to:

1. Provide feedback on learners' progress in demonstrating the anticipated learning outcomes to be used as a guide when providing remedial support.
2. Enable learners to identify their own strengths and areas to improve on for purposes of furthering their own learning.
3. Inform the teachers, schools, parents and ministry officials on the general performance of learners with respect to the intended learning outcomes.

All assessment activities will focus on checking all learners' progress in achieving the intended outcomes as prescribed in the teaching syllabus and lesson plans. In particular, assessment will focus on the following:

1. Learners' acquisition of knowledge, skills and values.
2. Learners' ability to apply skills and knowledge acquired in class in their daily lives.
3. Evidence of learning and behavioural change in learners.

Teachers will ensure that learners with special needs are given comparable assessment items without compromising the quality of assessment.

This curriculum promotes an inclusive assessment regime. It seeks to empower learners to participate in evaluating their own learning progress. Therefore, the following modes of assessment have been adopted:

1. Self-assessment: The learner is able to evaluate his or her own learning progress. This strategy should be encouraged in the upper primary and secondary level.
2. Peer assessment: Learners are empowered to comment on the learning progress of one another. The learner's work is assessed by fellow peers
3. Teacher assessment: Teachers will facilitate continuous and summative assessment in a more balanced manner.

Biology learning outcomes

The study of biology connects learners to the world they are living in and demonstrates the interconnectedness with all other life forms. It assists to develop awareness of the significance of Somalia's unique fauna and flora ecosystems. It provides learners opportunities to learn about the processes of all living things. Learners will be able to make more informed decisions about their own health and about important biological issues.

By the end of this level the following broad outcomes will be accomplished

Learners will be able to: confidently explore and investigate phenomena relevant to Life Sciences, use Life Sciences concepts to explain phenomena relevant to Life Sciences, to compare, contrast, and make accurate conclusions from findings so as to determine the scientific meaning of conclusions made, to compare, contrast, and recognize inconsistencies in data obtained, as well as assess the value of the experimental process, to develop an understanding of Living and non-living resources, nutrient cycles and energy flow within an environment, to conduct experimental investigation, of kidneys, hearts and eyes through dissections, to design a model, to develop an understanding of genetics, immunity, diseases, to explain the process of cell division, to state that the carbohydrates are made and importance of the foods, to state that respiration process, to develop an understanding of the nature of science and technology, social and environmental, to list various applications of Life Sciences knowledge in biotechnology, and describe and explain these applications, to analyze and report different beliefs, attitudes and values as well as the impact of scientific and technological processes and products on a surrounding communities , to evaluate and give recommendations on the impact of scientific and technological processes and products on different communities.

BIOLOGY FORM ONE

Introduction

At the onset of this level the student will be introduced to the basics of life science.

This textbook was prepared to suit the biological needs and abilities of a grade 9 student.

The book also seeks to bridge the gap of transition from primary level to secondary level.

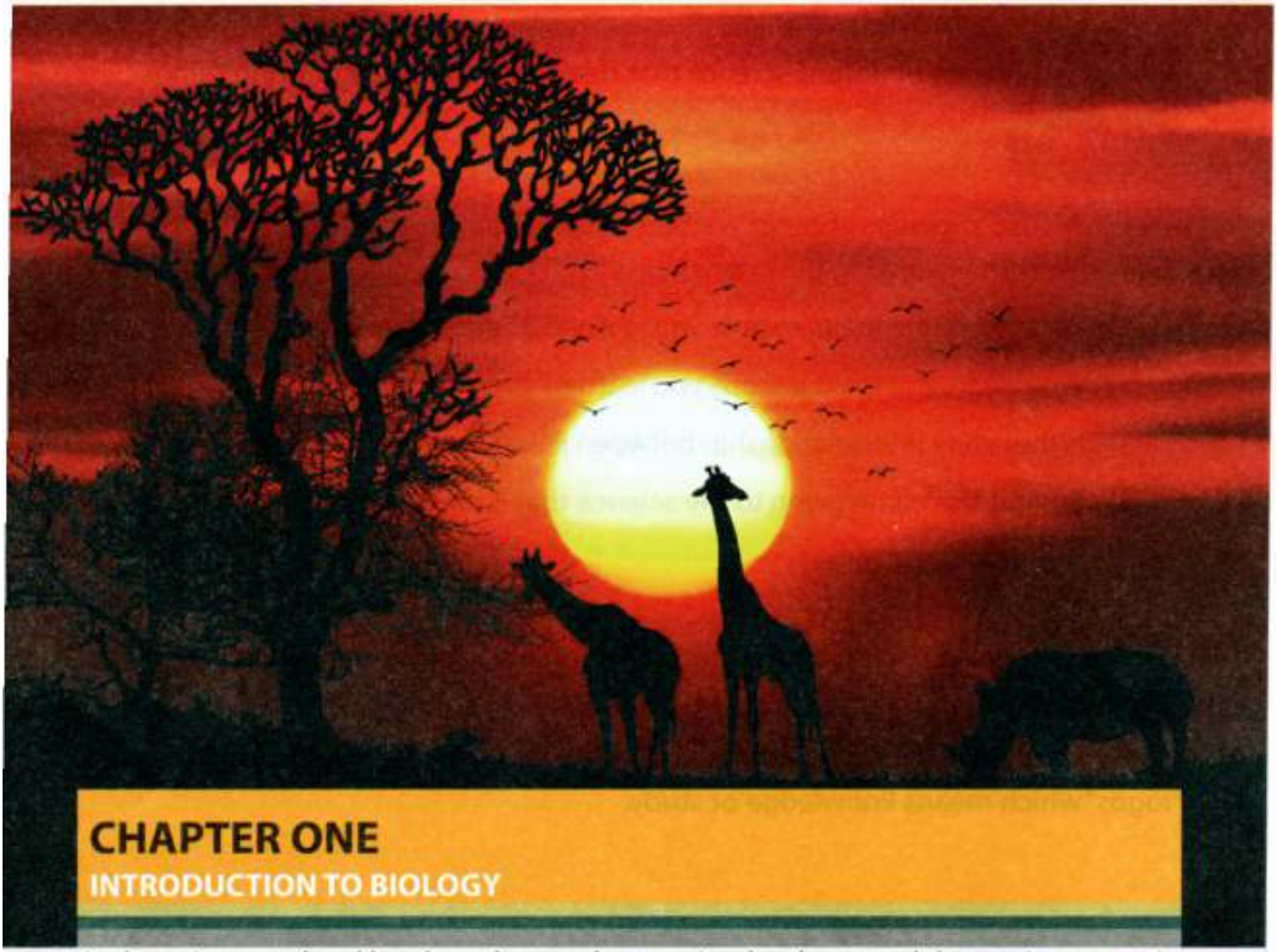
Throughout the book, students will be assessed on a regular basis and at the same time, they will perform constant tasks and activities due to the fact that the book designed to provoke the student's conscious and creativity to uplift him from being a passive recipient to an active, resourceful thinker.

Special consideration is given to the individual differences of students with the emphasis on diagrams, charts and models those facilitate the student's grasp of the main concepts.

The development of this book was the result of a cooperation made by cadres and experts of this field. Although these experts paid all their efforts in the improvement of this work yet, the supervising committee was adamant to obtain all the opinions, suggestions and observations from practitioners in the field whether teachers or mentors such that the work is flawlessly developed as much as possible with the help of Allah.

This textbook consists of seven chapters that are that are put together in a uniform sequence, chapter one is the dedicated to expose the student to the world of biology. Chapters two and three entails the basic units of structure and function of living organisms. Chapter four to seven discuss the principles of classification and brief studies on some kingdoms from viruses, bacteria, archaea, and Protista.

Contents



CHAPTER ONE
INTRODUCTION TO BIOLOGY

At the primary school level you learnt about animals, plants and the environment in the Science course. At the secondary level, you will continue to learn more about the animals, plants and the environment in different subjects. These subjects are biology, chemistry and physics. In biology, you will learn more about living things and their environment in greater detail. This chapter introduces you to what a living thing is.

By the end of this chapter, students should be able to:-

- Define biology
- Describe the branches of biology
- Explain the importance of biology in our daily life
- Outline the characteristics of living things
- Differentiate between plants and animals

1.1What is Biology?

Biology is a branch of natural science that deals with the study of living things

Activity 1:

Briefly discuss in groups about the science you have studied at primary level and then answer the following questions

1) What were the main lessons you learned about living things?
2) What were the main lessons you learned about nonliving things?
3) Is there any interrelationship between living and nonliving things?
4) What is the name given to the science that is concerned with the study of living things?

The science which deals with the study of living objects and their life processes is called Biology.

The word biology is derived from two Greek words, "bios" which means life and "logos" which means knowledge or study.

1.2. Branches of Biology

Biology is a broad science that has many branches.

Activity 2:

Based on your previous knowledge, discuss the following:-

1) Living things include animals and plants: could you give a name to the scientific study of animals or plants?
2) Can you mention the specialized fields of biology required in the study of medicine?
3) Can you guess the name of a specialized branch of biology that entails the interactions of living and nonliving things?

There are two major branches of biology:-

- Botany is the branch of biology, which deals with the study of plants.
- Zoology is the branch of biology which deals with the study of animals.

Some specialized branches of biology and their definations are shown in table 1.1

Table 1.1 Some Branches of biology and their definations

Branches of biology	Description
1. Morphology	The study of external features of an organism
2. Cytology	The study of cells.
3. Histology	The study of tissues.
4. Microbiology	The study of microorganism.
5. Anatomy	The study of internal structure
6. Physiology	The study of different types of body functions

Activity 3:

Write the descriptions of the branches of biology in the table below by using a dictionary or internet source.

No.	Branches of Biology	Description
1.	Embryology	
2.	Ecology	
3.	Genetics	
4.	Parasitology	
5.	Taxonomy	
6.	Entomology	
7.	Ichthyology	
8.	Herpetology	
9.	Ornithology	
10.	Mammalogy	

1.3. The importance of studying biology

The study of biology is very important. The knowledge acquired from this study can benefit an individual in many ways.

Activity 4:

Discuss the importance of biology, focusing on the following questions:

1) Which careers could you acquire from studying biology?
2) Describe the ways in which biology helps you in your daily life?

The study of biology is important in that:

1) It helps us know ourselves better. In biology, we learn what our bodies and other living organisms are made up of and this leads us to remember the greatness of Allah. Allah says in Surah Adh- Dariyat

﴿وَفِي أَنفُسِكُمْ ۚ أَفَلَا تُبْصِرُونَ ﴿٢١﴾﴾ الذاريات

and in your selves. then will you not see (Verse 21; surah Adh- Dariyat)

2) The knowledge acquired from the study of biology can be very helpful in solving environmental problems such as food shortage, poor health services, pollution and environmental degradation.
3) The study of biology can grant one an entry into various careers such as medicine, veterinary medicine, animal husbandry, horticulture and dentistry.
4) The study of biology leads to the development of scientific skills which are very useful in life. These include the skills of observing, identifying, recording, classifying, measuring, analyzing and evaluating. These skills can enable us to learn how to make informed choices and lead an improved life.
5) Through the study of biology we learn the causes of animal, plant and human diseases and how best these diseases can be prevented and cured.

7) **Respiration and Gaseous exchange**

It is the process by which living things release energy from the organic food substances and utilize this energy to perform various activities.

Gaseous exchange is a process whereby respiratory gases- oxygen and carbon dioxide- pass across a respiratory surface like the lungs and gills.

8) **Movement**

Living things show movement. Every day you see the animals, birds, insects and human beings moving from one place to another. This type of movement is called locomotion. Animals move for two main reasons – in search of foods and to escape from enemies. Most plants are fixed into the soil. They are unable to carry out locomotion, but show movement.

Discussion

The movement of animals is clear and fast, while the movements of plants is unclear and slow. Why?

9) **Irritability**

Irritability is the ability of living organisms to detect and respond to a stimulus (changes in their surroundings). In cold weather, we wear woolen clothes. If we touch something hot by mistake, we respond quickly by withdrawing our hands. During drought roots of plant grows further downward in search of water.

10) **Life Cycle**

Living things follow a life cycle. They start their life from a single cell and follow the path of growth, reproduction, and death. The period during which an organism completes its life cycle is called the lifespan. Based on your previous knowledge, what are the differences between living and nonliving things?

1.5. Comparison between plants and animals

The differences between plants and animals are easily noticeable. The table below shows the unique properties for each of them.

Table 1.2 Differences between plants and animals

Plants	Animals
1. Plants are generally rooted in one place and do not move on their own	1. Most animals have the ability to move from one place to another.
2. Plants contain chlorophyll.	2. Animals do not contain chlorophyll
3. Plants can make their own food, thus they are autotrophic.	3. Animals cannot prepare their own food, hence, are heterotrophic.
4. Plants respond slowly to changes in their environment.	4. Animals respond to changes in the environment.
5. Plants lack complex excretory organs	5. Animals have complex excretory organs.

Question

State other differences between plants and animals which are not mentioned in table 1.

CHAPTER QUESTIONS

Q_1: Choose the correct answer for each of the following

1. The branch of science that deals with the study of life is called
   a. Astronomy b. Biology c. Geology d. Meteorology

2. The process by which cells produce energy is known as
   a. Gaseous exchange b. Respiration c. Excretion d. Reproduction

3. Genetics is a branch of biology that deals with the study of:
   a. Classification and naming of organisms
   b. Living things and their environment
   c. Body functions
   d. Inheritance and variation

4. Which of the following is catabolic process?
   a. Photosynthesis b. Growth c. Respiration d. Irritability

5. The branch of biology that deals with the study of insects is called
   a. Entomology b. Ichthyology c. Embryology d. Ecology

Q_2: List at least five characteristics in which living things differ from nonliving things?

Q_3: Differentiate between the following:

1. Autotrophic and heterotrophic organisms.
2. Catabolism and anabolism

Q_4: Compare and contrast between plants and animals?

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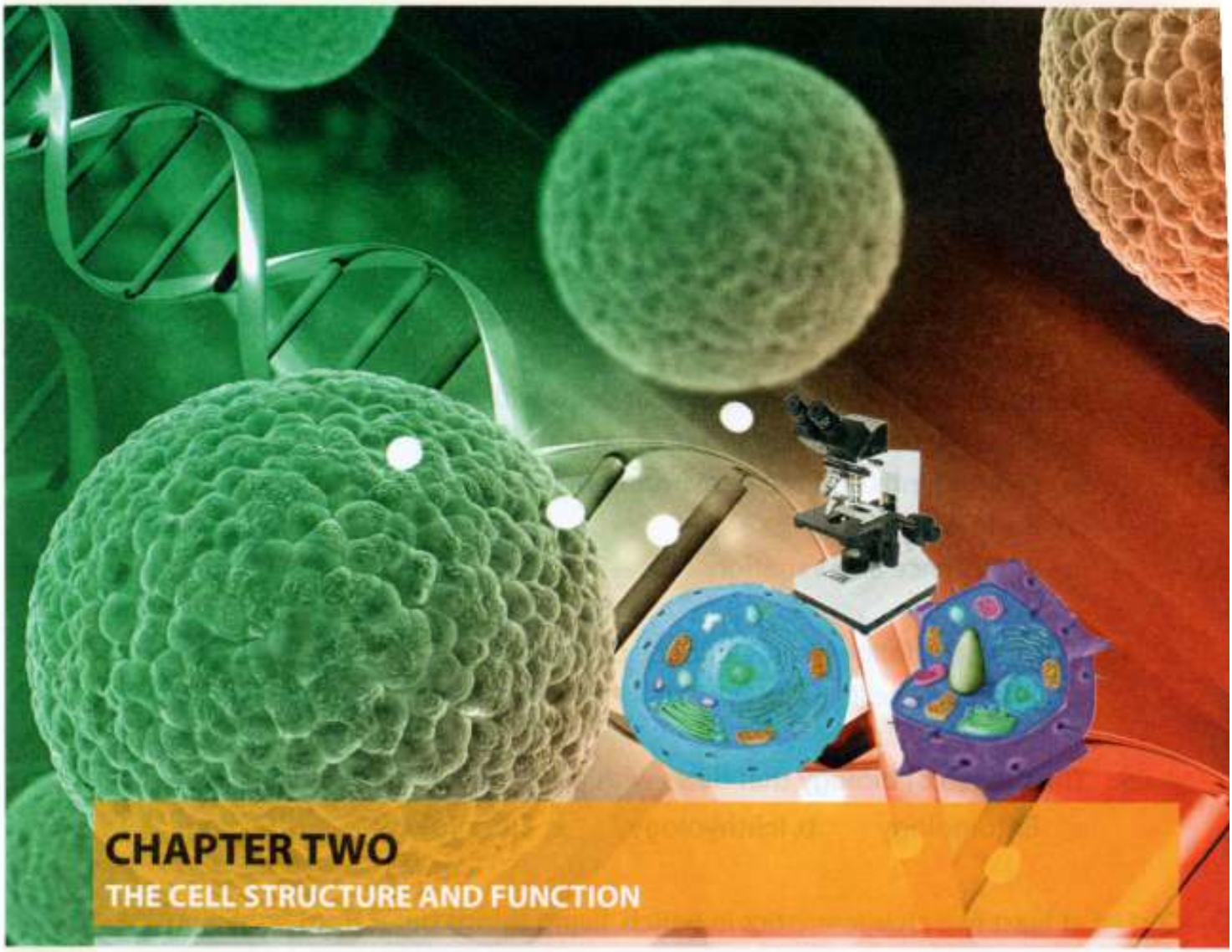


CHAPTER TWO
THE CELL STRUCTURE AND FUNCTION

All living organisms are made up of small structures called **cells**.

Cells are the basic units of life and they are responsible for keeping an organism alive and functioning. What are cells made up of? How do they work? In this chapter you will study the structure and function of basic units of life.

By the end of this chapter the students should be able to:

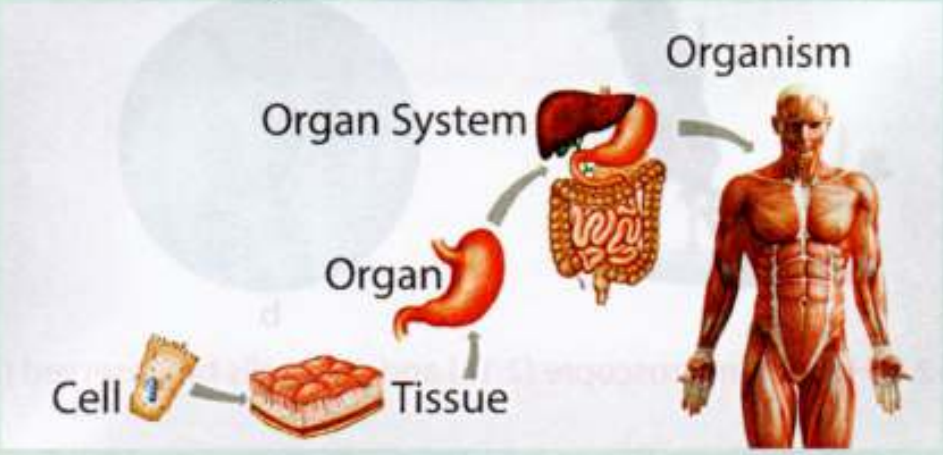
- Explain the discovery of the cell
- State the cell theory
- Justify why cells are different in size and shape.
- Differentiate between prokaryotic and eukaryotic cells.
- Explain the parts of light microscope and their function
- Identify the parts of light microscope and state their functions.

- Use adjustments of the microscope efficiently.
- Determine the magnification of the light microscope.
- Compare and contrast between the different types of microscopes
- Draw and label the plant and animal cells as seen under light and electron microscope.
- Compare and contrast between plant and animal cells.
- Differentiate between diffusion and osmosis
- Describe active transport
- Describe the cell division and its types.

2.1. The Cell and its Discovery

Activity 1:

The figure below shows the levels of body organization in human beings. Look at it carefully, and answer the questions that follow it:



1) What is the smallest structure that the human body is made up of?
2) What about the body of other living things. Are they made up of the same thing or something else?

The cell is defined as the smallest structural and functional unit of all living organisms. Some living things like amoeba, and bacteria consist of only a single cell. These are called **unicellular organisms.** However, most of the living things consist of many cells. For example, mango and elephant. These are called **multicellular organisms**.

Activity 2:

Debate with your peers about the following historical background of cells with special emphasis on cell theory. Make a research of your own on the recent discoveries regarding cells.

- Cells are so small, they were not discovered until the invention of the microscope in the 17th century.
- In 1665, Robert Hooke observed a piece of cork under the microscope and found it to be made of small compartments which he called "cells" (Latin cell = small room). see figure 2.1a and 2.1b that show Hooke's microscopre and the the cork cells he observed.

a b

figure 2.1: Hooke's microscopre (2.1a) and cork cells he observed (2.1b).

- In 1673, Anton van Leeuwenhoek, first observed bacteria, sperm cells and red blood cells which he termed "animalcules," or little animals.
- In 1831, Robert Brown, an Englishman observed that all cells had a centrally positioned body which he termed the **nucleus**.
- In 1838, German botanist Matthias Schleiden stated that all plants "are aggregates of separate beings, namely the cells themselves."
- In 1839, German physiologist Theodor Schwann reported that all animal tissues also consist of individual cells. Thus, the cell theory was born.

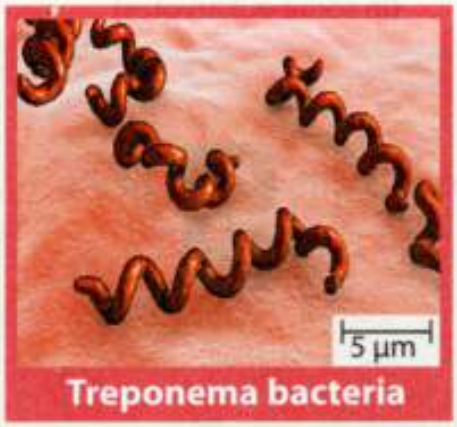
Cell theory states that:

1) All organisms are composed of one or more cells.
2) Cells are the basic units of structure and function of all organisms.
3) Cells arise only by division of a previously existing cell.

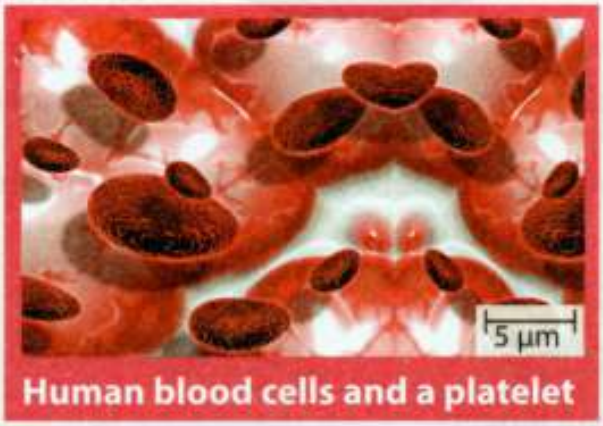
2.2. Size and Shape of Cells

Cells vary greatly in size and shape. You can express their size in units called micrometres. One micrometre (μm) is 1/1000 mm. A typical cell is about 20 μm (micrometres) in diameter. Large organisms contain millions of cells. The largest cell is an ostrich egg which is about 170 x 135 mm. The smallest cell is a bacterium which is about 0.25 μm in size. A human red blood cell is about 7.5 μm in diameter.

The diversity of cell shape reflects the different functions of cells. Compare the cell shapes and sizes shown in figure 2.2



Treponema bacteria



Human blood cells and a platelet

Stentor 'a protozona'

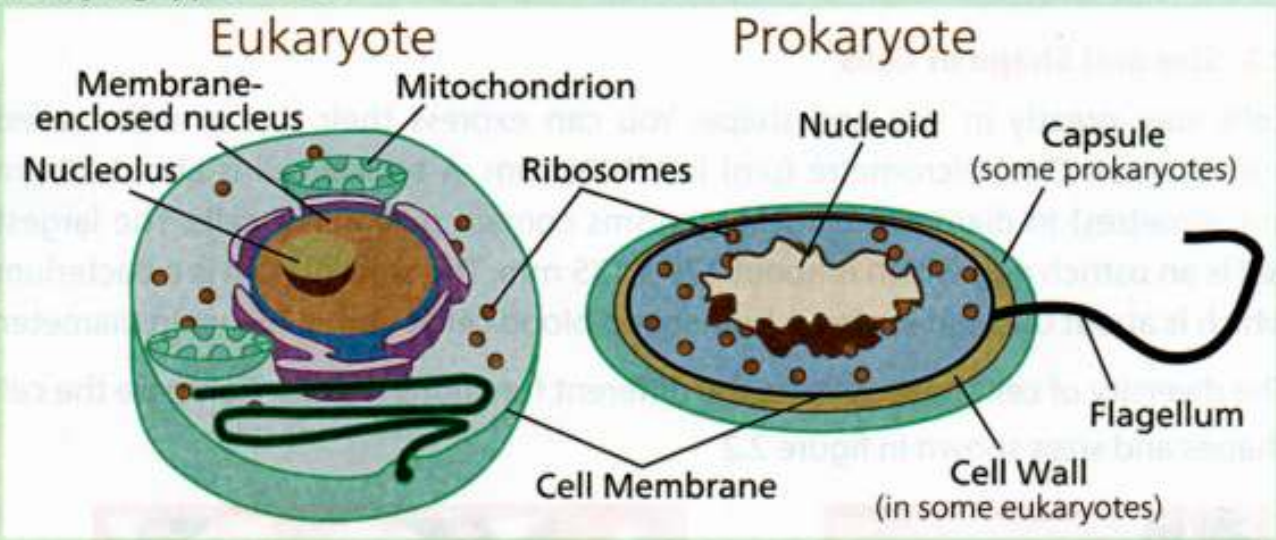
Human egg and sperm cells

Figure 2.2

TYPES OF CELLS

Activity 3:

Identiying types of cell



Look at the image above and answer the following

1) Compare between prokaryotic and eukaryotic cells with respect to the presence of:

- Cell membrane
- Cell wall
- Nucleus
- Organelles

2) Study the two types of cells discussed below and give some more examples

There are two basic types of cells:

1. **Prokaryotic cells:** are cells that do not possess a well formed nucleus such as bacteria.

2. **Eukaryotic cells**: are cells that possess a well-defined nucleus, covered by a nuclear membrane like plant and animal cells.Their differences are shown in table 2.1.

Table 2.1: Comparison between eukaryotic and prokaryotic cells

Points of Comparison	Prokaryotic cell	Eukaryotic cell
1. Nucleus 2. Diameter 3. DNA 4. Organelles 5. Cell division	1. Lack of true nucleus. The genetic material present in cytoplasm 2. ~ 1- 5 µm 3. Circular and does not contain histones (proteins) 4. No membrane bound organelles. 5. Binary fission	1. True nucleus is present that is surrounded by nuclear membrane 2. 10-100 ~ µm 3. Threadlike and contains histones (proteins) 4. Membrane bound organelles 5. Mitosis and meiosis

2.3. The Microscopes

There are two main types of microscopes.

These are: Light Microscope and Electron Microscope

A. **The Light Microscope**

Activity 4:

Use a hand lens for magnification required materials and tools: hand lens, plant leaf

1) Look at the plant leaf without using the magnifying lens. Then check the leaf itself with the hand lens. Record your observations of both scenarios.
2) Try to find something in the classroom or in your home like papers or textbooks and then observe it under the magnifying lenses. Share what you have seen with your classmates.

You have noticed that most of hand lenses magnify the objects around 1.25 to 1.50 times. Biologists use a more powerful tool for magnification of minute things and that is known as a microscope. The microscope aides the human eye to see the cells and its smaller structures.

Activity 5:

For further information about the parts and functions of a light microscope, consider studying figure 2.3 and table 2.2 then conduct the following tasks

1) Draw a labeled diagram of light microscope.
2) State the functions of the parts of the light microscope
3) Why do we need to use microscopes?

Parts of a light microscope

Figure 2.3 depicts the parts of a light microscope, the functions of these parts are shown in table 2.2.

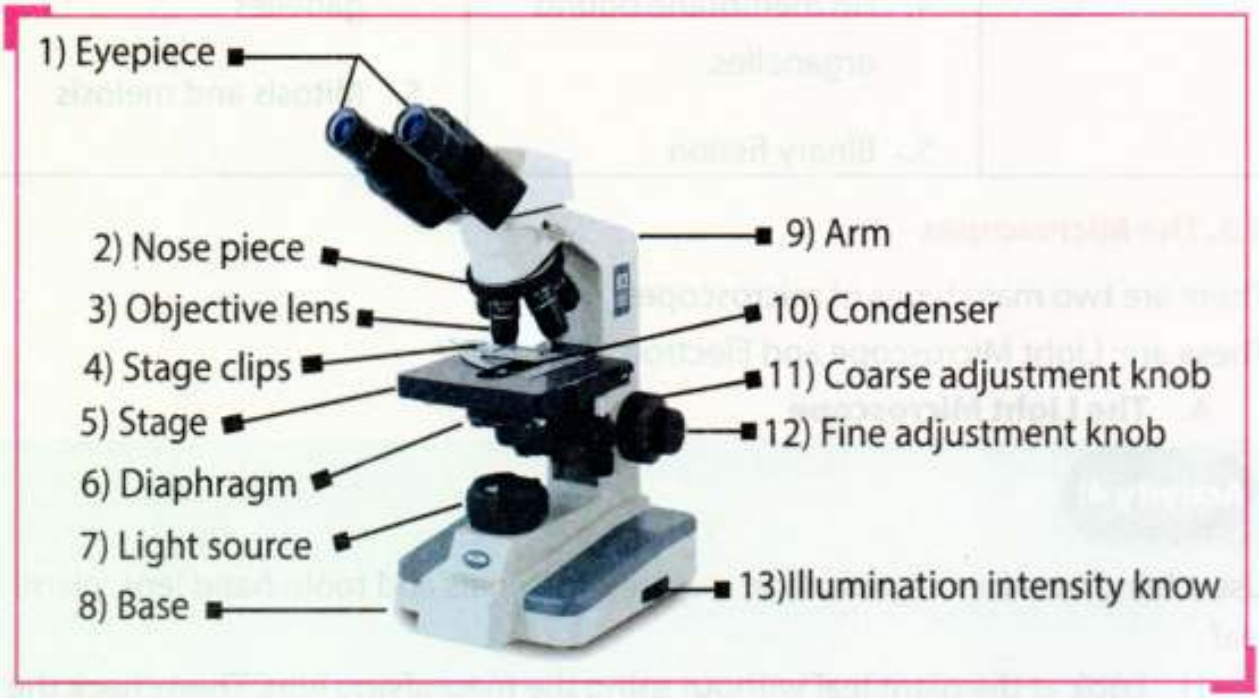


Figure 2.3: parts of the light microscope

Table 2.2. Parts of the light microscope and their functions

Parts of microscope	Function
1. Eyepiece	Contains a lens which contributes to the magnification of the image of the specimen under view
2. Nosepiece	Holds the objective lenses in place and enables the change from one objective lens to the other
3. Arm	Supports the body tube and stage
4. Coarse adjustment knob	Raises or lowers the body tube for longer distances to bring the image into sharper focus
5. Fine adjustment knob	Raises or lowers the body tube through smaller distances to bring the image into sharper focus. It is mostly used with the high power objective lens
6. Nosepiece	Holds the objective lenses in place and enables the change from one objective lens to the other
7. Objective lens	A second set of lens used in combination with the eyepiece lenses to bring the desired magnification
8. Stage	Flat platform where specimen on the slide is placed.
9. Condenser lens	Lenses that concentrate light to stage; Height adjustable; Position next to stage
10. Diaphragm	An aperture that regulates the amount of light passing through the condenser to illuminate the specimen
11. Light source	Illuminator, built into base
12. Base	Provides firm and steady support to the microscope

Using the light microscope

Activity 6:

Study the following concept about the use of microscope and its magnification power, then answer the following questions.

1. Explain how to use a light microscope to observe cells.
2. Describe how to calculate the magnification power of light microscopes.

The following steps explain how to use a light microscope:

1. Place the microscope on the bench with the stage facing away from you.
2. Turn on the microscope.
3. Turn the low power objective lens until it clicks into position.
4. Ensure that the diaphragm is fully open.
5. Look through the eye-piece; meanwhile adjust the illuminator under the stage to ensure that maximum light can pass through. The circular area seen is referred to as the field of view.
6. Again look through the eyepiece while adjusting the illuminator under the stage to ensure that sufficient light is passing through the specimen.
7. Use the coarse adjustment knob to bring the low power objective lens to the lowest point. Viewing through the eye-piece, turn the coarse adjustment knob gently until the specimen comes into focus.
8. Use the fine adjustment knob to bring the image into sharp focus. Make a drawing of what you observe.
9. For higher magnifications, turn the medium power objective lens into position and adjust the focus using the coarse adjustment knob. For sharper images, use the fine adjustment knob.
10. If finer details are required, turn the high power objective lens into position; now use only the fine adjustment knob to bring the details into sharper focus.

Magnification and resolution oflight microscopes

Magnification means how much larger the object appears compared to its real size.

Therefore,

Magnification= magnification of eye piece X magnification of the objective lens.

For example

If the objective lens magnifies 40x and eye piece magnifies 10x, the total magnification of the microscope is calculated as

Magnification of microscope = Magnification of eye piece X Magnification of objective lens

=40 x 10

= 400x

Resolution is the ability of the microscope to distinguish two structures that are very close together at distinct entities.

Activity 7:

Making a model of light microscope

Materials required: cardboard, scissors, glue, pencil, ruler and drawing compass.

Procedure: refer to the link *https://youtu.be/83mrft-la70*

B. **Electron Microscope**

In contrast to light microscopes, electron microscopes use a beam of electrons instead of a beam of light and electromagnetic lenses. It provides higher resolving power than light microscope. Specimens viewed under an electron microscope are dead. The types of electron microscopes include:

1. **Scanning electron Microscope (SEM):** In a scanning electron microscope, a beam of electrons moves back and forth across a cell's surface, rendering the details of cell surface characteristics by reflection. See figure 2.4 that shows Scanning electron Microscope

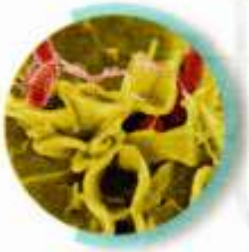
Figure 2.4 Scanning electron Microscope

2. **Transmission Electron Microscope (TEM):** In a transmission electron microscope, the electron beam is transmitted through the cell and provides details of a cell's internal structures. See figure 2.5 that shows

Figure 2.5 Transmission Electron Microscope

Figure 2.6 shows the images of salmonella bacteria viewed with a light microscope and scanning electron microscope.

a. Salmonella bacteria are viewed with a light microscope.



b. This scanning electron micrograph shows Salmonella bacteria (in red) invading human

Figureb 2.6

Activity 8:

The following diagram shows a picture of pollen grain taken under electron microscope, which of the images was captured by scanning electron microscope or by transmission electron microscope? Explain your answer?

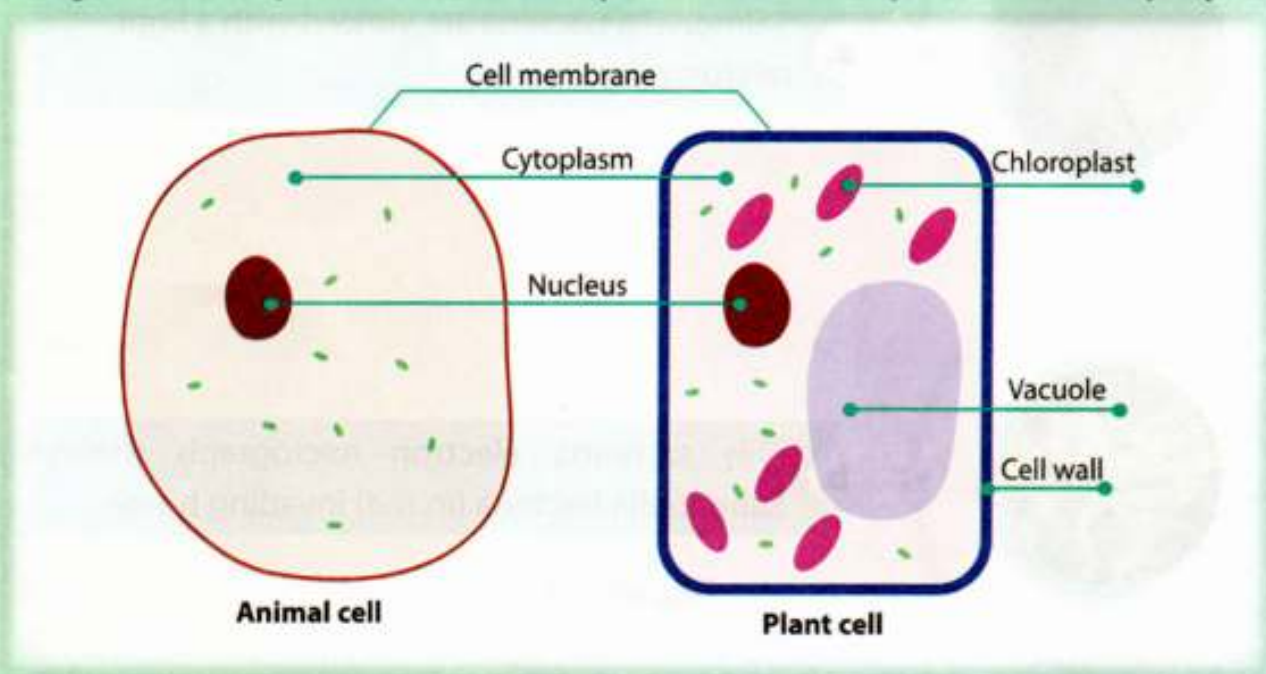
A

B

2.4. The Structure of Eukaryotic Cell

Activity 9:

The figure below shows a labeled diagram of a plant and animal cells as seen under the light microscope. Look at it carefully and answer the questions accompany it.



1) Name the structures that both cells have.
2) State the structures that are unique for the plant cell only.
3) State at least three differences between plant and animal cells

From activity 9, you came to conclusion that plant and animal cells are different based on their cellular components.

In this section, you will learn more about cellular components of plant and animal cells.The major components of the cell are:

(1) Cell membrane and cell wall in plant cells.

(2) Cytoplasm,

(3) Nucleus.

The cytoplasm and the nucleus together are called the **protoplasm**.

Figure 2.7a and 2.7b show the animal and plant cells as seen under the electron microscope.

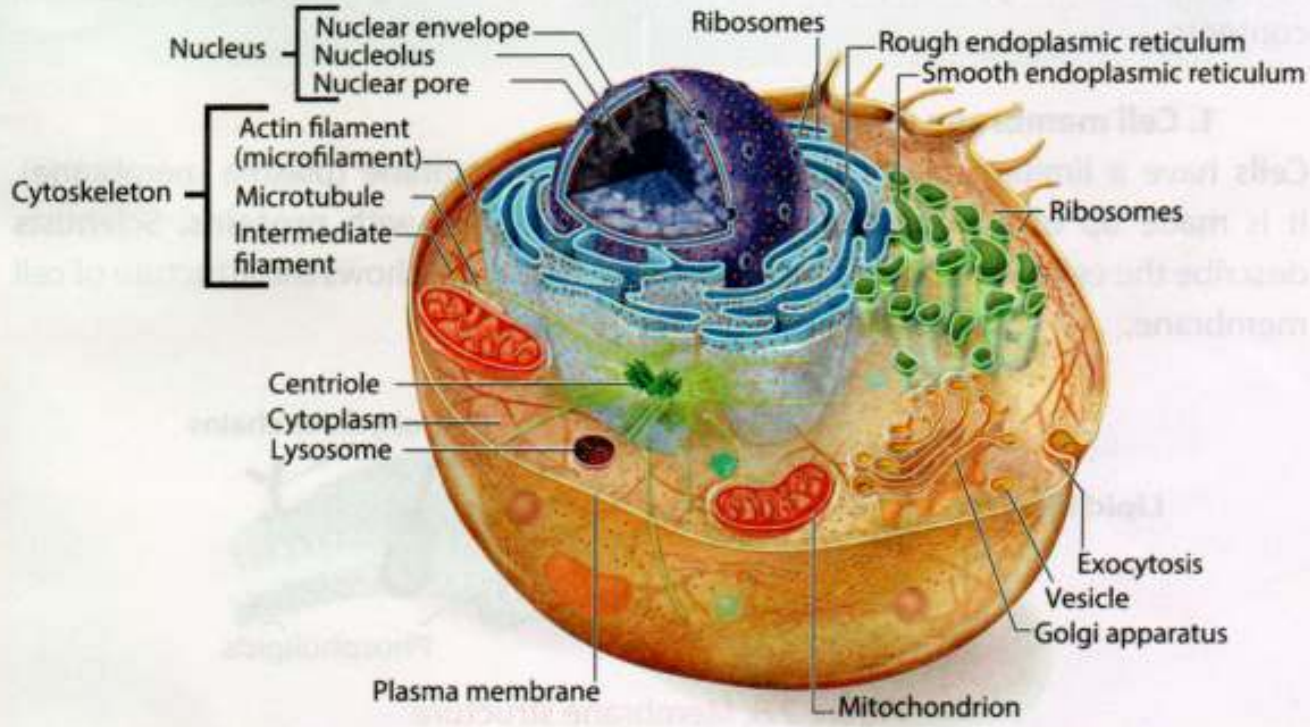


Figure: 2.7a

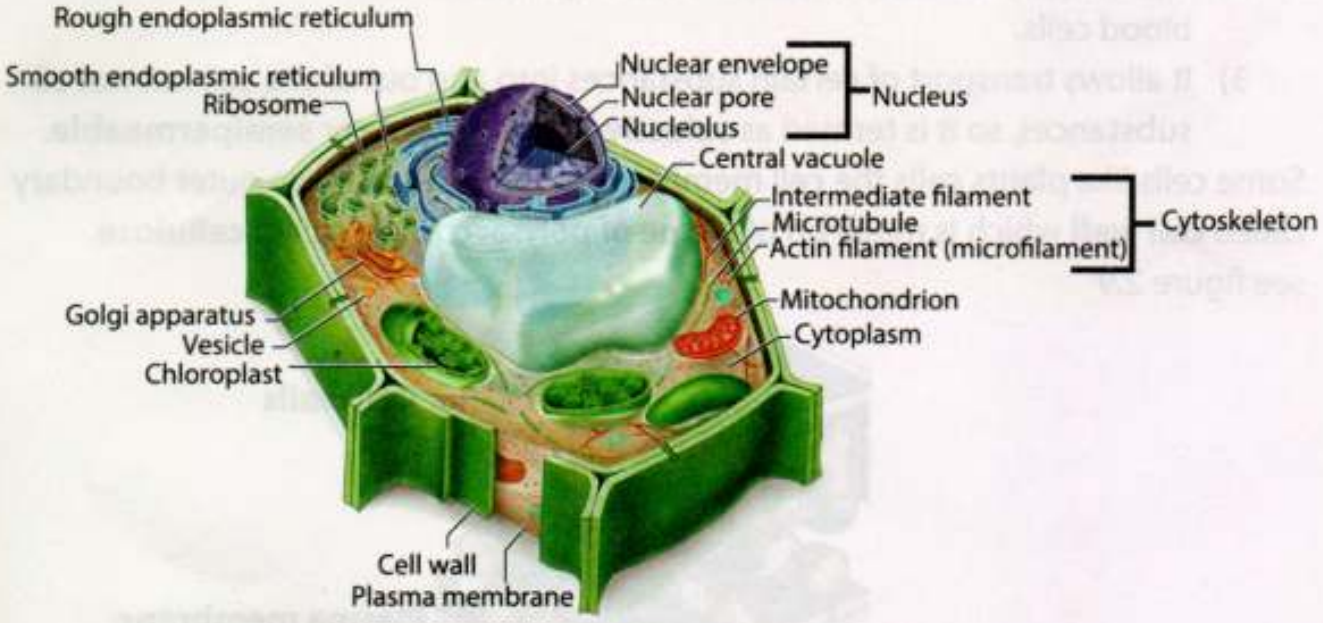


Figure: 2.7b

Activity 10:

Study the following concepts and summarize it by making flow charts of the cell contents.

1. Cell membrane (Plasma membrane)

Cells have a limiting boundary called the cell membrane (plasma membrane). It is made up of a **phospholipid bilayer** embedded with **proteins.** Scientists describe the cell membrane as a **fluid mosaic**. Figure 2.8 shows the structure of cell membrane.

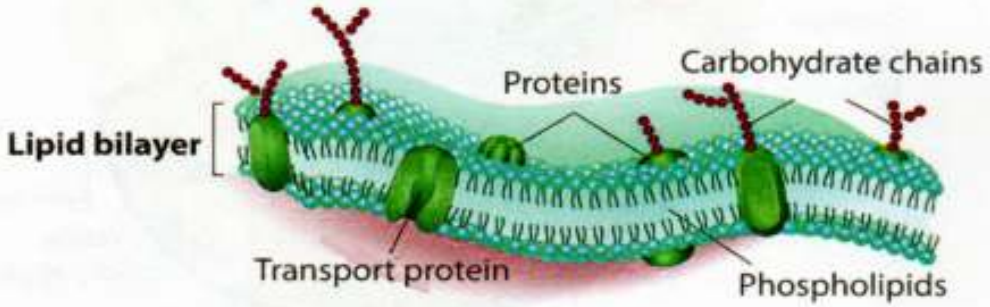


Figure 2.8: Membrane structure

Functions of plasma membrane

1) He plasma membrane encloses the cell contents.
2) It provides cell shape (in animal cells) e.g. the characteristic shape of red blood cells.
3) It allows transport of certain substances into and out of the cell but not all substances, so it is termed as **selectively permeable** or **semipermeable**.

Some cells like plants cells the cell membrane is surrounded by an outer boundary called **cell wall** which is made up of a type of polysaccharide called **cellulose**.
see figure 2.9

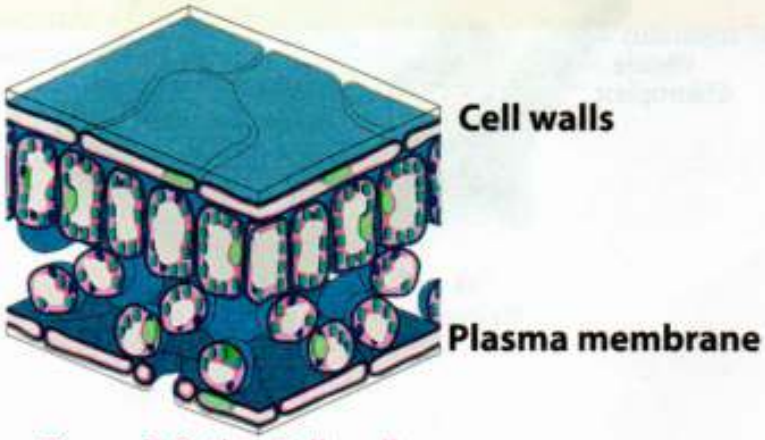


Figure 2.9: the Cell wall

Functions of the Cell wall

1) It protects and supports the plant cell. It also gives the plant cell its final shape.
2) Since it is composed of cellulose which allows water and other substance to pass through it. It is a fully permeable membrane.

2. The cytoplasm

Cytoplasm is a fluid medium that is found between the cell membrane and the nucleus. It contains membrane- bound organelles and membrane-less organelles. If the cytoplasm is removed from membrane-bound organelles the remaining portion is called the **cytosol**.

A. Membrane- bound organelles

These organelles are surrounded by membranes similar in structure to the plasma membrane. They have different structures and functions. These organelles are mitochondria, endoplasmic reticulum, lysosomes, Golgi apparatus, vacuoles and plastids.

i. Mitochondria: Power Generators

Mitochondria (sing., *mitochondrion*) are double-membrane-bound organelles that are spherical to elongate in shape and found in the cytoplasm of almost all eukaryotic cells.

The outer membrane of the mitochondrion is smooth, while the inner membrane folds and doubles in on itself to form incomplete partitions called **cristae**. The cristae increase the surface area available for the chemical reactions that trap usable energy for the cell. The inner mitochondrial membrane encloses a semifluid material called **matrix**. See figure 2.10 that shows the stucture of the mitochondrion

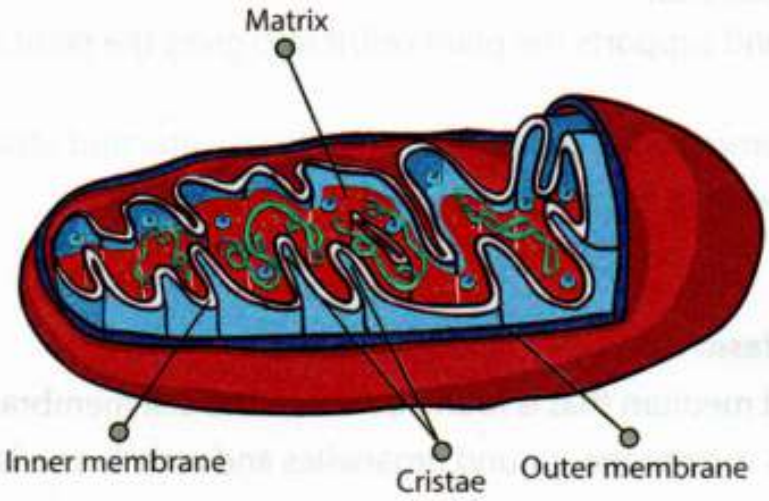


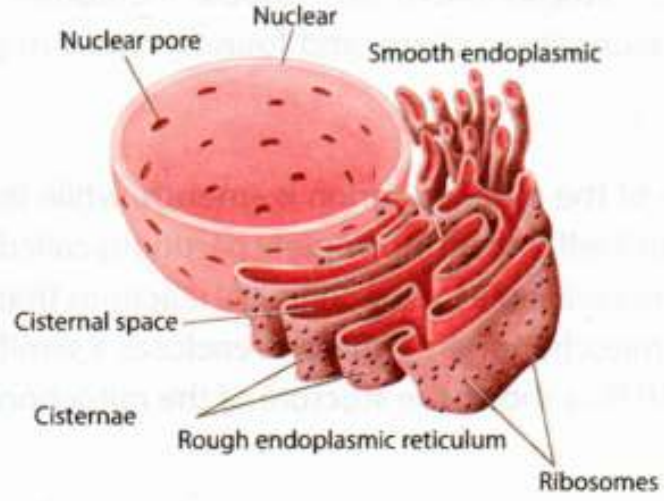
Figure 2.10 mitochondrion

Function

The function of mitochondrion is to generate large quantities of energy in the form of adenosine triphosphate (ATP) during the process of cellular respiration.

ii. Endoplasmic Reticulum

The **endoplasmic reticulum (ER)** is a network of membranes that are spread throughout the cytoplasm and consist of tubular membranes and flattened sacs called **cisternea**. See figue 2.11



Figue 2.11: Endoplasmic reticulum

Endoplasmic reticulum can be divided into two types:

a. **Rough endoplasmic reticulum** (RER): has ribosomes attached on its surface.

Functions

The funtion of rough ER is to synthesize protains. Ribosomes on the surface of rough endoplasmic reticulum are responsible for Protein synthesis. ER stores proteins made by ribosomes and transports them.

b. **Smoothendoplasmic reticulum** (SER): lacks ribosomes on its surface.

Functions

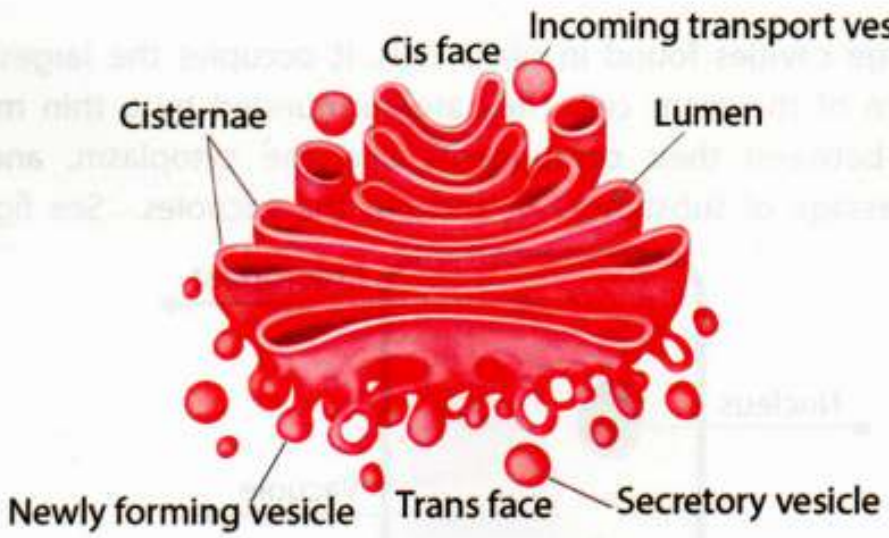
Smooth ER involves in the synthesis of lipids.

Question

What are the other functions of smooth ER?

iii. Golgi body (Golgi apparatus)

Golgi apparatus consists of flattened sacs called **cisternea** which are parallel to one another and receive proteins and lipids from ER. See figure 2.12



Figue 2.12: Golgi body

Functions:

1) They modify, package and transport glycoproteins.
2) They are involved in secretion of synthesized proteins and carbohydrates.
3) They manufacture lysosomes.

iv. Lysosomes

Lysosomes are membrane-bound spherical organelles produced by Golgi apparatus that contain digestive enzymes (lytic enzymes). see figure 2.13. Some Human diseases such as (Tay- sachs disease) are caused by lack of particular lysosome enzymes.

Functions

- They can digest proteins, fats and carbohydrates.
- They can digest worn out organelles and aged cells.
- Lysosomes of white blood cells can break down bacteria.

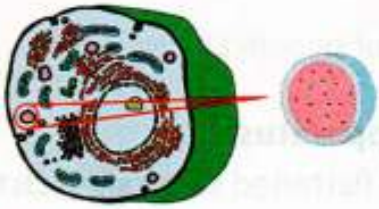
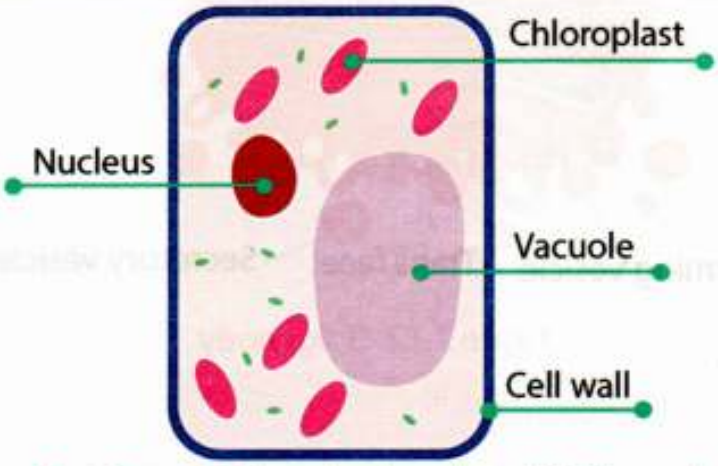


Figure 2.13: lysosome

v. Vacuoles

Vacuoles are large cavities found in plant cells. It occupies the largest portion of the cytoplasm of the plant cell. They are surrounded by a thin membrane that separates between their components and the cytoplasm, and it also regulates the passage of substances in and out the vacuoles. See figure 2.14.



See figure 2.14: a plants cell and its Vacuole

Function:

The function of the vacuole is to store juices and excess products of the cell.

vi. Plastids

Plastids are large organelles found in plant cells. There are three types of plastids:

a. **Chloroplasts** (green plastids)

b. **Chromoplasts** (coloured- plastids

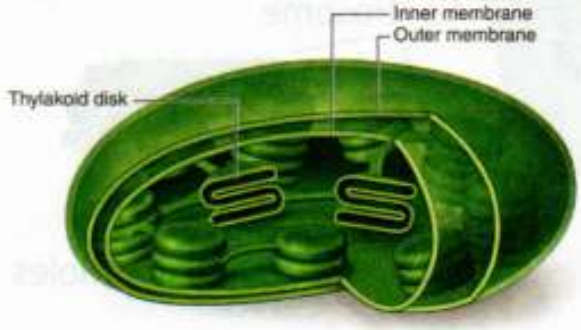
c. **Leucoplasts** (colourless plastids)

Chloroplasts

Chloroplasts are oval shaped organelles that are found in plant cells. It is surrounded by double membranes. The chloroplast contains stacks of **thylokoid membrane** which form the **grana** (singular; granum). In the thylokoid membrane there are chlorophyll molecules, the main molecule that captures light energy for the cell. The fluid-filled space that is outside the grana is called **stroma**. See figure 2.15

Function

The chloroplast is the site of photosynthesis in plant cells.



See figure 2.15: Chloroplasts

Question

What is the role of chromoplasts and leucoplasts for the plants?

B. **Membrane- less organelles**

i. **The Ribosomes**

Ribosomes are very fine granules, found in large numbers on the surface of rough endoplasmic reticulum or free in the cytoplasm. See figure 16

Function: are the centers of protein synthesis in the cell. See figure 2.16

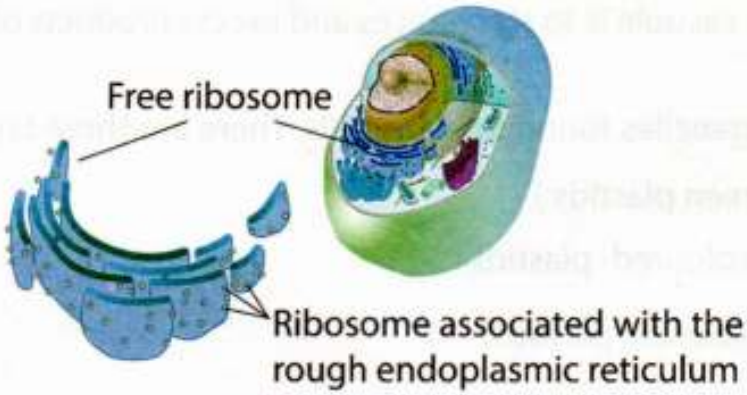


Figure 2.16: Ribosomes

ii. **Centrioles**

Centrioles are rod-shaped structures located near the nucleus of animal cells. Each centriole is a small cylindrical body, its outer wall contains a number of fine tubules arranged into nine groups each of which consists of three tubules. Two centrioles which are perpendicular with another are called a **centrosome**. See figure 2.17.

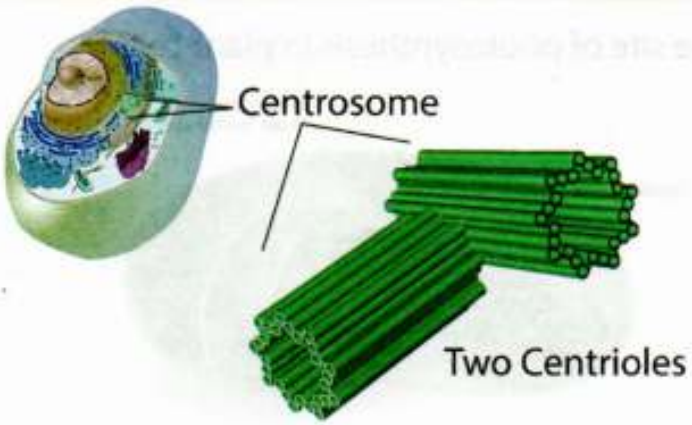


Figure 2.17

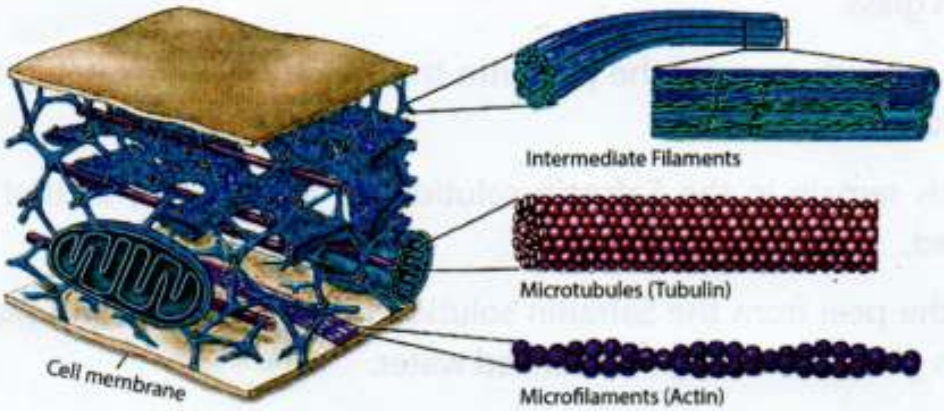
Function:

- Centrioles have an important role in cell division by forming spindle fibres
- They form cilia and flagella in cells and organisms where these structures occur.

iii. **Cytoskeleton**

The cytoskeleton is a network of interlinking proteins filament present in the cytoplasm of all cells.

There are three structural element of the cytoskeleton; microtubules, microfilaments and intermediate filaments. See figure 2.18



See figure 2.18: Cytoskeleton

Function

- The cytoskeleton supports the cell and gives its distinctive shape
- It plays a role in cell movement and its organelles.

Activity 11:

To prepare and observe temporary slide of onion cells under the light microscope

Materials Required

Procedure

- Pour some distilled water into a watch glass.
- Peel off a leaf from half a piece of onion and using the forceps, pull out a piece of transparent onion peel (epidermis) from the leaf.
- Put the epidermis in the watch glass containing distilled water.
- Take a few drops of safranin solution in a dropper and transfer this into another

watch glass.

- Using a brush, transfer the peel into the watch glass containing the safranin solution.
- Let this remain in the Safranin solution for 30 seconds, so that the peel is stained.
- Take the peel from the Safranin solution using the brush and place it in the watch glass containing the distilled water.
- Take a few drops of glycerine in a dropper and pour 2-3 drops at the center of a dry glass slide.
- Using the brush, place the peel onto the slide containing glycerine.
- Take a cover slip and place it gently on the peel with the aid of a needle.
- Remove the extra glycerine using a piece of blotting paper.
- Place this glass side on the stage of the compound microscope and view it. Refer to the link https://youtu.be/wMgXsrpVrJg

2.5. Differences between plant and animal cells

Plant and animal cells are a lot of similarities in their structure and function.

How ever, there are seferal differences between plant and animal cells. Some of these are summarised in the table 2.3:

Table 2.3: Differences between plant and animal cells.

Plant Cell	Animal Cell
1. Has a cell wall	1. Has no cell wall
2. Has chloroplasts	2. Has no chloroplasts
3. Usually has a large central vacole	3. Has no large vacole
4. Has no centriole	4. Has centriole

Question

State at least other four differences between plant and animal cells

3. Nucleus

Nucleus is a double membrane bound structure containing a viscous fluid known as **nucleoplasm** in which **nucleolus** and **chromatin reticulum** are suspended. Nucleus generally takes a spherical or oval shape see figure 19

Note.

Solutions with the same solute concentration are called **Isotonic solutions**.

Hypertonic solution has a greater concentration of solutes than another solution.

Hypotonic solution has a lower concentration of solutes than another solution.

Activity 13:

Demonstrating osmosis by using a potato

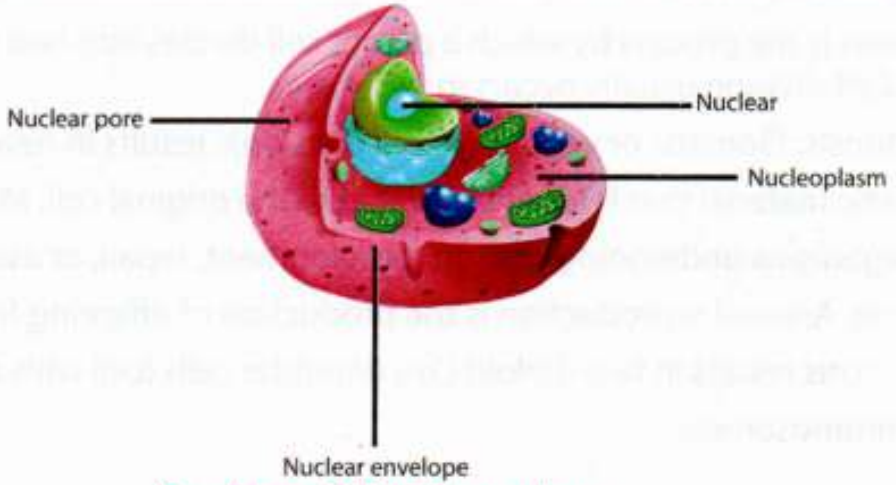
Materials Required

Procedure

1) Place the peeled potato on the tile and using the knife, cut both ends of the potato to make it flat.
2) Use the knife to make a cavity at the centre of the potato from one of the flat sides almost up to the bottom.
3) Pour distilled water into the Petri dish until it is half full.
4) Now, place the potato in the Petri dish.
5) Fill half the cavity made in the potato with 20% sugar solution.
6) Mark the level of sugar solution in the cavity using a pin.
7) The potato now functions as an osmometer.
8) Leave the osmometer undisturbed for about two hours.
9) Mark the rise in the level of the sugar solution in the cavity with another pin

The **nuclear membrane** (nuclear envelop) has minute pores called nuclear pores which allow materials to move in and out of the nucleus.The nucleolus is responsible for manufacture of ribosomes while chromatin contains the hereditary materials (DNA). See figure 2.19

Function: The nucleus controls all the activities of the cell.



See figure 2.19: The nucleus

The Chromosome

Chromosomes are threadlike structures found in the nucleus of the cell. Chemically a chromosome consists of the **deoxyribonucleic acid** (DNA) and proteins .

DNA is the genetic material that carries the genetic information for each cell. It has the ability to duplicate itself i.e forms a new complete copy of it, before the cell starts to divide. The number of chromosomes in each living cell is constant, in each species which differs from one species to another. For example, in corn there are 20 chromosomes in each cell, in pea plant there are 14 chromosomes in each cell and in human there are 46 chromosomes. There are two types of cells in the body of living organisms. These are somatic cells and sex cells. Their differences are summarized in table 2. 4

Table 2.4 Somatic cells (body cells) and gametes (reproductive cell):

Points of comparison	Somatic cells	Gametes
Location:	In the whole body	In gonads (Reproductive organs).
Chromosomal number:	Diploid (2n). I.e: contains the total number of chromosomes.	Haploid (n) i.e: contains half the number of chromosomes.
Kind of division:	Mitotic cell division (Mitosis)	Meiotic cell division (Meiosis)

Examples:	Corn plant: body cell contains 20 chromosomes. Human being: Body cells contain 46 chromosomes.	Gametes [pollen grain or ova] contains 10 chromosomes. Human being: gametes contain 23 chromosomes.

2.6. The Cell Division

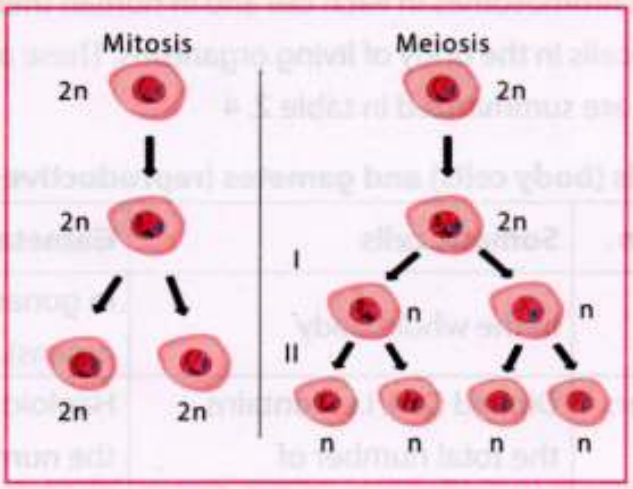
Cell division is the process by which a parent cell divides into two or more daughter cells. Cell division usually occurs in two forms.

1) Mitosis: (Somatic or vegetative cell division): results in new cells with genetic material that is identical to that of the original cell. Mitosis occurs in organisms undergoing growth, development, repair, or asexual reproduction. Asexual reproduction is the production of offspring from one parent. Mitosis results in two diploid (2n) daughter cells (cell with a complete set of chromosomes).

2) Meiosis (Reproductive cell division): occurs during the formation of gametes, which are haploid (n) (cell with half number of chromosomes). Meiosis reduces the chromosome number by half in new cells. Meiosis results in four haploid daughter cells

Each new cell has the potential to join with another haploid cell to produce a diploid. See Figure 2.20 that shows mitosis and Meiosis.

Where 2n represents cells with complete number of chromosomes (Diploid)



Where n represents cells with half number of chromosomes (Haploid)

Figure 2.20: Mitosis and Meiosis.

2.7. Transportation Across The Cell Membrane

You have studied in previous secion that the main function of plasma mebrane is to control the movment of materails in and out of the cell. The major physiological processes that facilitate the movement otf materials into and out of cells are **diffusion, osmosis and active transport**

Activity 12:

Study the following information that explains diffusion, osmosis and active transport, then answer the questions listed below

- Differentiate between diffusion, osmosis and active transport
- Describe the role diffusion, osmosis and active transport in plants and animals

Diffusion and its role in living organisms

Diffusion is the movement of substances from their region of higher concentration to their region of lower concentration, this does not require energy. It plays a significant role in

a. Absorption of materials like mineral salts in plant roots and digested food in the intestine of animals.

b. Gaseous exchange in plants and animals

Osmosis

Osmosis is movement of water molecules from the region of high water concentration to the region of low water concentration through a semi permeable membrane. There is no expenditure of energy in osmosis.

Water relations in animal and plant cells

If an animal cell is placed in an **isotonic** solution, it will neither shrink nor swell. If the solution is **hypertonic**, the cell will lose water and shrink (plasmolyse). If the solution is **hypotonic** the cells will swell and may even rupture.

If a plant cell is placed by a **hypertonic** solution, water molecules will leave the cells of the plant. As water molecules leave, the **turgor pressure** drops, as result, the cytoplasm shrinks away from the cell wall. This loss of turgor pressure is called Plasmolysis. **Plasmolysis** causes plants to wilt.

Note.

Solutions with the same solute concentration are called **Isotonic solutions**.

Hypertonic solution has a greater concentration of solutes than another solution.

Hypotonic solution has a lower concentration of solutes than another solution.

Activity 13:

Demonstrating osmosis by using a potato

Materials Required

Procedure

1) Place the peeled potato on the tile and using the knife, cut both ends of the potato to make it flat.
2) Use the knife to make a cavity at the centre of the potato from one of the flat sides almost up to the bottom.
3) Pour distilled water into the Petri dish until it is half full.
4) Now, place the potato in the Petri dish.
5) Fill half the cavity made in the potato with 20% sugar solution.
6) Mark the level of sugar solution in the cavity using a pin.
7) The potato now functions as an osmometer.
8) Leave the osmometer undisturbed for about two hours.
9) Mark the rise in the level of the sugar solution in the cavity with another pin

Active Transport

When the direction of movement of a certain molecules is opposite that of diffusion i.e. from region of their lower concentration towards the region of their higher concentration, it would require an "active effort" by the cell for which energy is needed. This energy is provided by ATP (adenosine triphosphate).

The second way in which active transport may occur is by means of vesicles. **Endocytosis** is the process of supporting substances in to the cell through a vesicle. Endocytosis can occur in two ways: A small particle or liquid droplet enters the cell by a process known as **Pinocytosis** (cell drinking). When cell ingest large solid particles such bacteria or food is called **phagocytosis** (cell eating).

Exocytosis: is the reverse of endocytosis by which a cell ejects waste product or specific secretion products such as hormones by fusion of vesicle on the plasma membrane of the cell. See figure 2.21.

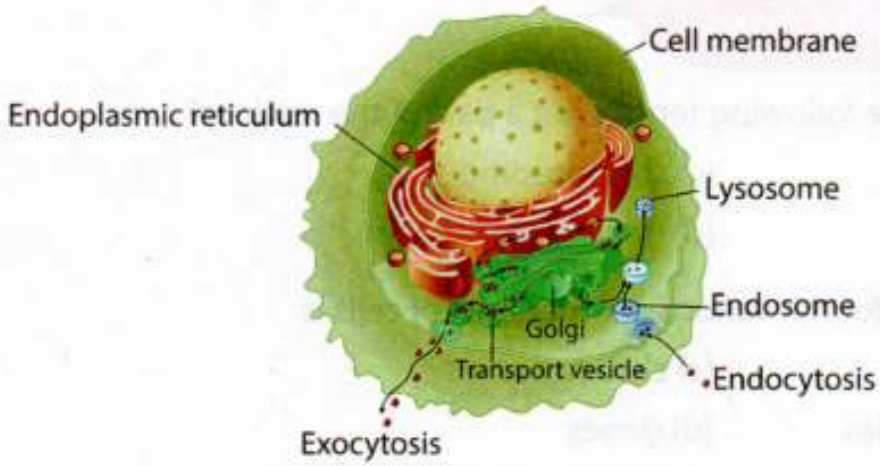


Figure 2.21: Mitosis and Meiosis.

Pinocytosis and Phagocytosis

There are many significances of active transport such as:

- It is involved in active re-absorption of glucose and mineral salts in kidney tubules during urine formation
- It enables the absorption of digested food from the alimentary canal/small intestines into the blood stream.
- In plants it enables plant roots to absorb water from the soil against the concentration gradient.
- It is involved in translocation of manufactured food in the phloem tissue within the plant body.
- It is involved in the opening and closing of the stomata through the sodium-potassium pump mechanism.

CHAPTER QUESTIONS

1. Which one of the following term is not a part of the nucleus?
   a) ribosome (c) chromosome
   (b) nucleolus (d) gene

2. A suitable term for the various components of cells is
   (a) tissue (c) chromosomes
   (b) cell organelles (d) genes

3. Green colour of leaves is due to presence of the pigment
   (a) chlorophyll (c) mitochondira
   (b) ribosomes (d) chloroplast

4. The unit of measurement used for expressing dimension (size) of cells is:
   (a) centimeter (c) micrometer
   (b) millimeter (d) metre

5. The thread-like structures present in the nucleus are
   (a) nucleolus (c) genes
   (b) chromosomes (d) ribosomes

6. Which of the following feature will help you in distinguishing a plant cell from an animal cell?

(a) cell wall (c) mitochondria

(b) cell membrane (d) nucleus

7. Where are the ribosomes produced?

(a) nuclear pore (b) nucleolus

(c) chromatin (d) endoplasmic reticulum

8. Which is not part of the cell theory?

(a) The basic unit of life is the cell.

(b) Cells came from preexisting cells.

(c) All living organisms are composed of cells.

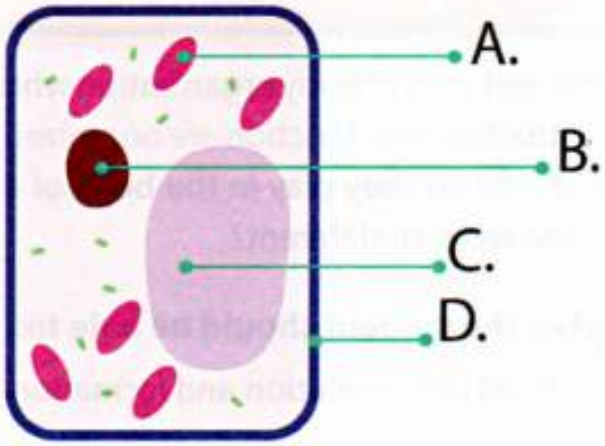
(d) Cells contain membrane-bound organelles

9. Which type of transport requires energy input from the cell?

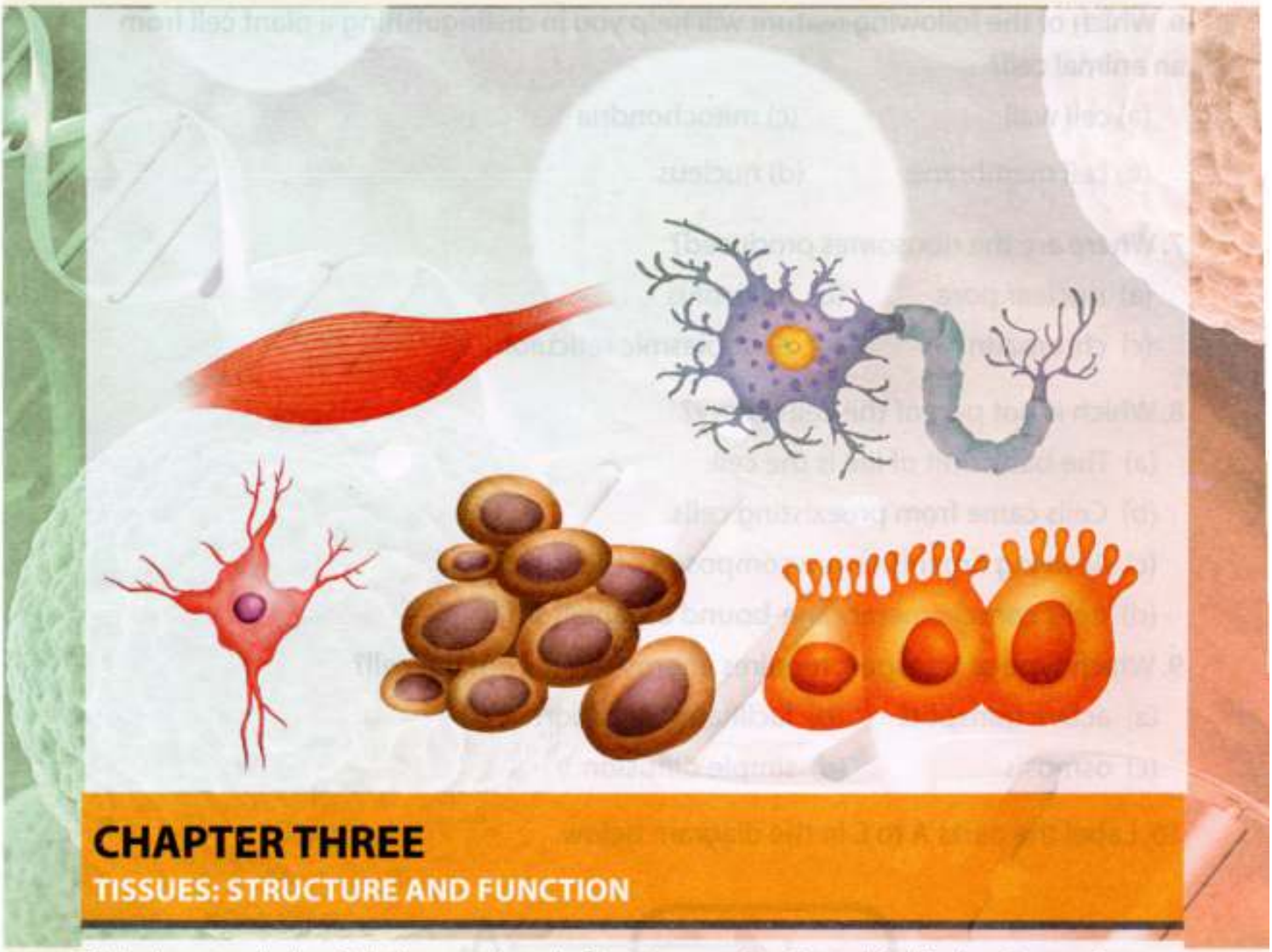
(a) active transport (b) facilitated diffusion

(c) osmosis (d) simple diffusion

10. Label the parts A to E in the diagram below.



1) Differentiate between diffusion and osmosis?
2) Give an example of diffusion and osmosis
3) Describe active transport and its significances in living organisms
4) Differentiate between endocytosis and exocytosis?



CHAPTER THREE
TISSUES: STRUCTURE AND FUNCTION

This chapter deals with the next level of body organization which is the tissue. Groups of cells that are similar in structure and function are organized into tissues. What are the types of tissues? What role do they play in the body of a living organism? Are plant and animal tissues the same or different?

By the end of this chapter, the student should be able to:

- Explain the concept of cell differentiation and formation of tissues, organs and organ systems
- Outline the importance of cell differentiation and formation of tissues.
- Define tissues.
- Classify plants tissues
- Name the various kinds of plant tissues
- List types of animal tissues.

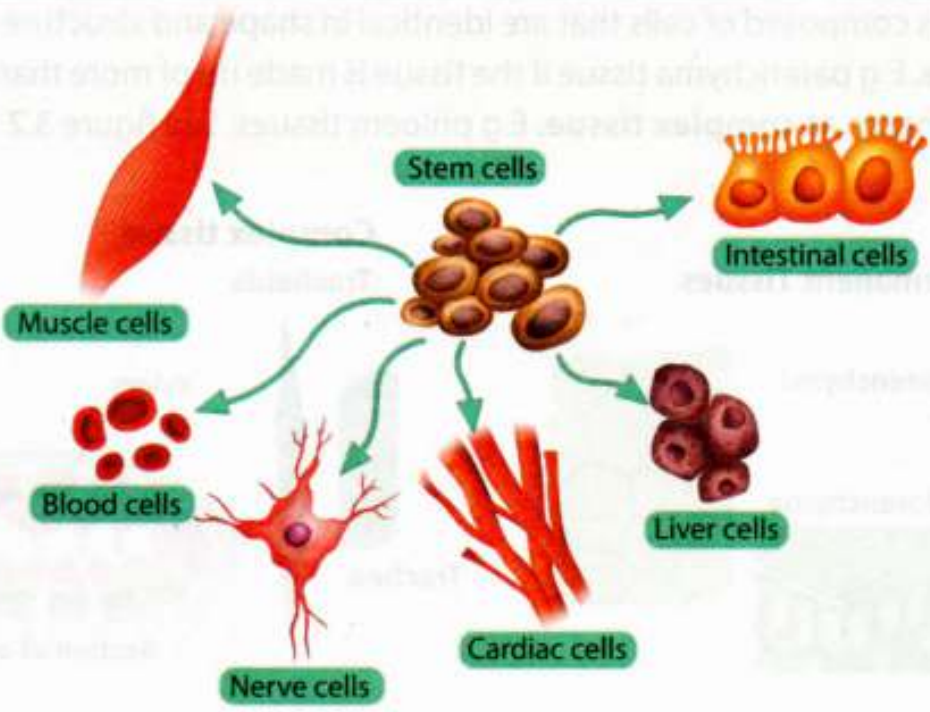
- Describe the structure and function of various kinds of epithelial tissues;
- Discuss the structure and function of various kinds of connective tissues;
- Explain the structure and function of muscular tissue
- Draw a labeled diagram of a neuron

3.1. Differentiation and specialization of cells

Activity 1:

With the help of the following figure and the biological concept below, discuss in groups and answer the following questions:

1) Why differentiation of cells in multicellular organism is important?
2) Why unicellular organisms do not differentiate



From the last chapter, you recall that all living organisms are made of cells.

In unicellular organisms, a single cell performs all basic functions of life. For example, in Amoeba, a single cell carries out movement, intake of food, gaseous exchange and excretion.

But in multicellular organisms there are many of the cells. These cells differentiate and become specialised to carry out specific functions. For example, muscle cells contract and relax to cause movement, nerve cells carry messages. So, multi-cellular organisms show division of labour. See figure 3.1

Figure 3.1

Each specialised function is taken up by a different group of cells. Cells specializing in one function are often grouped together in the body.

A group of cells that perform particular function forms a **tissue.**

A tissue that is composed of cells that are identical in shape and structure is called a **simple tissue.** E.g parenchyma tissue if the tissue is made up of more than one type of cells, it is known as **complex tissue.** E.g phloem tissues. See figure 3.2

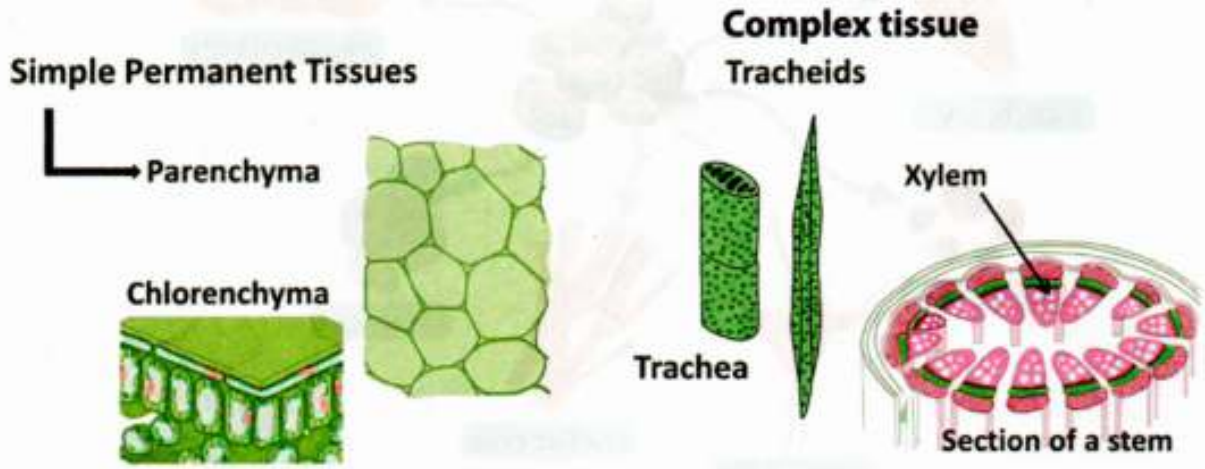


Figure 3.2

Types of tissues

Tissues can be classified into the plant and animal tissues.

3.2 . Plant tissues

The plant tissues are classified according to their stage of development into two main types:

1) Meristematic (dividing)
2) Permanent (non-dividing)

Activity 2:

- Take two glass jars and fill them with water.
- Now, take two onion bulbs and place one on each jar, as shown in the figure below.
- Observe the growth of roots in both the bulbs for a few days.
- Measure the length of roots on day 1, 2 and 3.
- On day 4, cut the root tips of the onion bulb in jar 2 by about 1 cm. After this, observe the growth of roots in both the jars and measure their lengths each day for five more days and record the observations in tables, like the table below

length	Day1	Day2	Day3	Day4	Day5
Jar1					
Jar2					

Jar 1 Jar 2

From the observations, answer the following questions:

1) Which of the two onions has longer roots? Why?
2) Do the roots continue growing even after we have removed their tips?
3) Why would the tips stop growing in jar 2 after we cut them?

The growth of plants occurs only in certain specific regions. This is because the dividing tissue, also known as meristematic tissue, is located only at these points.

Activity 3:

Prepared slide tissue for meristematic (Parenchyma, cholenchyma and sclerenchyma)

Requirements: Prepared slides for (Parenchyma, cholenchyma and sclerenchyma)

Or watch this link https://youtu.be/qTtKi4rvbI4 and then describe, and draw what you see

1. Meristematic tissues

Composed of immature or undifferentiated cells without intercellular spaces The cells may be rounded, oval or polygonal; always living and thin walled. Each cell has abundant cytoplasm and prominent nuclei in it. Vacuoles may be small or absent. The 3.3 shows the types, location and functions of the three types of meristematic tissues

Table 3.1: Types of meristematic tissue

Types	Location	Function
1. Apical Meristem.	Root tip and shoot tip. Growth in length of plants	Growth in length of plants
2. Intercalary Meristem	At the base of leaves or at the base of internodes	Internodal growth.
3. Lateral Meristem	Cambium between xylem plant body. cambium in the cortex of dicot plants.	Growth in thickness of the and phloem and cork (secondary growth).

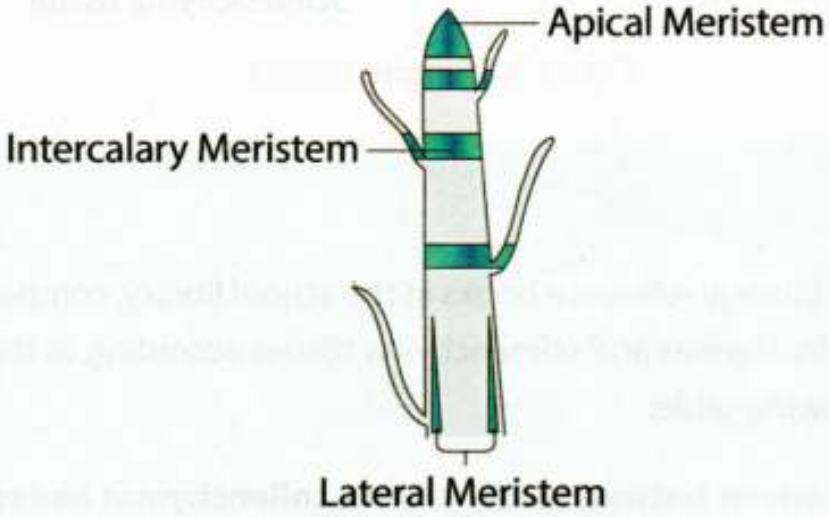


Figure 3.3 Types of meristematic tissue

2. **Permanent tissues**

Permanent tissues are those in which growth has stopped either completely or for the time being. The cells of these tissues may be living or dead; and thin walled or thick walled. Thin walled permanent tissues are generally living, whereas the thick walled tissues may be living or dead.

Types of permanent tissues

1) **Simple tissues:** Simple tissue is made up of only one type of cells. Common simple tissues are parenchyma, collenchyma and sclerenchyma. See

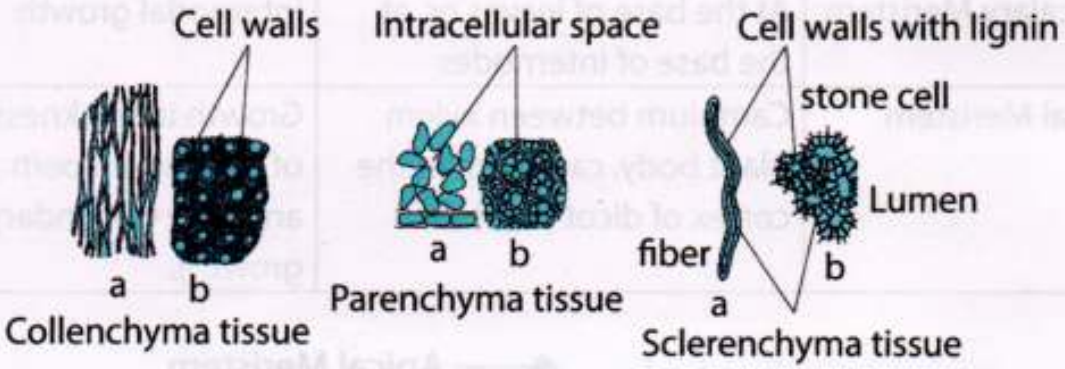


Figure 3.4 Simple tissuea

Activity 4:

with the help of biology reference books in the school library, compare between parenchyma, collenchymas and sclerenchyma tissues according to the features given in the following table:

Table 3.2. Comparison between parenchyma, collenchymas and sclerenchyma

Features	Parenchyma 	Collenchymas 	Scherenchyma 
1. Cell shape			
2. Cell wall			
3. Cytoplasm			
4. Nucleus			
5. Vacuoles			
6. Intercellular space			
7. Occurrence			
8. Functions			

Table 3.3: the structural and functional components of xylem and phloems

Complete the following table with what is suitable

Tissues	Living or dead	Structure	Function
Xylem 1. Tracheids 2. Vessels 3. Xylem fibers 4. Xylem parenchyma			
Phloem 1. Sieve tube 2. Companion cells 3. Phloem fibers 4. Phloem parenchyma			

Activity 6:

With the help of your previous knowledge, complete the blank spaces in the following table 3.4.

Table 3.4 Difference between Meristematic and Permanent Tissues

Meristematic Tissue	Permanent Tissue
1. Capable of cell division	1. .....
2.	2. Differentiated cells
3. Have not attained definite form and size	3. .....
4.	4. Thin layer of cytoplasm around vacuole (if living)
5.	5. May be living or dead

Activity 5:

Study the following biological concept together with reference biology books in the library and then complete the table 3.3:

2) **Complex tissues:**

Complex tissue is made up of more than one type of cells working together as a unit. Common examples are xylem and phloem

Xylem and phloem form a continuous system inside the plants, that is, from the roots through the stem and leaves. They are known as vascular tissues and form vascular bundles in roots and stems.

a) **Xylem**: Xylem is a conducting tissue, which conducts water and salts upward from roots to leaves.

Xylem is composed of tracheids, vessels, fibers, and xylem parenchyma.

b) **Phloem:** Phloem too is a conducting tissue, which conducts food synthesized in the leave to different parts of the plant.

Phloem is composed of: - Sieve Tubes, Companion Cells, Phloem Fiber and Phloem Parenchyma. Figure 3.5 shows the structure of the xylem and Phloem.

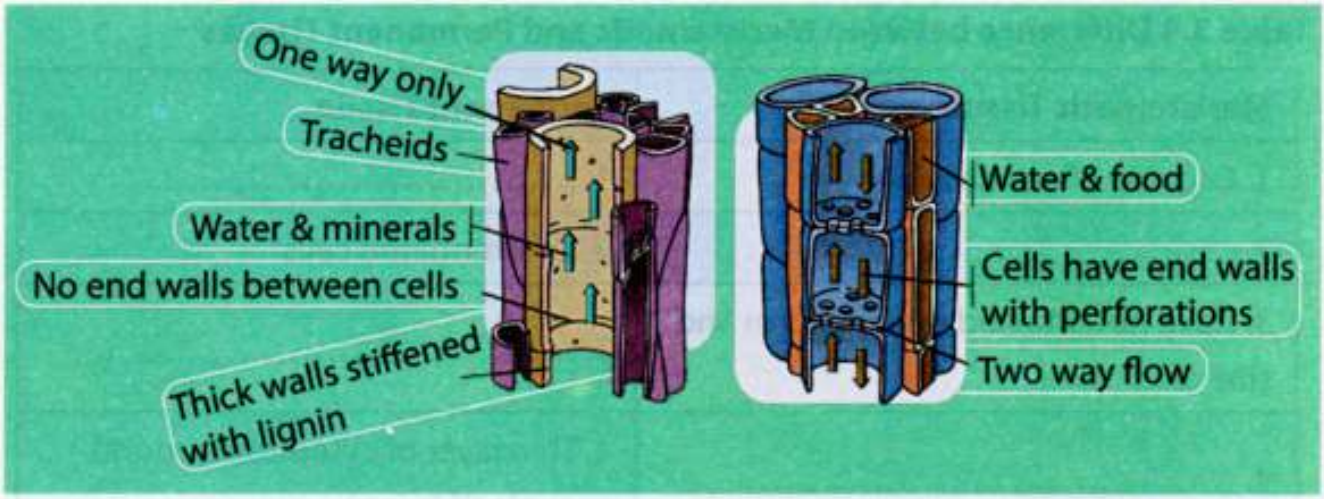
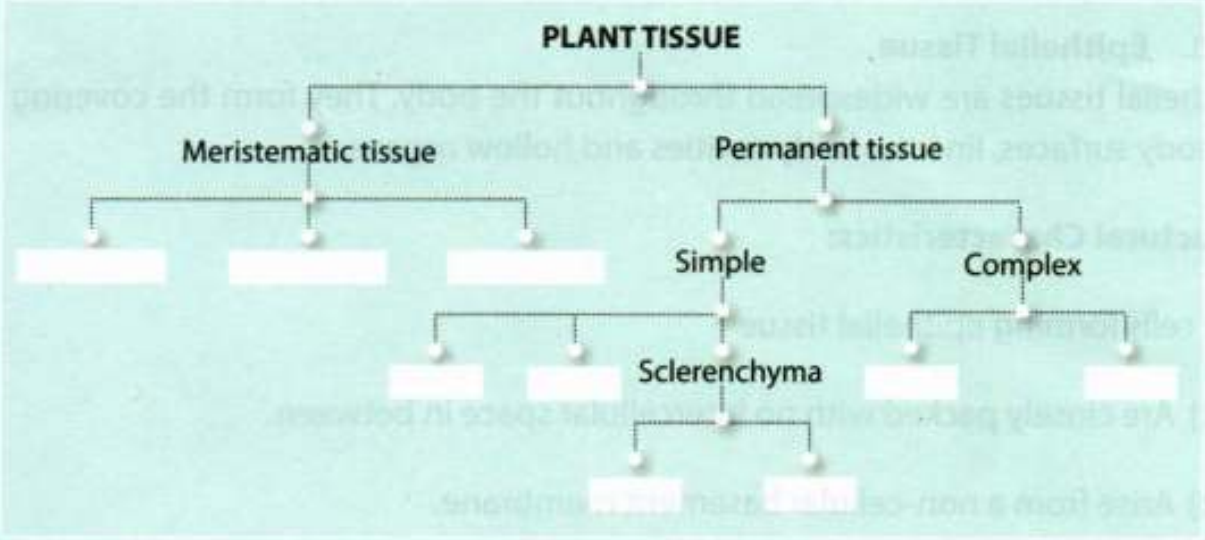


Figure 3.5 structure of the xylem and Phloem.

Activity 7:

According to what you have learned in the previous section, complete the flow chart below.



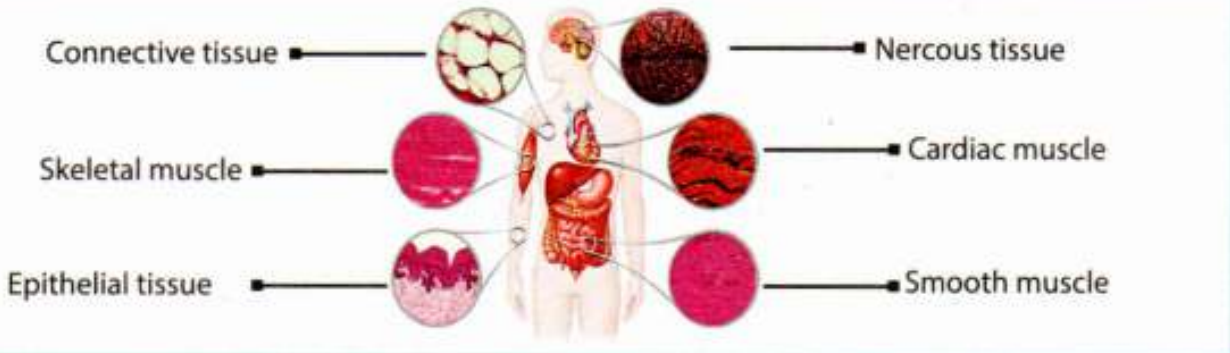
3.3 Animal Tissues

Animal tissues are grouped into four basic types:

1) Epithelial tissue
2) Connective tissue
3) Muscle tissue
4) Nervous tissue.

Activity 8:

With the help of figure discuss in groups and answer the questions below



1) How many types of animal tissue exist?
2) Do the human beings and livestock such as goats, cows and camels have the same types of tissues?
3) Give one example of each type of animal tissue.

1. Epithelial Tissue

Epithelial tissues are widespread throughout the body. They form the covering of all body surfaces, line the body cavities and hollow organs.

Structural Characteristics:

The cells forming epithelial tissue

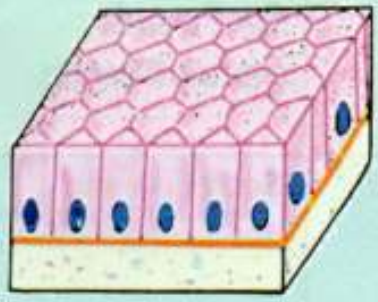
1) Are closely packed with no intercellular space in between.
2) Arise from a non-cellular basement membrane.
3) Not supplied with blood vessels.

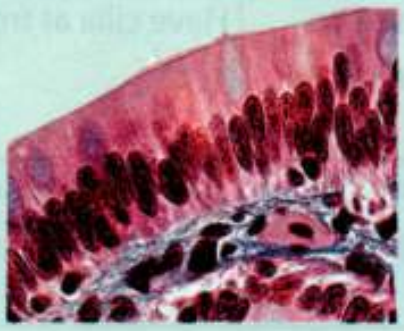
Function of epithelial tissues

1) Protection of the underlying tissues
2) Absorption
3) Secretion
4) Reception of sensory stimuli.

Activity 9:

With the help of table 3.1 give the names of the following figures of epithelial tissue.





There are many types of epithelial tissues and are summarized in the table below.

Table 3.5: Types of epithelial tissue

Type	Structure	Location	Function
1. Squamous Epithelium	Flattened cells with a centrally placed nucleus. Have irregular margins	- Lining of air sacs in the lungs. -Lining of Kidney tubules. -Lining of blood capillaries.	-For exchange of O_2 and CO_2 -For absorption. -For exchange of materials.
2. Cubodial Epithelium	Cube like cells with a centrally placed nucleus. Cells appear polygonal.	-Lining of saliva and pancreatic ducts. -Found in sweat, salivary gland	-For absorption. -For secretion
3. Ciliated columnar Epithelium	Have cilia at free ends	-Lining of Kidney tubles	-For flow of nephric filterate.
4. Columnar Epithelium	Tall column like cell, with nucleus at the basal end	-Lining of stomach, intestine	-Secretion and absorption
5. Brush bordered Columnar Epithelium	Numerous folds at free ends	-Lining of intestine	-Increasing the surface area for absorption

If the epithelial cells are in a single layer, they form **simple epithelium**. If the epithelial cells are arranged in many layers, they form **compound epithelium** or **stratified epithelium** (many layers). Stratified epithelium is present in the body, where there is a lot of wear and tear. For example, skin, inner lining of cheeks etc.

2. **Connective Tissue**

Connective tissue is one of the most common tissues in our bodies. It includes many types, including: bone, cartilage, lymph, and blood.

Practical Activity 10: permanent slides of connective tissue

Materials required: permanent slides of connective tissue and light microscope

Procedure:

1) Observe the permanent sides under the microscope
2) What are the shapes the cells you observe?
3) Describe and draw what you see

Conclusion

By carrying out the previous activity, you noticed that the cells of connective tissues are not compacted, and its cells are characterized by the spread of an abundant intercellular substance (matrix), which are either liquid, solid, or gelatinous, and contain a network of protein strands.

Critical thinking: how do the connective tissues get food?

For further information of connective tissues, read the following concepts in groups.

Type of connective tissue

Connective tissues can be classified in to:

A. **Proper Connective Tissue**

1. Areolar: Most widely spread connective tissue.

The cells forming the tissue are:

a. **Fibroblasts**-which form the yellow (elastin) and white (collagen) fibres in the matrix.
b. **Macrophages**-which help in engulfing bacteria and micro pathogens.
c. **Mast cell**-which secrets heparin (helps in clotting of blood).

2. Adipose tissue: It has specialized cells storing fat called **adipose cells**. Help in forming paddings.

3. Fibrous : It is mainly made up of fibroblasts. It forms tendons and ligaments.

B. **Supporting Connective Tissue**

1. **Cartilage**

Matrix is composed of **chondrin**. The cells of cartilage (Chondrocytes) lie in the matrix singly or in groups of two or four surrounded by fluid-filled spaces. see figure 3.6 The cartilage may be elastic whose matrix has yellow fibres as in pinna of ear.

The cartilage may be fibrous, whose matrix has white fibres. Firbous cartilage is present in between vertebrae. The cartilage can be calcified where the matrix is deposited with calcium salts as in head of the long bones.

2. **Bone**

The bone matrix is composed of **ossein** (the collagen of bones). The matrix also contains salts of calcium, phosphorus and magnesium. Matrix in mammalian long bones (such as thigh bone) is arranged inconcentric rings.

Bones are of two types: **Spongy** and **Compact Bones.** See figure 3.6

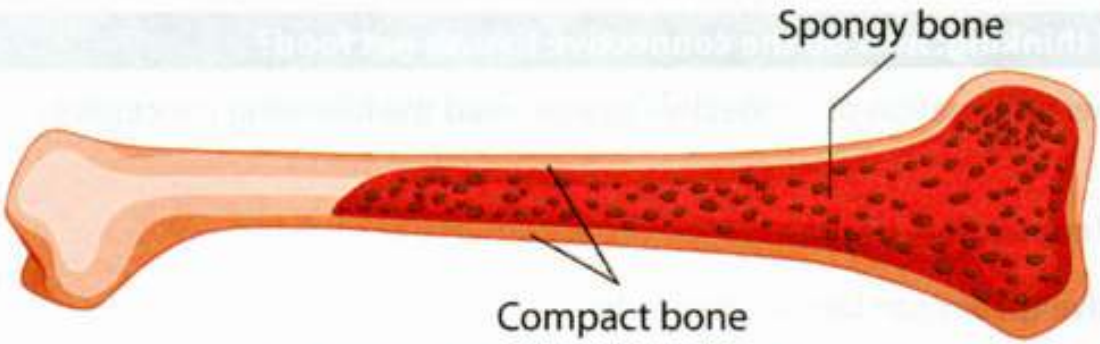


Figure 3.6: Spongy and Compact Bones

- In spongy bone, bone cells **(osteocytes)** are irregularly arranged. Such bones are found at the ends of the of long bones.
- In the compact bones, cells are arranged in circles or lamellae around a central canal- the Haversian canal.

The bone cells lie on the lamellae (concentric rings in the matrix.) Osteocytes give out branched processes which join with those of the adjoining cells. Some bones have a central cavity which contains a tissue that produces blood cells. The substance contained in the bone cavity is called bone marrow. see figure 3.7.

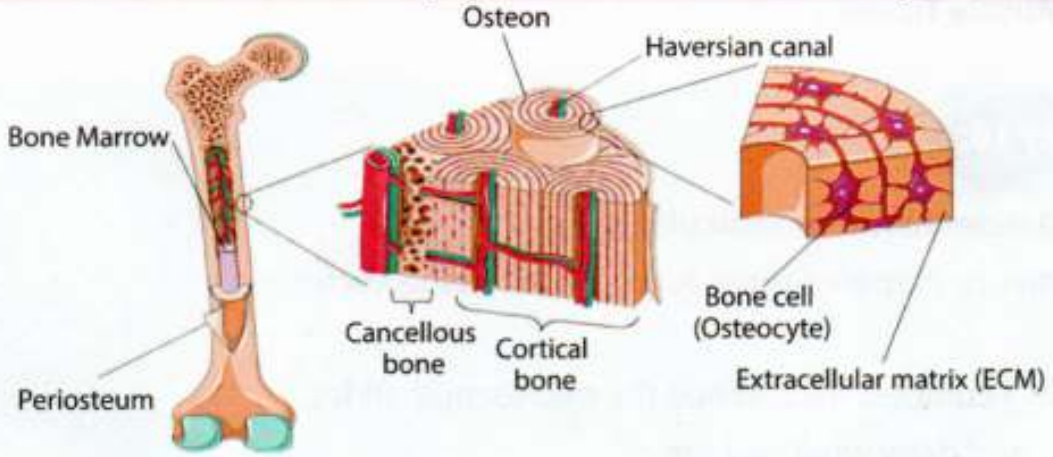


Figure 3.7: Structure of the bone

C. Fluid connective tissue

Blood and Lymph are the two forms of the fluid connective tissue.

Blood: It is a complex of blood cells and plasma. Plasma forms the matrix.

The blood cells are:

1. Red Blood Cells (Erythrocytes) - Transport O_2 and CO_2

2. White blood cells (leukocytes) - Function in defense against bacteria, viruses and other invaders.

3. Platelets (Thrombocytes) -help in the clotting of blood. Figure 3.8 shows blood cells

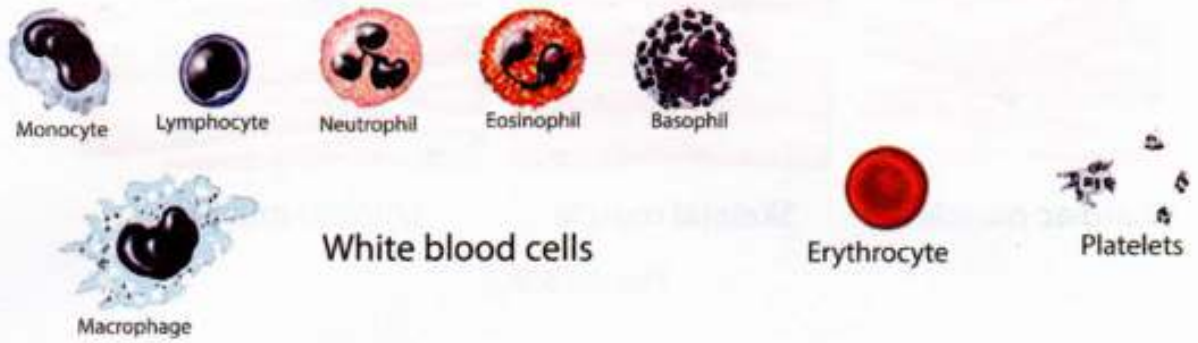


Figure 3.8: Blood cells

Plasma is the extracellular fluid of the matrix, the ground substance. It contains a large number of proteins such as fibrinogen, albumin, globulin to be transported to various parts of the animal body for various purposes.

3. **Muscle Tissue**

Activity 10:

Prepared slides tissue for muscular tissue

Requirements: Prepared slides for muscular tissue Microscope

Steps:

Scan with a complex microscope the microscopic slides.

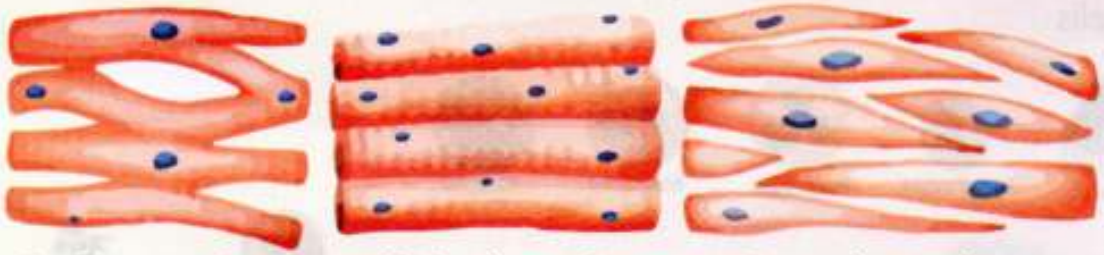
Describe, and draw what you see.

Muscle tissue is composed of long excitable cells containing parallel microfilaments of contractile proteins like actin and myosin. Because of its elongated shape, muscle cell is called a **muscle fibre.** The muscle tissues are of three different types:

a) Striated muscles
b) Unstriated muscles
c) Cardiac muscles

Figure 3.9 shows types of Muscles.

Types of Muscle



Cardiac muscle Skeletal muscle Smooth muscle

Figure 3.9

Table 3.6: Types of muscle tissues

Features	Striated/Voluntary/ Skeletal	Unstriated/ Involuntary/ Smooh	Cardiac
Location	Attached to the skeleton like head, limbs, face etc.	In the walls of body organs like stomach, intestines. Spindle shaped, tapering.	Walls of heart.
Shape	Elongated, cylindrical, unbranched fibres Myofibrils so arranged in the cytoplasm, that there are striations seen.	No such striations seen as myofibrils are not uniformly arranged.	Elongated, cylindrical, branched. Striations (stripes) seen.
Sarcolemma	Thin and tough membrane sarcolemma of the fibre (cell).	Thin cell membrane, no sarcolemma.	Thin
Nucleus	Multi nucleated, Peripheral nuclei.	Uninucleated, centrally placed.	One nucleus in each unit, centrally placed.
Blood Supply	Rich	Poor	Rich
Intercalate Discs	Absent Voluntary (Contracts at will)	Absent Involuntary	Present Involuntary

The musce fibres have the following characteristics:

1) Excitability, (respond to stimulus)
2) Extensibility, (stretch)
3) Contractility, (contract)
4) Elasticity, (move back to the original position)

4. **Nervous Tissues**

Activity 11:

Prepared tissue for nerve tissue
Requirements: Prepared slides for nerve tissue, Microscope
Steps:
Scan with a complex microscope the microscopic slides.
Describe, and draw what you see.

Nervous tissues has two kinds of cells i.e. **neurons** and **neuroglia cells**

Neurons

Neuron is the functional unit of nervous tissue. Neurons are also called **nerve cells**.

Nervous tissues constitute the brain, spinal cord, nerves and the sensory cells and sense organs.

Like any other cells of the body, it has the main cell body called **cyton** from which project out a varying number of processes –one of which is usually very long. This long fibre is called the **axon**.

The smaller but branching processes of the cyton are called the **dendrites.** The function of the nerve tissue is to transmit impulses. See figure 3.10.

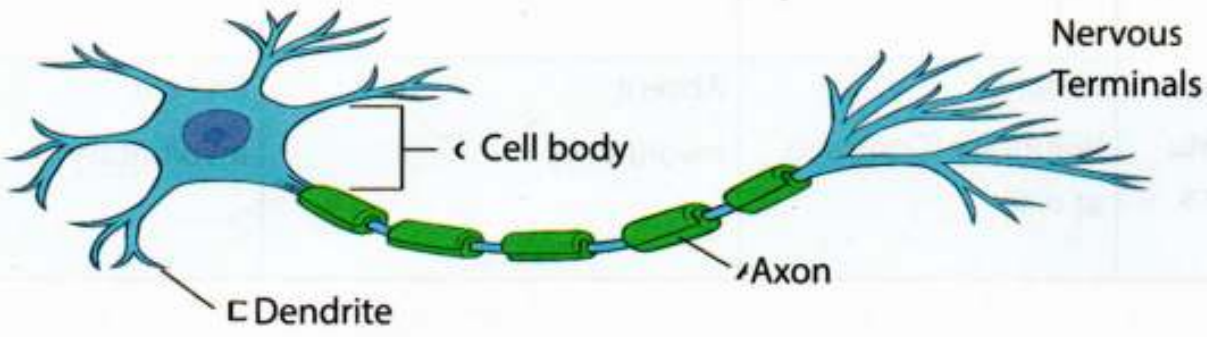


Figure 3.10: The structure of a neuron

Neuroglia

Neuroglia also called glial cells or glia, any of several types of cell that function primarily to support neurons. The term neuroglia means "nerve glue".

Activity 12:

Prepare model of the neuron in figure 3.10

3.4. Levels Of Organisation - From Cell To Organism

1) Cellular Level of Organization–

The organization of the activities by different organelles in a single cell. Example, white blood cell or a green cell of a leaf.

2) Tissue Level–

The aggregates of cells of same origin and having same function, example, the surface epithelium of our skin or the dividing cells at the root cap of a plant.

3) Tissue System–

Generally seen in plants where two or more different cell types combine to perform a particular activity. Example – Vascular tissue (veins, etc.) of a leaf, consisting of xylem and phloem, for transport of water and food materials.

4) Organ Level–

A distinct recognizable part of the body, composed of a variety of tissues and performing one or more special functions which contribute to the well being of the organism. Example : Liver in animals and leaf in plants.

5) Organ System-

Combination of a set of organs all of which are usually devoted to one general function. Example : respiratory system (consisting of lungs, trachea, diaphragm, etc.) in man or the shoot system (consisting of leaves, stem and branches, etc.) in a plant.

6) Organism– The complete individual made of different organ system. Examples: man, monkey, or a mustard plant. see figure 3.11

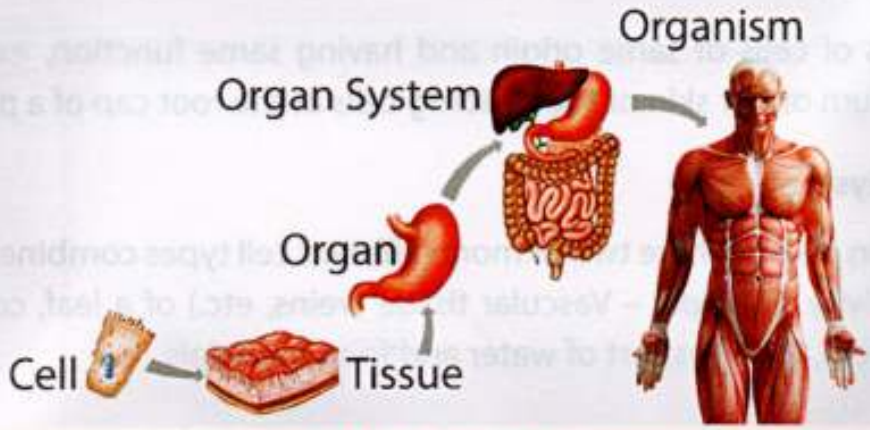


Figure 3.11: Levels Of Organisation

CHAPTER QUESTIONS

Q1: Circle the letter represents the correct Answer

1. Group of cells that are similar in structure and function are known as
   a. Organ b. System c. Tissue d. Cell
2. A tissue whose cells are capable of dividing is called
   a. Complex tissue b. Connective tissue c. Permanent tissue
   d. Meristematic tissue
3. Cartilage and bone are types of
   a. Muscular tissue b. Connective tissue c. Meristematic tissue
   d. Epithelial tissue
4. Sieve tubes and companion cells are present in
   a. Xylem b. Phloem c. Cork d. Cambium
5. The tissue that helps in the movement of our body are
   a. Muscular tissue b. Skeletal tissue c. Nervous tissue
   d. All of the above
6. The size of the stem increases with the width due to
   a. Apical meriste b. Intercalary meristem c. Primary meristem
   d. Lateral meristem
7. What is the correct order of the levels of organization in the human body from the simplest to the most complex?
   a. Tissue, cell, organ, system and organism
   b. Cell, tissue, organ, system and organism
   c. Cell, organ, tissue, organ and system
   d. Organism, system, organ, tissue and cell

8. The study of tissues is called

   a. Cytology b. Embryology c. Histology d. Patholog

9. Many kinds of tissues organise to form a/an

   a. Organ b. organ system c. body system d. organelle

10. Fats are stored in human body as

    a. cuboidal epithelium b. adipose tissue c. bones d. cartilage

11. Which of the following is not a simple tissue?

    a. Xylem b. Parenchyma c. Collenchyma d. Sclerenchyma

12. Which meristem is present at the base of the leaves or internodes on twigs?

    a. Apical meristem b. Cambium c. Intercalary meristem

    d. Epidermis

13. The tissue which has dead cells in the functional state is

    a. Collenchymas b. Sclerenchyma c. Parenchyma

    d. Phloem

14. Collenchyma are characterized by the presence of

    a. Elongated cells with deposits of cellulose and pectin all over the wall

    b. Isodiametric cells with deposits of cellulose and pectin at the corners

    c. Elongated cells with thickening at the corners

    d. Isodiametric cells with thickening all over the wall

15. Which of the following is most likely to be found lining the inside of the intestines?

a. Epithelial tissue b. Nervous tissue c. Connective tissue

d. Muscular tissue

Q2: Which tissues are responsible for secondary growth in plants?

Q3: state the types of animal and plant tissues.

Q4: write a short note on the Comparison between parenchyma, collenchymas and sclerenchyma.

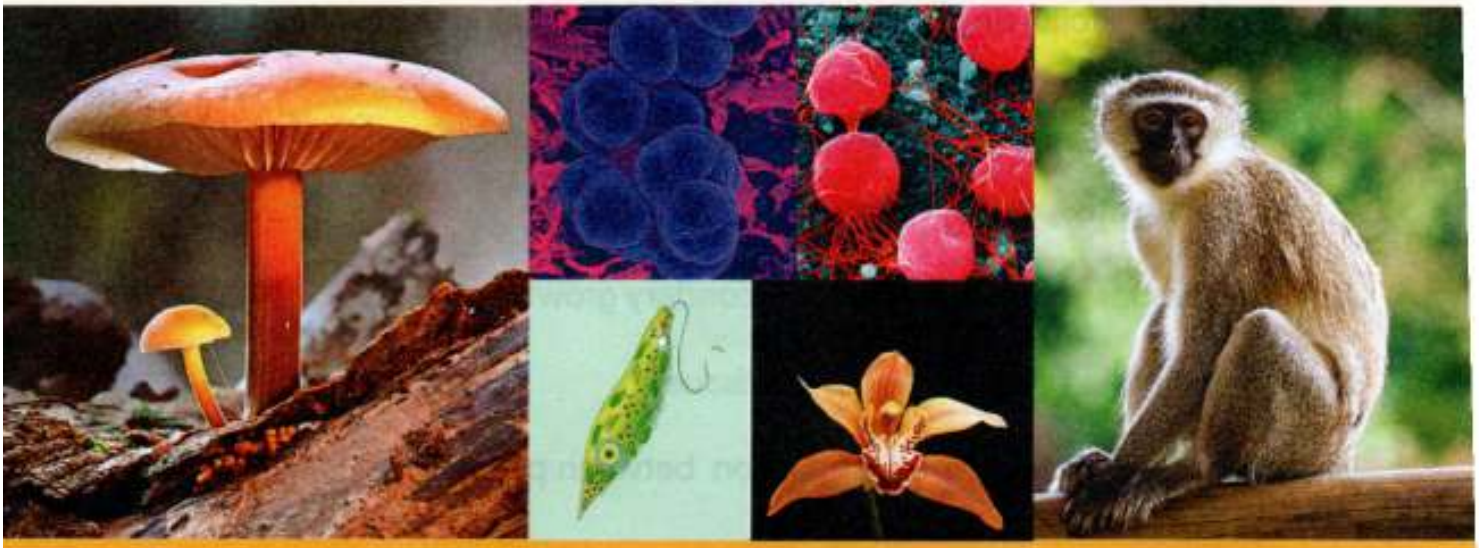
Q5: what are the functions of?

b. Epithelial tissues

c. Nerve tissues

d. Meristematic tissues

e. Permanent tissues



CHAPTER FOUR
PRINCIPLES OF CLASSIFICATION

It is estimated that more than 10 milion types of living organisms exist in our planet earth, so what is the secret behind this diversity?

In order to simplify the broader diversity in living organisms, scientists followed a scientific method to classify living organisms into kingdoms based on their similarities and differences so, what is this methodology? How does it contribute to the identification of living organisms? And how does this affect our lives?. These questions and many more will be discussed in this chapter

By the end of this chapter, the students should be able to:

- Explain the concept of taxonomy and classification
- Group living things according to their similarities and differences.
- State the importance of classifying living things.
- List the taxonomic units from the largest to the smallest.
- Explain the system of binomial nomenclature and rules followed when writing scientific names.
- Mention the five kingdoms of living organisms.
- Describe the dichotomous key.

4.1. Meaning and importance of taxonomy and classification

Classification means identifying similarities and differences between different kinds of organism and then placing similar organisms in one group and different kindsof organisms in different groups.

Activity 1:

Look at the following figures, then answer the following questions:

1) Do these two goats look alike to you?
2) List the similarities and differences between them.
3) What is the basis of your identification?

The science of describing, naming, and classifying organisms is called **taxonomy**. Any particular group within a taxonomic system is called a **taxon** (plural, taxa). Taxonomists classify organisms, mostly according to their morphological features.

Discussion
Why is it important to classify living organisms?

Classification of living organisms is important due to the following reasons:

1) Classification improves our ability to explain relationships among living organisms.
2) Classification helps in identifying living organisms into their correct groups for reference.
3) It makes the study of such a wide variety of organisms easy.

4.2. Early systemsof Classification

There are millions of species of living organisms, so classifying them into proper categories can be a difficult task. To make it easier for all scientists to do, a classification system had to be developed.

A. Aristotle's classification:

Aristotle classified living organisms according to their differences in general characteristics.He classified living organisms as plants and animals then he classified plants into **trees**, **shrubs** and **weeds**, and animals into **red blooded** and **bloodless** animals or **viviparous** and **oviparous** animals.

Note:

Viviparous are animals which give birth
Oviparous are animals which lay eggs.

B. John Ray's classification:

John Ray is considered the first scientist who tried to classify living organisms on scientific bases. He classified living organisms according to similarities in their external features. He defined the term **species** and considered it as a unit of classification.

Organisms that belong to the same species can mate and produce fertile offspring.

C. Carl Linnaeus classification (Binomial nomenclature)

The Linnaean classification system was developed by Swedish botanist Carolus Linnaeus in the 1700s. He tried to classify all living things that were known at his time. He grouped together organisms that shared obvious physical traits, such as number of legs or shape of leaves. For his contribution, Linnaeus is known as the "father of taxonomy"

Linnaeus used a scientific principle in taxonomy, which are still applied till now called **natural taxonomy**.

Linnaeus followed three main principles in his classification:

1) Using Latin language.
2) Series of taxonomy (classification units)
3) Using the binomial system of nomenclature.

4.3. Taxonomic units of classification

Activity 2:

classify the following organisms based on their common features and fill the table below respectively.

Mango, rabbit, neisseiria gonorrhoeae, banana, tuna, plasmodium, yeast, li-on,treponema ballidum, amoeba, mushroom, archaea

Animals	Plants	Fungi	Protists	Bacteria	Archaea

The taxonomic units (texa) or series of classification are: Kingdom, Phylum/ Division, Class, Order, Family, Genus and Species.

1. **Kingdom**: this comprises similar phyla together.

2. **Phylum/Division**: the phylum includes similar classes together.The division is used in the classification of plants.

3. **Class**: the class comprises similar orders together

4. **Order:**. One order comprises similar families together

5. **Family:** one family comprises similar genuses together

6. **Genus:** the genus comprises similar species together.

7. **Species** the species includes an interbreeding organisms that can produce fertile offspring. The figure 4.1 shows the taxonomic ranking of a camel.

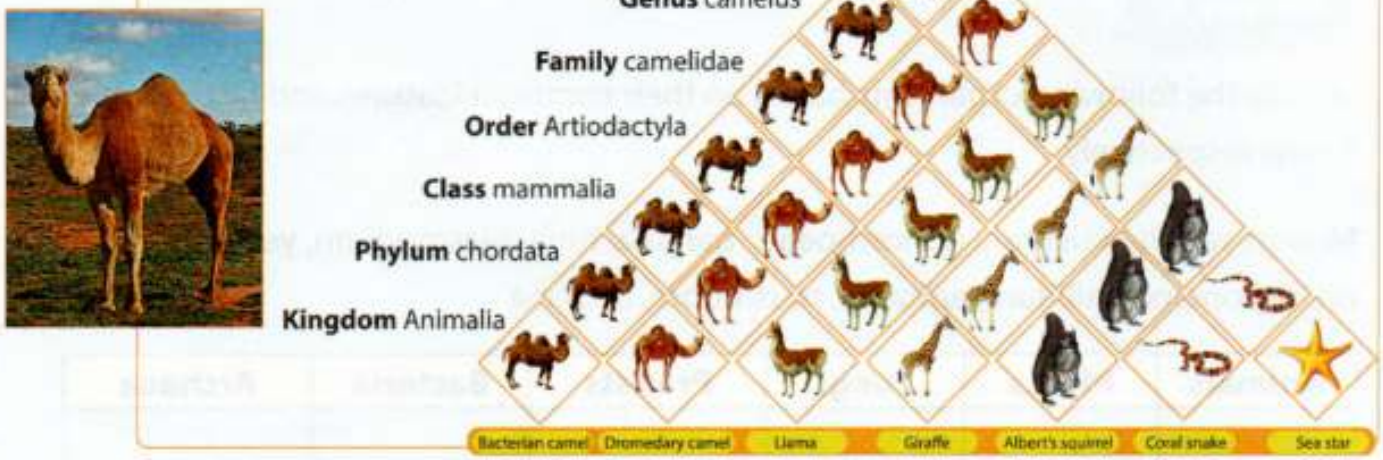


Figure 4.1

Activity 3:

With the help of internet sources find the taxonomy of:

a. Goat
b. Cow
c. Maize

4.3. Modern classification

A major change, to the Linnaean system was the addition of a new taxon called the domain. **Adomain** is a taxon that is larger and more inclusive than the kingdom. Most biologists agree there are three domains of life:

1) Domain Bacteria
2) Domain Archaea
3) Domain Eukaryota

Both Bacteria and Archaea consist of single-celled prokaryotes. Eukaryota consists of all eukaryotes. See figure 4.2

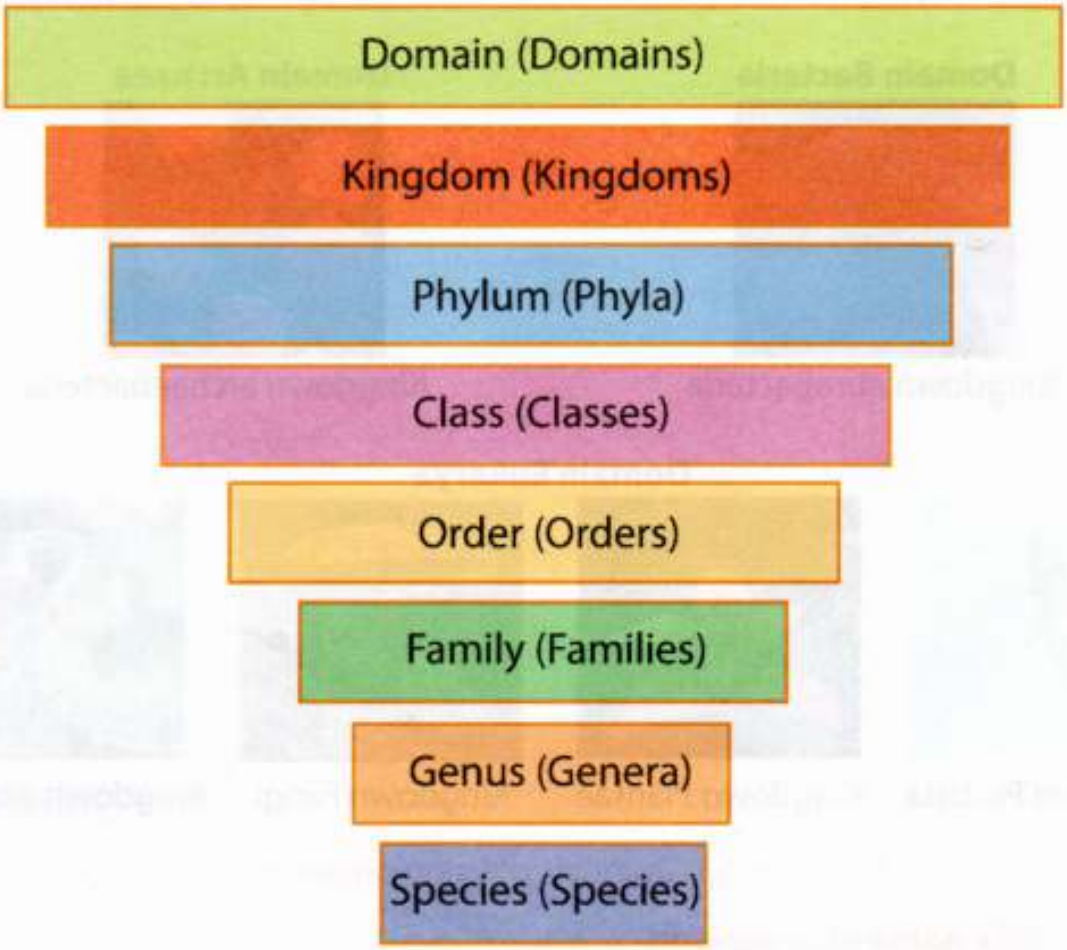


Figure 4.2

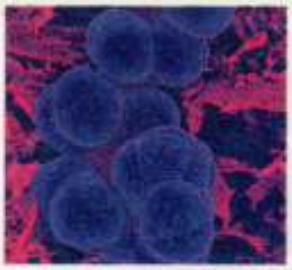
By adding a domain, the claasification as shown in figure 4.2 are domain.

The system of three domains generally aligns with the system of six kingdoms

1) **Kingdom Eubacteria**: The name *Eubacteria* means "true bacteria".
2) **Kingdom Archaea**were originally called **archeobacteria** before they we discovered to be different from eubacteria.
3) **KingdomProtista:** the members of this kingdom include euglena and amoeba
4) **Kingdom fungi:** this includes mushrooms, yeasts, bread molds, etc.
5) **Kingdom Plantea:** this comprises mangoes, maize plant, pea plant, etc.

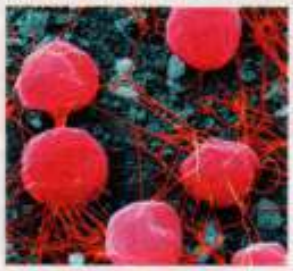
1. **Kingdom Animalia:** whose members include tapeworms, bees, human beings, etc.

Domain Bacteria



Kingdown eurobacteria

Domain Archaea



Kingdown archaebacteria

Domain Eukarya

Kingdown Protista

Kingdown Plantae

Kingdown Fangi

Kingdown animalia

Figures 4.3: Domains of living organisms

4.4. Scientific name of organisms

Study the following concepts about scientific naming to get a clear idea of how organism are named. Look at table 4.5 closely and then apply the binomial nomenclature in naming other organisms.

Different plants and animals have different common names. For example a cat is called 'قطة' In Arabic, 'chatte' in frenc , 'gatta' in Italian. In Somali language, there are different names for a cat like Bisad, mukulaal, and yaanyuur. There arose the need to give organisms names which could be understood throughout the world. So, the scientific names were given to organisms. Scientific names of organisms are understood all overthe world.

There is a simplified system of naming organisms called **binomial nomenclature** proposed by Carl Linnaeus. Binomial nomenclature simply means **two-name** system of naming which consists of the **genus** name followed by that of a **species name.**

There are rules followed in the writing of scientific names. These are:

1) The first part of the scientific name is the genus name and second name is the species name.
2) The genus name begins with a capital letter and species name starts with small letter. E.g: the scientific name of the lion is *Panthera leo*
3) The scientific name should be written in italics in books, but in hand wiring it should be underlined as separate words. Panthera leoin text books or Pathera-leo in hand written

Table 4.5: classification of some organisms and their scientific names

Taxonomic unit	Human being	Cat	Maiz	Bean
Domain	Eukarya	Eukarya	Eukarya	Eukarya
Kingdom	Animalia	Animalia	Plantae	Plantae
Phylum/ division	Chordate	Chordate	Spermatophyte	Spermatophyta
Class	Mammalia	Mammalia	Monocotyle-donae	Dicotyledonae
Order	Primate	Carnivora	Graminales	Rosales
Family	Homonidae	Falidae	Graminae	Leguminosae
Genus	Homo	Felis	Zea	Phaseolus
Species	Sapiens	Catus	Mays	Vulgaris
Scientific name	*Homo sapiens*	*Felis catus*	*Zea mays*	*Phaseolus vul-garis*

Dichotomous key

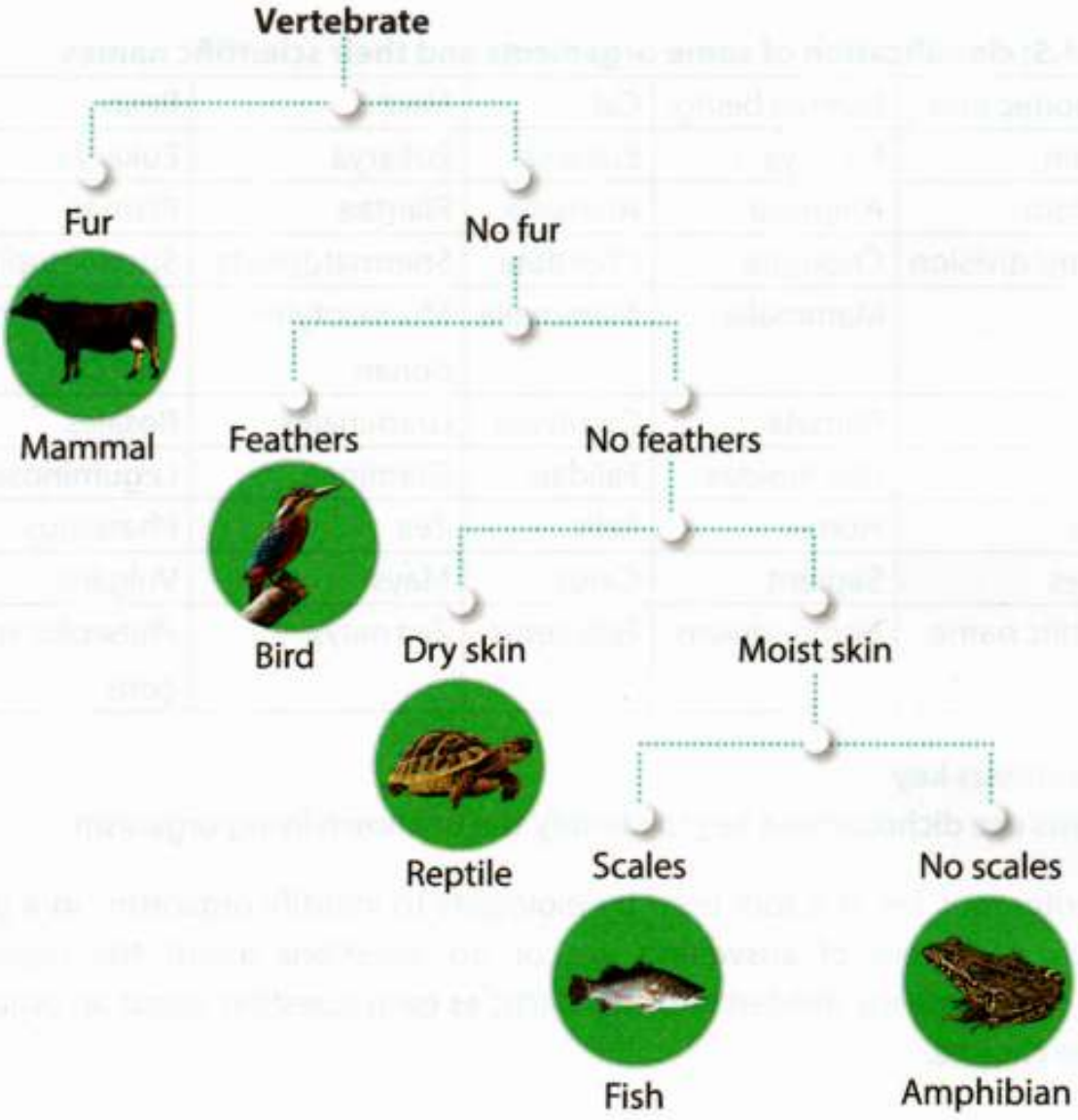
Scientists use dichotomous key to identify the unknown living organism.

A dichotomous key is a tool used by biologists to identify organisms in a group through a process of answering yes or no questions about the organism. Dichotomous means 'divided into two parts', as each question about an organism has two choices.

How it works:

1) It starts with broad features, then it gets more specific as we go through the levels of dichotomous key.
2) In each step, either of two descriptions are selected based on the traits of the organisms.
3) Finally, you will end up with one organism or the group it belongs to.

Figure 4.4 is a typical example of a dichotomous key for five vertebrates.



Figures 4.4: Dichotomous key for five vertebrates

CHAPTER QUESTIONS

Q1: choose the letter of the correct answer

1. In the system of binomial nomenclature, the 1st name represents the
   a. Genus b. Species c. Phylum d. Class

2. _____ Includes a number of orders
   a. Class b. Family c. Phylum d. Genus

3. The lowest taxonomic level of living organisms is the
   a. Kingdom b. Phylum c. Class d. Species

4. _____ is produced from mating of a female horse with a male donkey
   a. Donkey b. Mule c. Tigon d. Horse

5. The taxonomic hierarchy of classification is
   a. Kingdom-class-family-order-phylum
   b. Kingdom-phylum-class-order-family
   c. Kingdom-family-order-class-phylum
   d. Kingdom –phylum-order-family-class

6. To which level of classification does a group of closely related species of organisms belong?
   a. Class b. Order c. Genus d. Kingdom

7. All of the following belong to the domain eukarya EXCEP
   a. Amoemba b. Bacteria c. Mushroom d. Mangoe

Q2: Define the term species. Give a reason why a leopard and a lion cannot breed yet they belong to the same genus

Q3: What is the relationship between a genus and a species?

Q4: a) What is the name given to the scientific system of naming living organisms

b) Give reasons why scientific names are given in Latin

Q5: Distinguish between:

a. Common names and scientific names of living organisms

b. Taxonomy and taxon

Q 7: Why biologists consider the classification of living organisms is useful?

Q8: The following organisms represent a group of vertebrates:

a. Cat ii. Crocodile iii. Bird (Hawk) iv. Toad

Classify these organisms using the dichotomous key depending on the following characteristics according to their order:

1) Type of skin (naked or covered)
2) Type of the skin cover (hair or scale)
3) The scales (scale on the whole body or scales and feathers)

CHAPTER FIVE
VIRUSES

You probably heard of the viruses that cause human diseases like the common cold virus. Did you ever wonder how do they look like? Where do they live? How do they reproduce?. In this chapter you will explore viruses and study them closely.

By the end of the chapter students should be able to:

- Define a virus and discuss its discovery.
- Describe the structure, shape and size of viruses.
- Outline classification of viruses.
- Describe characteristics of viruses.
- Discus viral reproduction and the life cycle of bacteriophages.
- Delineate the significance of viruses.

5.1.Definition and Discovery of viruses?

A **virus** is an extremely small, infectious agent that is metabolically inert and only replicates in living hosts. The study of viruses is known as **virology.**

In 1892, Russian botanist Iwanowsky prepared an extract from tobacco plants suffering from tobacco mosaic disease. The extract was filtered to keep back bacteria in the residue. The filtrate was still infectious. Dutchman Beijerinck gave the term virus in 1898 (Virus - poison in Latin) to these infective particles.

Activity 1:

Discuss in groups disease-causing viruses and viruses that damage computers and mobiles in terms of:

1) Similarities and differences of both viruses
2) The way they cause the damage
3) Methods of prevention of the damages they cause?

Activity 2:

Study the following information in groups and then outline the main concepts:

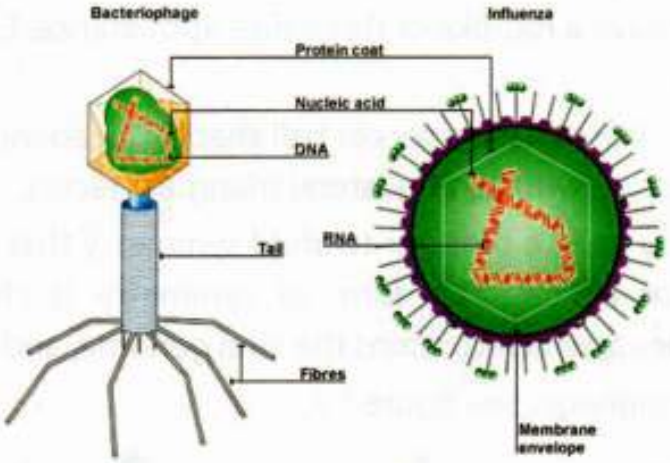
5.2. Structure of Viruses

Viruses vary in their structure. A virus particle consists of **DNA or RNA** within a protective protein coat called a **capsid**. The shape of the capsid may vary from one type of virus to another. The capsid is made from the proteins that are encoded by viral genes within their genome.

Note that:

DNA stands for deoxy ribonucleic acid and **RNA** stands for ribonucleic acid.

The shape of the capsid serves as one basis for classification of viruses. Virally coded proteins will self-assemble to form a capsid. Some viruses have an envelope of phospholipids and proteins. The envelope is made from portions of the host's cell membrane. It surrounds the capsid and helps protect the virus from the host's immune system. See figur 5.1



Figures 5.1: The structure of the Virus

Activity 3:

Make a model of a typical viral structure by using flexible metal wires with different colors (fiilofeero, fiilokorontoiwm.).

5.3. Characteristics of Viruses

1) Viruses are usually considered to be nonliving.
2) All viruses have the same basic structure—a core of nucleic acidsurrounded by protein.
3) They lack cytoplasm and cellular organelles.
4) They have host specificity.
5) They have genetic material (DNA or RNA) and they can evolve.
6) Antibiotics have no effect on viruses and only a few **antiviral drugs** are available for some diseases.

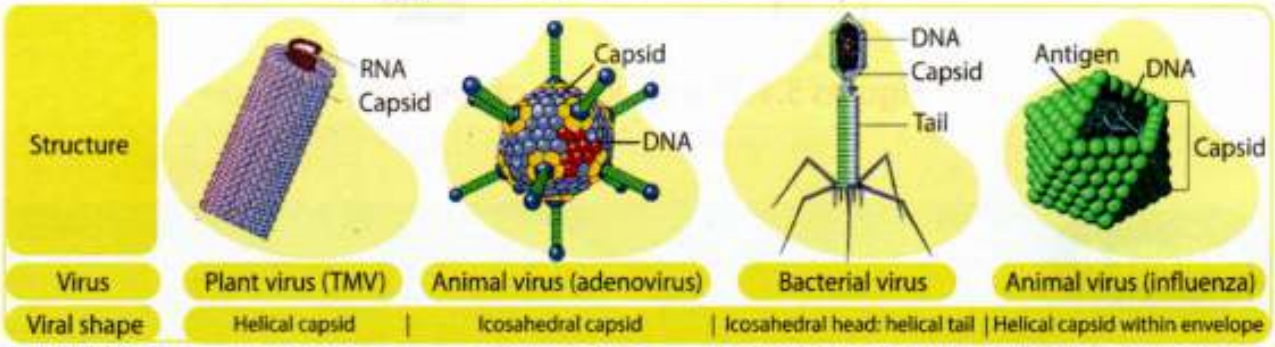
5.4. Size and Shape of Viruses

Viruses are extremely small and can be seen only under electron microscope.They are smaller than the smallest bacteria and can pass through filters which retain bacteria.The size of viruses is about 20 to 400 nm in diameter. A nanometer (nm) is a unit of microscopic measurement, equal to 10^{-9} m.

Most viruses come in two simple shapes and a complex one which are:

1) **Helical**: they have a rod-like or threadlike appearance. E.g. the tobacco mosaic virus.
2) **Icosahedral**: viruses have a soccer ball shape. E.g. adenovirus. The icosahedron is a structure with 20 equilateral triangular facets.
3) **Complex**: they have a binal, or twofold symmetry that is not either purely icosahedral or helical. This form of symmetry is characterized by an icosahedral head, which contains the viral genome, and a helical tail.

   E.g. T4 Bacteriophage. See figure 5.2.



Figures 5.2: Virus shapes

5.5. Classification of Viruses

Viruses can be classified according to:

1) The shape of the virus. E.g. helical, icosahedral and complex.
2) The type of nucleic acid
   - DNA viruses like hepatitis B virus
   - RNA viruses like influenza and measles viruses
3) Mode of transmission like oral, sexual, blood transfusion etc.
4) Presence of an envelope.
5) The type of host organisms like plant, animal and bacterial viruses
6) The type of disease they cause like common cold and mumps viruses

The Table 5.1 Lists the classification of virus according to characteristics such as capsid shape, presence of an envelope, and the diseases the viruses can cause.

Virus Family	Virus	Envelope	Capsid shape	Nucleic Acid	Disease
Adenoviruses	Adenovirus	No	Icosahedral	DNA	upper respiratory infections
Parvoviruses	Parvovirus	No	Icosahedral	DNA	fifth disease, Canine parvovirus
Herpesviruses	Herpes simplex virus, Varicella zoster virus, Epstein Barr virus	Yes	Icosahedral	DNA	Herpes, chicken pox, shingles, infectious mononucleosis
Hepadnaviruses	Hepatitis B virus	Yes	Icosahedral	DNA	Hepatitis B
Reoviruses	Rotavirus	No	Icosahedral	RNA	gastroenteritis
Retroviruses	HIV, HTLV-I	Yes	Complex	RNA	HIV/AIDS, leukemia
Orthomyxoviruses	Influenza viruses	Yes	Helical	RNA	Influenza (flu)
Rhabdoviruses	Rabies virus	Yes	Helical	RNA	Rabies

Virus Family	Virus	Enve-lope	Capsid shape	Nu-cleic Acid	Disease
Coronaviruses	Corona virus	Yes	Complex	RNA	Comon cold, Covid-19, SARS and MERS
Cystoviruses	Cystovirus	Yes	Icosahedral	RNA	Infects *Pseu-domo-nas* bacteria

5.6. Reproduction in viruses

As you already learnt, viruses are acellular particles. How do you think they can reproduce?

Viruses cannot reproduce on their own. They can replicate only by infecting a host cell. Viruses are not cells; they are a strand of DNA or RNA within a protective protein coat called a capsid. They infect a wide variety of organisms, including both eukaryotes and prokaryotes. Once inside the cell, they use the cell's ATP, ribosomes, enzymes, and other cellular parts to replicate thus, they are considered **obligate intracellular parasites.**

Bacterial viruses (Bacteriophages) exhibit two reproductive cycles, namely; **lytic** and **lysogenic cycles**.

A- Lytic cycle

The lytic cycle is one of the two cycles of viral reproduction, the other being the lysogenic cycle. These cycles should not be seen as separate; they should rather be seen as two parts of viral reproduction. The lytic cycle is typically considered the main method of viral replication since it results in the destruction of the infected cell and the release of new viruses.

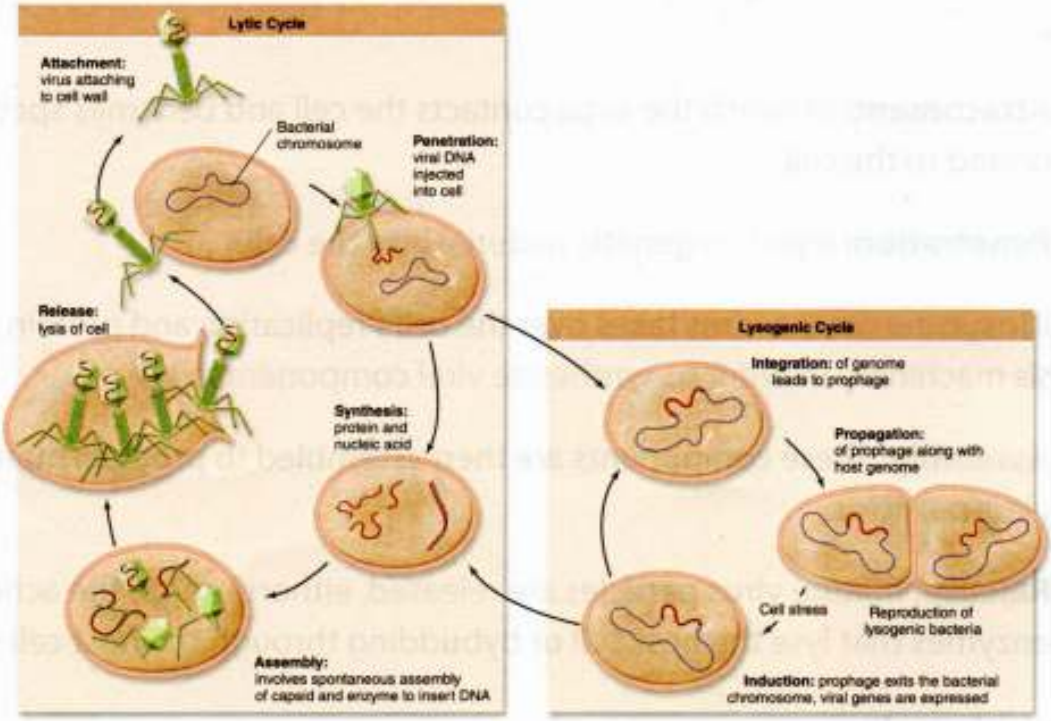
The lytic lifecycle of a phage is shown in Figure below. The lytic cycle is a five-stage process.

1) **Attachment:** in which the virus contacts the cell and becomes specifically bound to the cell.
2) **Penetration:** inject its genetic material into the cell.
3) **Biosynthesis:** the virus takes over the cell's replication and protein synthesis machinery in order to synthesize viral components.
4) **Assembly:** These components are then assembled to produce mature virus particles.
5) **Release:** mature virus particles are released, eitherthrough the action of enzymes that lyse the host cell or bybudding through the host cell wall.

B- Lysogenic cycle

This involves **viral latency** which is the dormant or inactive phase of the viral life cycle. The lysogenic cycle can be divided into three stages, as shown in Figure below:

1) **Fusion of Genetic Material**:Lysogeny is characterized by the fusion of the viral nucleic acid with that of the host cell. The viral DNA is called a **prophage**and thecell containing a prophage is called a **lysogen.**
2) **Propagation of the prophage**:The newly integrated prophage can be passed on to daughter cells during every cell division. Cells containing the prophage may replicate many times.
3) **Induction:** prophage leaves host DNA and the virus has entered the lytic cycle and virus particles are made by the host cell.



Figures 5.3: Lytic and Lysogenic cycle

Activity 4:

Look at the figure above carefully, then spot the viral DNA then discuss with your classmates how viral DNA integrates with that of the phage.

5.7. Importance of viruses

1) Viruses are very much used as biological research tools due to their simplicity of structure and rapid multiplication. They are widely used in research especially in the field of **molecular biology, genetic engineering, medicine** etc.

2) **Biological Control Programs**: Viruses are used in eradicating harmful pests like insects.

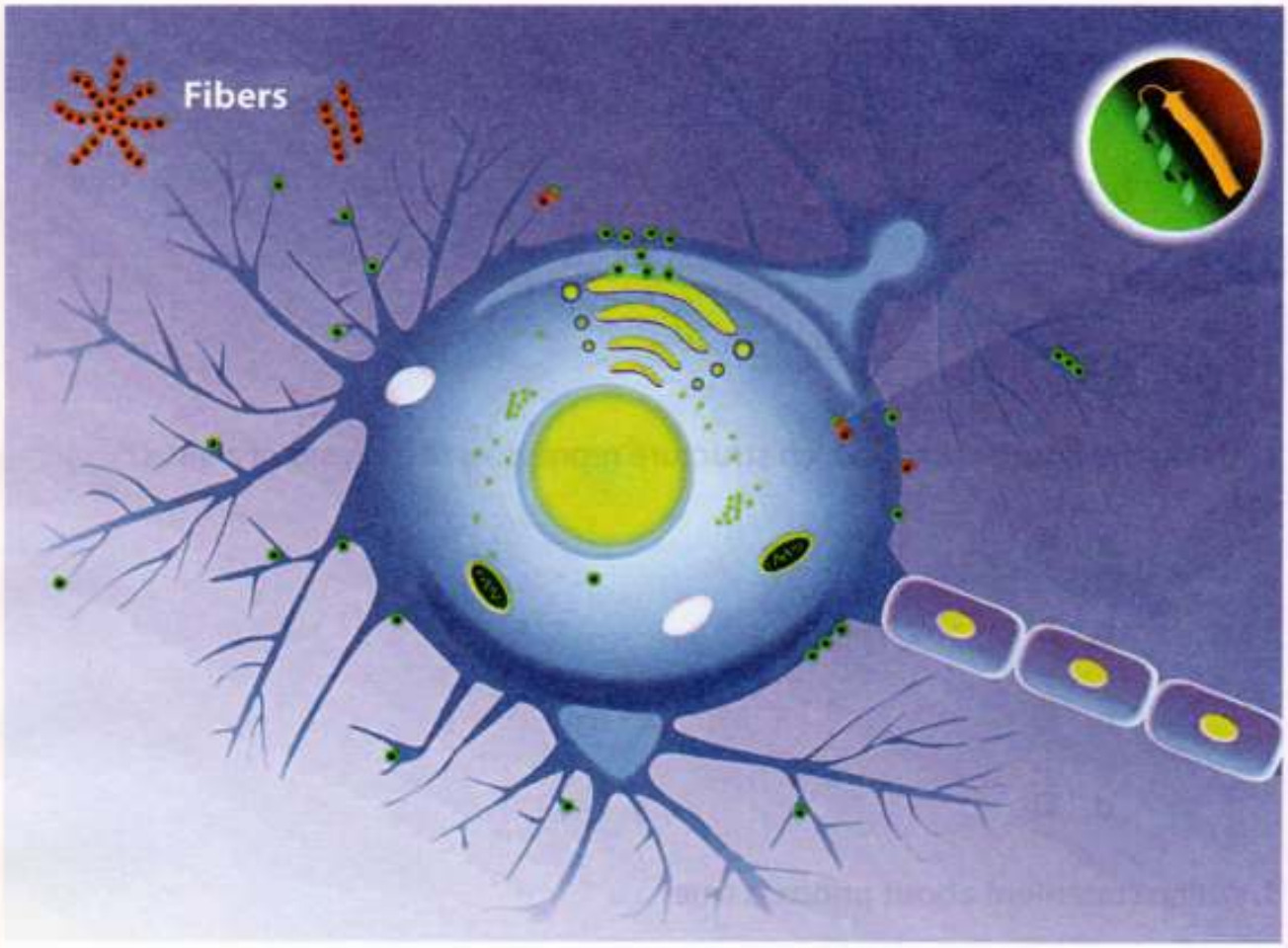
3) Viruses play a key in increase of agricultural yields and thus tackling the issue of food shortage. It's also beneficial in water treatment processes.

5.8. Viroids and Prions

A **viroid** is a coiled RNA molecule which has no capsid (protein coat). They are smaller than viruses and are important infectious disease agents in plants. They can cause crop failures like tomatoes, potatoes and fruit trees, which means a huge loss of revenue for the agriculture industry each year. Viroids don't cause human disease.

Prions are just infectious protein particles that have neither DNA nor RNA to transmit infection. A prion is an abnormal form of a usually harmless protein. The most well-known disease caused by prions is mad cow disease.

Figure 5.3 describes prion theory



Is a normal protein

PrPc

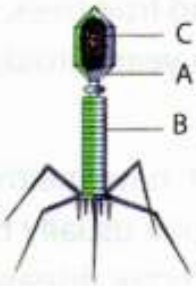
The disease causing form of the prion protein

PrPsc

Figures 5.4: Prion theory

CHAPTER QUESTIONS

Q1 choose the correct answer from the following



1. Using the figure above, which labeled structure represents the genetic material of a virus?

a. A

b. B

c. C

d. D

2. Using the figure above, which structure represents the capsid of a virus?

a. A

b. B

c. C

d. D

3. Which statement about prions is true?

e. Prions are renegade pieces of RNA that infect cells.

f. Prions are infectious proteins.

g. Prion-based diseases only affect cows.

h. Prions are a newly discovered type of genetic material.

4. Which one of these is an example of a helical virus?

a. Tobacco mosaic virus

b. Bacteriophage

c. Coronavirus

d. Influenza virus

5. Viruses contain which substances?

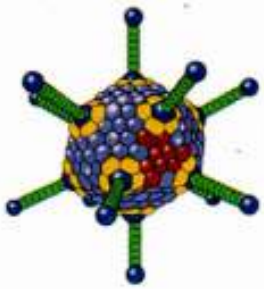
a. genetic material and a capsid

b. a nucleus, genetic material, and a capsid

c. a nucleus, genetic material, a capsid, and ribosomes

d. a nucleus, genetic material, a capsid, ribosomes, and a plasma membrane

6. Which organisms does this virus infect?



a. humans

b. bacteria

c. plants

d. fungi

Q2: What chemical substances are found in all viruses?

Q3: What kind of nucleic acid is found in retroviruses?

Q4: Name two diseases caused by Coronaviruses?

Q5: What are the types of viruses on the basis of their shapes?

Q6: Viruses are host specific, clarify that?

Q7: Discuss the importance of viruses?

Q8: Write short notes on:

a. The life cycle of a bacteriophage

b. Classification of viruses

Q9: Briefly describe these terms

a. Virus

b. Viroid

c. Prion

d. Viral latency

CHAPTER SIX
BACTERIA AND ARCHAEA

قال تعالى: ﴿فَلَا أُقْسِمُ بِمَا تُبْصِرُونَ ﴿٣٨﴾ وَمَا لَا تُبْصِرُونَ ﴿٣٩﴾﴾

Contemplate over the creation of Allah through this qur'anic verse and connect it with the microbial science that will be discussed in the following chapter.

Bacteria are microorganisms with a diameter of 0.5 – 5µm. They live in all environments and have a great effect on plants and animals. Where bacteria are found? What is their composition? How do they feed? These questions and others you will be able to answer after studying this chapter.

By the end of the chapter students should be able to

- Outline the main groups of eubacteria and archaeabacteria.
- Identify the shapes of bacteria.
- Link between different bacterial structures and their functions.
- Compare the bacterial types in terms of feeding, breathing and reproductive methods.
- Describe bacterial growth and reproduction.
- Discuss the role of bacteria in the field of environment, agriculture and biotechnology.
- Make a model for a bacterial cell.

6.1. Characteristics of Bacteria

Activity 1:

According to your previous knowledge about cell, use a light microscope to study animal and bacterial cell slides. Discuss in groups and then answer the following questions

1) What is the difference between animal cells and bacterial cells? How do you compare them?
2) Bacteria are unicellular organism; how could it survive?

Bacteria are single-celled prokaryotic organisms that are made of very simple components. They often lack a nucleus and a cell membrane. They have some very unique and interesting characteristics include:

1) They are unicellular, prokaryotes and microscopic organisms.
2) They have varied body shapes.
3) They have cell wall made up of **peptidoglycan** (murein) which is a polymer consisting of sugars and amino acids.
4) Most of them are heterotrophic, feeding saprophytically or parasitically, some are autotrophic.
5) Reproduction is mostly asexual through binary fission.
6) Most of them are anaerobes, but some respire aerobically.
7) Most of them move by use of flagella.

6.2. Classification of Bacteria

Activity 2:

Look at the figure below carefully, discuss in groups and then answer the following questions

1) What does the figure describe?
2) What are the morphological differences they show?
3) How could you classify them?

Write the answer in your work book

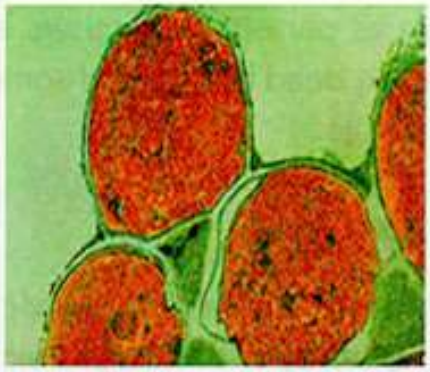
Bacteria are classified based on their composition, functions, and interactions with specific types of dyes within two kingdoms. Which are **Kingdom Eubacteria** and **Kingdom Archaeabacteria**

1) **Kingdom Archaeabacteria**

Archaeabacteria different from the eubacteria in the structure of their walls, which are free of peptidoglycan, and grow in harsh environments such swamps, salt lakes, and hot springs. The main types of Archaebacteria are:

i) Methanogenic bacteria:

these are bacteria that can live in aerobic environments such as sewage and intestinal tracts of animals. These kinds of bacteria are capable of production of methane gas. see figure 6.1



Figures 6.1: Methanogenic bacteria

ii) Thermoacidophilic bacteria:

these bacteria live at high temperatures up to 110 ° C and a pH less than 2. see figure 6.2

Figures 6.2: Thermoacidophilic bacteria

iii) Halophilic bacteria:

these bacteria live in environments with a very high salt concentration, such as the Dead Sea and in hot springs. see figure 6.3

Figures 6.3: Halophilic bacteria

2) **Kingdom Eubacteria**

Eubacteria are the most common types of bacteria that live on the surface of the earth, and they have different shapes and sizes, and they practice patterns of different living conditions that enable it to live and obtain food, some of which live freely in the soil, or live as parasites on others are living, causing diseases. Some are saprobes that feed on dead bodies and some are photoautotrophic and chemoautotrophic.

Eubacteria canbe classified into three phyla:

i) Phylum proteobactria

It is the largest group of true bacteria, which include different types of bacteria, such as chemoautotrophic bacteria, and nitrogen-fixing bacteria. And some can be saprophytic or parasitic such as Salmonella bacteria, which affects the human intestine. see figure 6.4

Figures 6.4: Phylum proteobactria

ii) Phylum Cyanobacteria(blue-green algae):

The bacteria that belong to the phylum Cyanobacteria are photosynthetic. Cyanobacteria are also known as **blue-green bacteria**. Those bacteria that are blue-green in color contain a blue pigment called **phycocyanin**. They also contain chlorophyll.

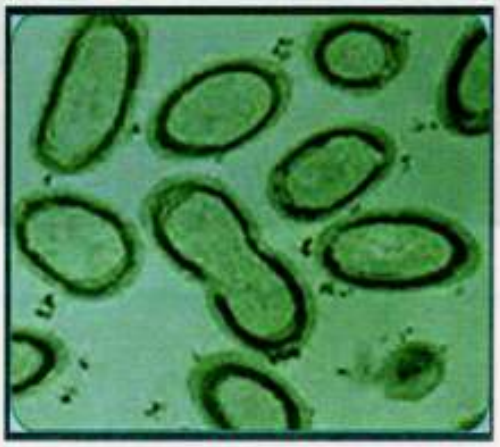
The presence of these two pigments gives the name blue-green to the entire group of cyanobacteria.

Cyanobacteria live as colonial in marine and fresh water environment. Few live in hot spring and frozen areas. An example of cyanobacteria is **Nostoc.** See figure. 6.5

Figures 6.5: Nostoc

iii) Prochloro bacteria (prochlorophyta)

The prochlorobacteria are photosynthetic organisms that contain chlorophyll a and b as their principal pigments. The presence of these pigments makes prochlorobacteria more similar to chloroplasts of green plants than to cyanobacteria. For this reason, prochlorobacteria are sometimes called Prochlorophyta. See figure 6.6



Figures 6.6: Prochloro bacteria

6.3. Shapes of Bacteria

The shapes of bacteria vary according to their types, ways of life, and the environment in which they are active.

Practical

Activity 3:

The stud of the shapes of bacteria

Materials required: compound microscope and prepared slides of different types of bacteria.

Procedure:

- Observe microscopic slides using the low power objective and gradually up to the high power objective lens.
- Draw the different shapes of bacteria you see in your notebook. What do you notice?

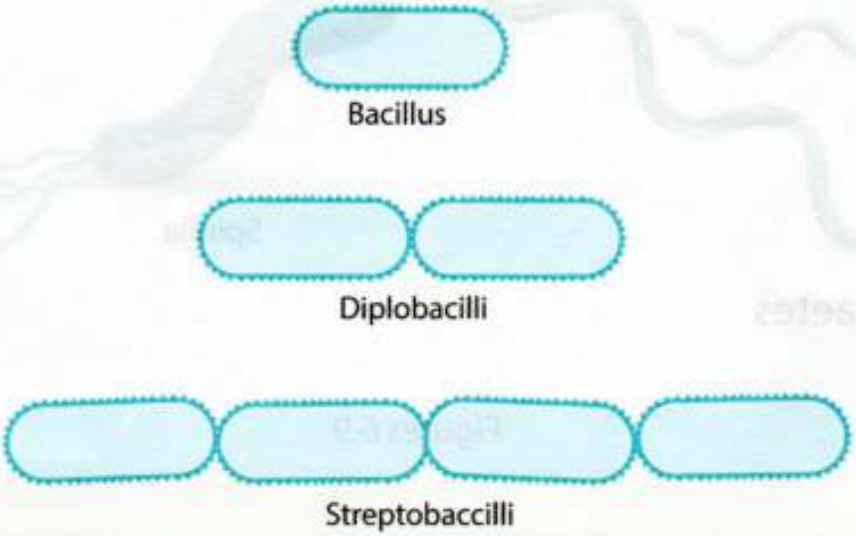
Spherical (Cocci)

Rod-shaped (bacilli)

Spiral

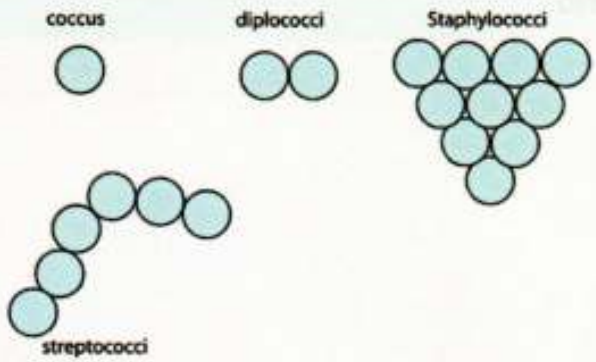
Bacteria have three basic shapes: **rod-shaped, spherical-shaped,** and **spiral-shaped.**

1. **Rod-shaped bacteria (Bacilli)**
   They differ in their shapes and sizes, and can exist as a single cell called bacillus, or colonies of two cells (diplobacilli), or a chain form called **streptobacilli**. See figure 6.7



Figures 6.7

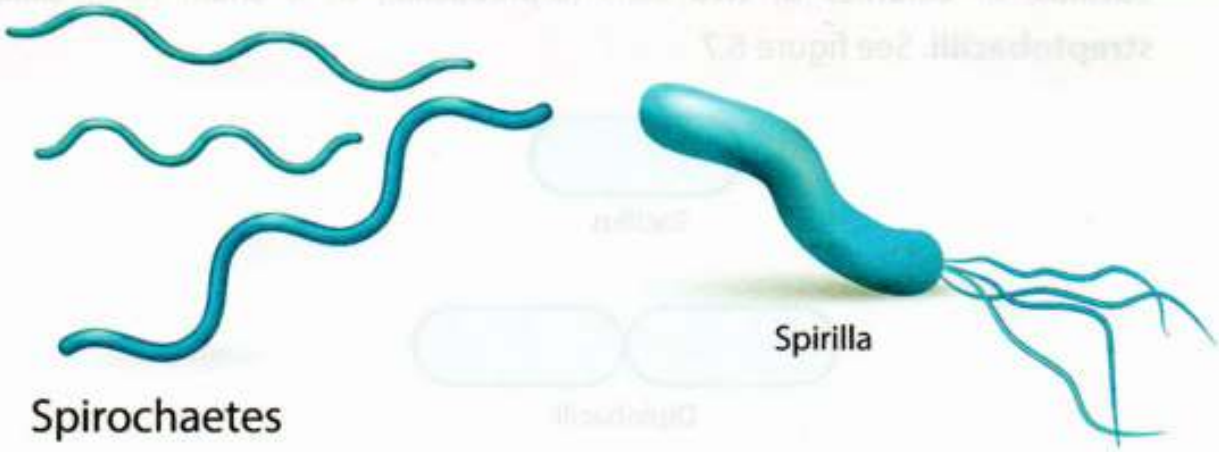
2. **Spherical-shaped bacteria (cocci)**
   They differ in their shapes and sizes. Cocci may occur as single cells **(coccus)** or remain attached following cell division, for example; **diplococci** forms colonies containing two cells. **Streptococcus** may form long chains. A few others, such as **Staphylococcus**, form large clumps or clusters. See figure 6.8



Figures 6.8

3. **Spiral- shaped bacteria**

It is one of the three primary shapes of bacteria. They are coiled or twisted in form of spirals. It occurs in two shapes i.e. spirillum and spirochetes. See figure 6.9



Figures 6.9

Activity 4:

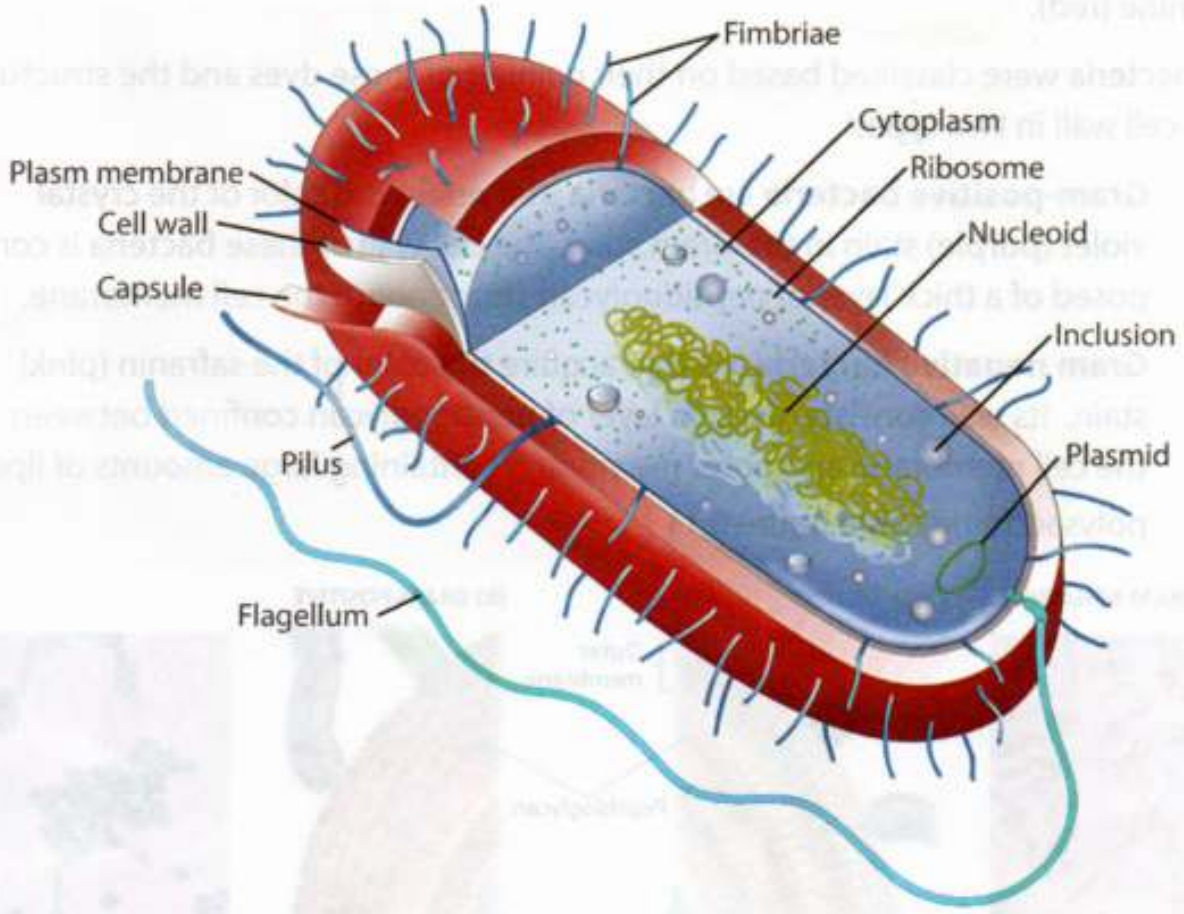
With the help of reference biology books in the school library or internet resources, outline some of the diseases caused by the following bacterial types:

1) Diplococcus bacteria
2) *Streptococcus bacteria*
3) *Bacillus bacteria*
4) *Spirillum bacteria*

6.4. The Structure of Bacterial Cell

Activity 4: Read the following information about the structure of bacterial cell and then compare it with animal and plant cell structures that you have learnt

The bacterium has a cell wall covering the cell membrane, cytoplasm and a single chromosome. The cell has ribosomes but no membrane bound organelles. Some bacteria have an additional structure that enables it to adapt with a unique way of life. See figure 6.10



Figures 6.10: Structure of Bacterial Cell

Cell wall

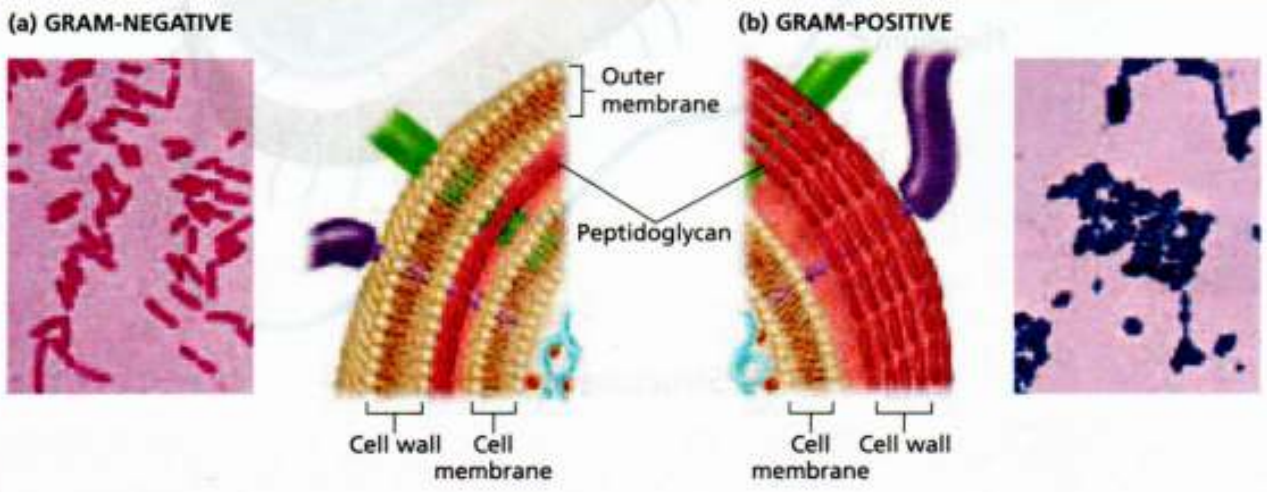
All prokaryotes have a rigid cell wall, which protects and gives shape to the cell. The cell wall is made up of a chemical called **peptidoglycan,** unique to bacteria.

Pili (Singular : pilus) are short and thin thread- like structures projecting out from the cell wall in some bacteria. The function of pilli is to attach the bacterial cell to specific surface or other cells.

In 1884, the Danish physician Hans Gram developed a method for staining bacteria called **Gram stain**. Gram's stain consists of two dyes-crystal violet (purple) and safranine (red).

The bacteria were classified based on their gaining of these dyes and the structure of its cell wall in two types:

1. **Gram-positive bacteria** are bacteria that retain the color of the crystal violet (purple) stain in the Gram stain. The cell wall of these bacteria is composed of a thick layer of peptidoglycan surrounding the cell membrane.
2. **Gram negative bacteria** are that acquire the color of the safranin (pink) stain. Its wall consists of a thin layer of peptidoglycan confined between the cell membrane and outer membrane containing large amounts of lipopolysaccharide. See figure 6.11



Figures 6.11

Activity 5:

Materials required

Bacterial sample, slides, compound microscope, heat source, crystal violet, iodine solution, alcohol and safranin.

Procedure

1) Prepare a thin smear of the given bacterial species on a clean glass slide and let the smear dry.
2) Heat fix the smear.
3) Cover each smear with crystal violet for 1 minute.
4) Wash each slide with distilled water for few seconds using wash bottles.
5) Cover each smear with Gram's iodine solution for 1 minute.
6) Gently wash with distilled water.
7) Decolorize the smear with alcohol for 20 seconds.
8) Wash the slide with distilled water and drain it.
9) Apply Safranin for 30 seconds.
10) Wash with distilled water and dry it with absorbent paper.
11) Air dry the stained slides and observe under the microscope.
12) Explain the results of your observation according to what you have studied in the structure of bacterial cell wall.

Capsule

It is viscous layer that surrounds the cell wall and consists of polysaccharides or proteins. It protects the cell and helps it to attach other surfaces.

Flagella

Some bacteria move with the help of one or two flagella. Flagella are longer and thicker than pili. Their structure is different from flagella of eukaryotes.

Plasma Membrane

Plasma membrane, present below the cell wall, encloses the cytoplasm and other cell contents. It is made up of lipids and proteins, as in eukaryotes.

Cytoplasm

It is a viscous liquid that is surrounded bacterial cell membrane, and consists of different components such as ribosomes which is used for protein synthesis and enzymes necessary for metabolic reactions. Membrane bound organelles like endoplasmic reticulum, mitochondria, chloroplast, Golgi complex are absent.

Nucleoid

It is a dense irregularly shaped area that is not surrounded by a nuclear membrane, and contains a chromosome that is composed of a circular DNA.

Plasmid

It is an extra chromosomal, small, circular DNA molecule within a cell that is separated from chromosomal DNA. Plasmids provides bacteria with genetic advantages such as antibiotic resistance.

Activity 6:

Project : Designing three dimensional model for bacterial cell

1) Students are divided into groups, and each group has to design a three-dimensional structure of bacterial cell, based on their previous knowledge.
2) The different models should be presented and compared, and give reasons for differences that exist between the models students made.

Material required:

Styrofoam sheet, glue, cutting blades, tissue, colors, water and brushes

Procedure: refer to this link https://youtu.be/mxDpbkZzgBM

Activity 7:

Read the following information about nutrition, respiration, and reproduction of bacteria and then answer the following questions

- How do bacteria feed?
- How do they respire?
- What are the reproductive methods of bacteria?

6.5. Nutrition in Bacterial

Bacteria can be classified according to their mode of nutrition into:

a) **Autotrophs:** are the bacteria that can make their own food into two ways:
   1) **Phototrophic autotrophs.** They use the energy of sunlight for photosynthesis. For example cyanobacteria.
   2) **Chemotrophic autotrophs**. They obtain energy from inorganic molecules like hydrogen sulfide, nitrites, sulfur, and iron for the fixation of carbon dioxide and formation of food. For example Nitrosomonas.

b) **Heterotrophs:** Many bacteria obtain energy by taking in organic molecules and then breaking them down and absorbing them. These bacteria are called **chemotrophic heterotrophs**.

6.6. Respiration in Bacteria

Bacteria can be classified according to their requirements for oxygen into three types:

1) **Obligate aerobes:** These require a constant supply of oxygen in the process of respiration. For example *Mycobacterium tuberculosis* which causes tuberculosis

2) **Obligate anaerobes:** These do not require oxygen, and may be poisoned by it. For example Clostridium tetani that causes tetanus.

3) Facultative Aerobes: These group of bacteria are those that can survive with or without oxygen, neither are they poisoned by its presence. For example Escherichia coli, that found in large intestine.

6.7. Bacterial Reproduction

Bacteria can reproduce both sexually and asexually

(i) Asexual Reproduction

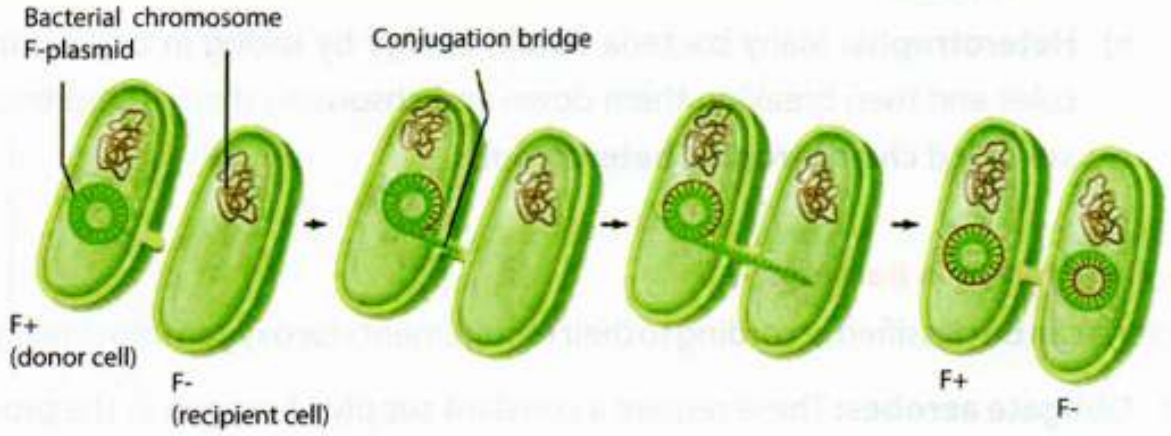
Bacteria reproduce asexually by binary fission under favorable conditions it takes about 20 minutes for one bacterium to divide into two by binary fission.

(ii) Sexual Reproduction

Some bacteria show a primitive mode of sexual reproduction called **conjugation** which is a type of sexual reproduction that occurs in some bacteria which involves the exchange of genetic information. It involves the following steps:

a) Two conjugating (lie very close for exchange of genes) bacteria are held together by pili.

b) Part of the genetic information from one cell, called the **donor,** is transferred to the other cell, called the **recipient**. see figure 6.12.



Figures 6.12: conjugation

(iii) Endospore Formation:

When growth conditions become unfavorable, many bacteria form structures called **endospores**. An endospore is formed when a bacterium produces a thick internal wall that encloses its DNA and a portion of its cytoplasm.

The endospore can remain dormant for long periods, waiting for more favorable growth conditions. When conditions improve, the endospore will open and the bacterium will begin to grow again.

Activity 8:

In groups, discuss the advantages and disadvantages of bacteria. Then write down the main points of your discussion in your notebook.

6.8. Importance of Bacteria

Despite the many damages that bacteria causes yet, it is possible to take advantage of it in different aspects which include:

1. **In the Environment**:
   Along with fungi, bacteria decomposes dead bodies enriching the soil with beneficial nutrients that increase its fertility. Bacteria also gets rid of industrial wastes including heavy metals like Pb and Hg. It is utilized in waste recycling to produce methane gas which is used in energy production. Bacteria is helpful in the modification of oil spills because it can break down petroleum and use it as an energy source.

2. **In Agriculture:**
   Some bacteria produce toxins that are used in the eradication of many insects. Some others perform nitrogen fixation in the roots of leguminous plants.

3. **In Biotechnology**
   Bacteria has many distinctive properties like its simple genetic structure, fast growth and reproduction, and presence of plasmids, which enabled scientists to use it in the following aspects:

   a. Bacteria is used in the production of antibiotics.

   b. It is used in the fermentation of certain organic substances producing medical alcohol, and lytic enzymes that are used in detergents.

   c. Production of vaccines and hormones in commercial quantities.

   d. It is used in the production of yogurt or curd.

   e. Certain bacteria mutually lives with certain living organisms, like E.coli that lives in the intestines of humans. It helps us in digestion and the production of some vitamins such as vitamin K and B_{12}

CHAPTER QUESTIONS

Q1: Circle the letter of the best suitable Answer

1. Methanogens are members of the phylum

   a) Cyanobacteria. c) Prochlorobacteria.

   b) Archaebacteria. d) Eubacteria.

2. A rod-shaped bacterium is known as a

   a. Spirillum. b. coccus.

   c. Bacillus. d. virus.

3. Organisms that need a constant supply of oxygen in order to live are called

   a) Obligate anaerobes. b) chemotrophic autotrophs.

   c) Facultative anaerobes. d) obligate aerobes.

4. A structure that forms when a bacterium produces a thick internal wall that encloses its DNA and part of its cytoplasm is called a (an)

   a) endospore. b) prophage.

   c) capsid. d) spirillum.

5. Which organism is not included in Domain Archaea?

   a. cyanobacteria b. methanogens

   c. halophilic bacteria d. thermoacidophilic bacteria

6. Methane gas is produced by

   a. Eubacteria b. Archaebacteria

   b. Mycoplasma c. Cyanobacteria

7. Organisms that use the complex molecules of once-living organisms for energy and nutrition are called:

   a. parasites. b. saprophytes.

   c. viruses. d. eukaryotes.

8. An example of a disease caused by a bacterium is
   a. influence b. AIDS
   c. measles d. syphilis
9. Bacteria which retain purple colour after staining with Gram stain is
   a. Gram positive. b. Gram negative
   c. Trichous d. Spirillum
10. Which is the correct identification for the bacteria shown above? Use the diagrams below.


i


ii


iii

A. I—cocci, II—bacilli, III—spirochetes

B. I—bacilli, II—cocci, III—spirochetes

C. I—spirochetes, II—cocci, III—bacilli

D. I—bacilli, II—spirochetes, III—cocci

11. Bacterial cell wall is made up of a polymer that consists of sugars and amino acids and it is called

A. Peptide chain

B. Peptidoglycan

C. Peptide bond

D. Peptidase

12. A viscous layer that surrounds the cell wall of bacteria and consists of polysaccharides or proteins is

A. Capsule

B. Pili

C. Flagella

D. Murein

13. An extra chromosomal, small, circular DNA molecule within a cell that is separated from chromosomal DNA is referred

A. Chromosome

B. Genetic material

C. Plasma

D. Plasmid

14. Cyanobacteria is an example of

A. Heterotrphic bacteria

B. Autotrophic bacteria

C. Chemotrophic bacteria

D. Chemotrophic autotrophs

15. A spherical bacteria that forms colonies containing two cells are termed as

A. Diplobacilli

B. Streptobacilli

C. Diplococci

D. Streptococci

Q2: Outline the main groups of eubacteria and archaeabacteria

Q3. Identify the shapes of bacteria.

Q4. Draw a labeled diagram of bacteria.

Q5. Explain the following:

A. Bacterial respiration

B. Bacterial reproduction

Q6. Discuss the role of bacteria in the fields of environment, agriculture and bio-technology.

Q7. Make a model for a bacterial cell

Q8. Differentiate between

A. Bacteria and archaea.

B. Gram positive and gram negative bacteria.

CHAPTER SEVEN
KINGDOM PROTISTA

Have you ever seen the surface of the ocean glistening at night? Where do you think that light comes from? If you take a drop of water from the ocean, and examined under a microscope, you will find thousands of living organisms. Some of which resemble a small trumpet, and some resemble it jewelry, and there is what appears as a moving point with appendages.

The scientists put these organisms and others that have similar characteristics into a kingdom called **Protista**. What are the characteristics of the organisms that belong to this kingdom? How do they get their nutrients? How they reproduce? And what role they play in our lives?. These questions and others will be able to answer after the completion of this chapter.

By the end of this chapter, the students should be able to:

- Describe the general characteristics of kingdom Protista.
- Classify protists according to their mode of nutrition.
- Identify the diseases caused by some varieties of protists.
- State the importance of protists.

7.1. General Characteristics of Protists:

Activity 1:

Study the following lesson that explains the characteristics of protists and then compare with the characteristics of bacteria that you've studied in chapter 6. Write down the similarities and differences in your notebook.

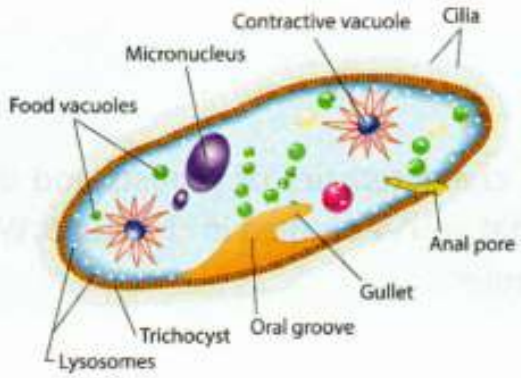
The general characteristics of protists are:

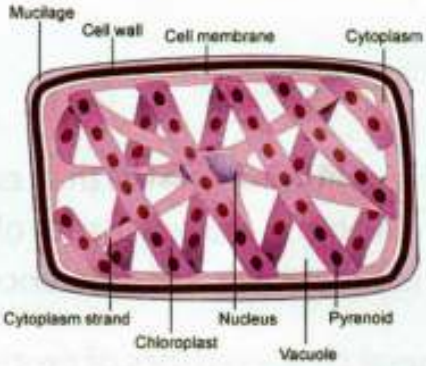
1) Protists are eukaryotic organisms with varied body forms. Some are unicellular while others are colonial.
2) They have many organelles including mitochondria.
3) Most of them are heterotrophic, feeding saprophytically or parasitically, some are autotrophic.
4) Reproduction is mainly asexual by binary fission or budding. Some reproduce sexually by conjugation.
5) Most protista are mobile, moving by means of pseudopodia, cilia or flagella. Some are sessile.
6) Some may have specialized structures that perform specific functions. For example contractile vacuole for osmoregulation.
7) Most of them are anaerobes, but some aerobes.

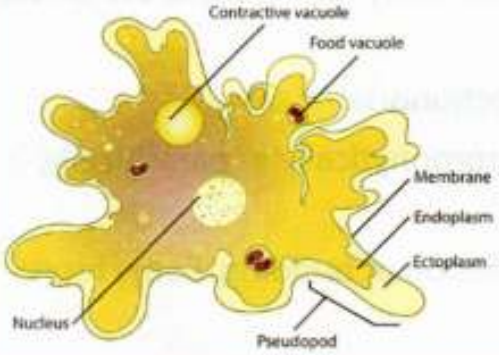
7.2. Classification of Protista

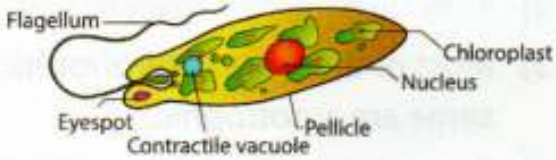
Activity 2:

The figure below represents various types of living organisms that belong to the kingdom Protista, name these organisms and then discuss the similarities and differences between them.









Biologists classify protists into three groups according to their mode of nutrition:

1) Animal-like protists (protozoans)
2) Plant-like protists (algae)
3) Fungus-like protists

1. Animal-like protists (protozoans)

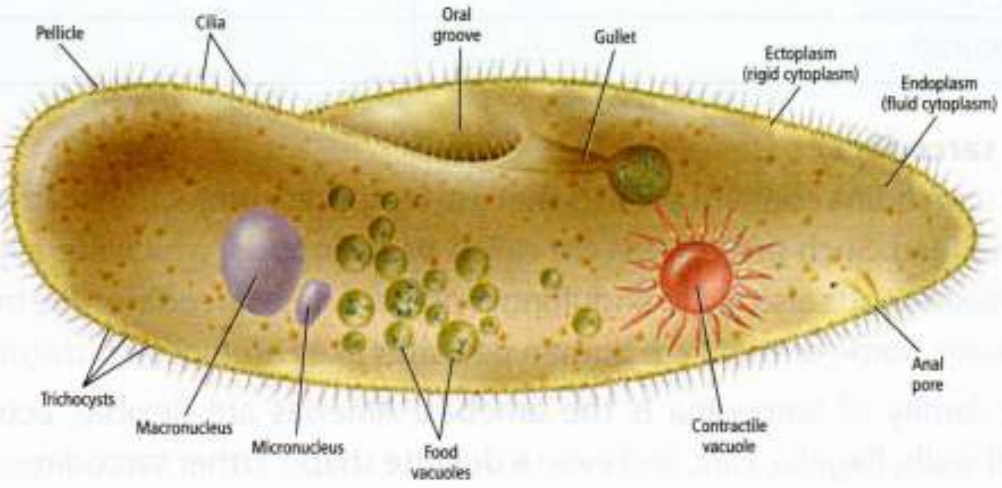
They exist as free or as parasites and possess some of the characteriscs of animals, so they are called protozoans which means 'first animals'. They don not have specialized systems instead, their organelles carry out the same functions as the organs of higher animals. Their cells have contractile vacuole. They mainly reproduce asexually or rarely by sexual means, while some others undergo a life cycle that involves both sexual and asexual reproduction.

Animal like protists can be classified according to their type of movement into four phyla:

1. **Phylum Ciliophora:**

Members of the phylum ciliophora are either solitary or colonial organisms. They called ciliates, because they have cilia (singular: cilium). Cilia are short hairlike projections that produce movement in the water and helps in food capturing. Most ciliates are free-living, which means that they do not exist as parasites or symbionts. A well-studied example of the ciliates is Paramecium. Paramecium does not contain a cell wall, instead it has a srtructure made up of protein known as **pellicle**. Figure 7.1

Paramecium reproduces asexually by binary fission or sexually by conjugation.



Figures 7.1: The structure of Paramecium

Question

Explain how paramecium reproduces by conjugation?

Activity 3:

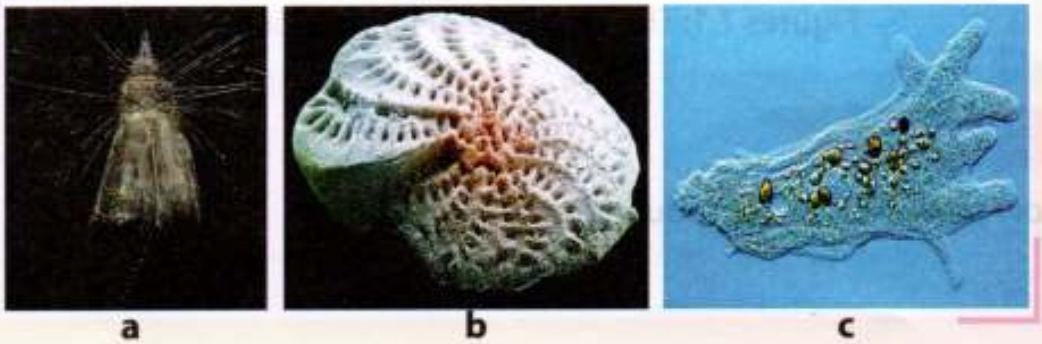
The following table lists the structures of paramecium. With the help of reference books in the library or internet complete their functions.

Structure	Function
1. Pellicle	
2. Macronucleus	
3. Micronucleus	
4. Contractile vacuole	
5. Gullet	
6. Trichocyst	
7. Food vacuole	

2. Phylum sarcodina

The phylum Sarcodina contains protists that use temporary projections of cytoplasm to move and feed. Such projections are called **pseudopods**, which literally means false feet. Pseudopods also aid in engulfing food particles. Sarcodines live in marine and freshwater. Some of them are human parasites like *Entamoeba histolytica.*

One major family of Sarcodina is the amebas. Amebas are flexible, active cells without cell walls, flagella, cilia, and even a definite shape. Other sarcodines include foraminiferans, radiolarians. see figure 7.2



a b c

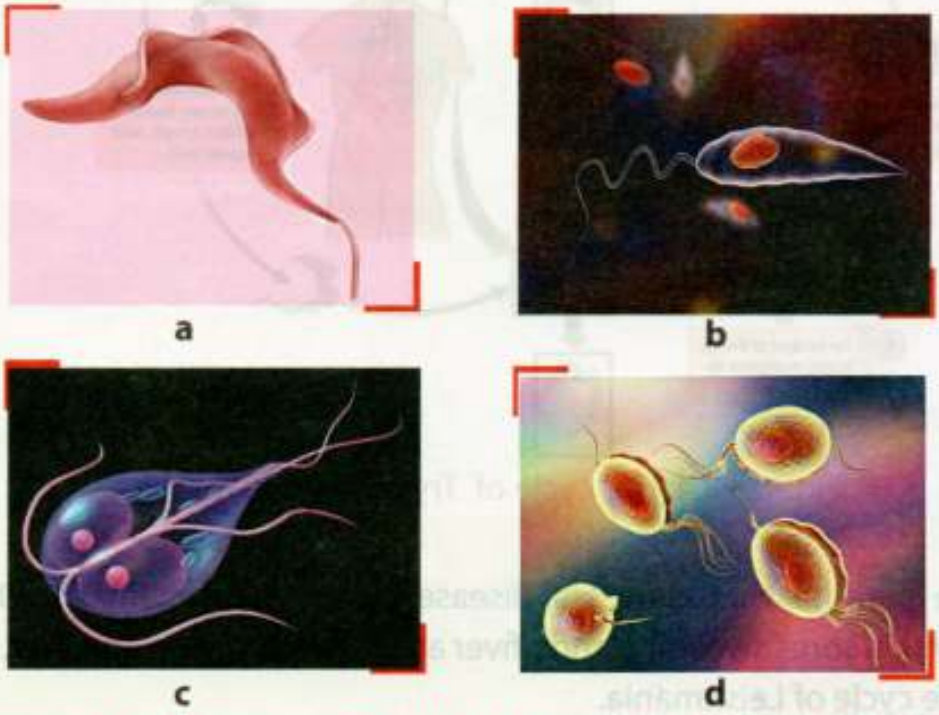
Figures 7.2: a) Radiolarian, b) Foraminifera and c) Ameba.

Question

Discuss methods of transmission of "Entamoeba histolytica" into the human body, the name of the disease it causes, the symptoms and the prevention methods.

3. Phylum mastigophora

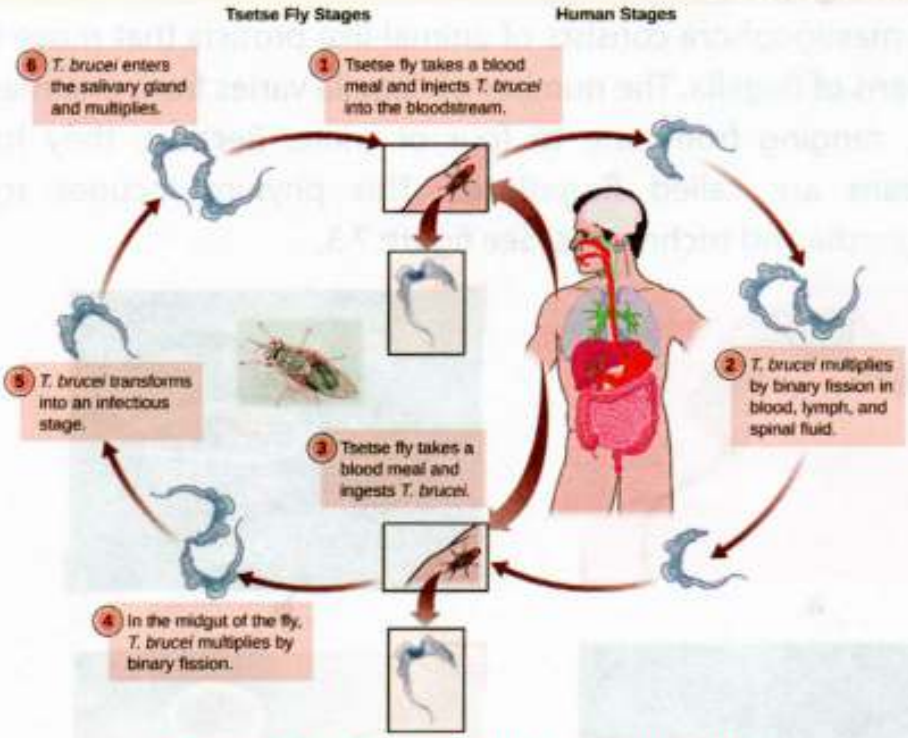
The phylum mastigophora consists of animal-like protists that move through the water by means of flagella. The number of flagella varies from one mastigophoran to the next, ranging from one to four or more. Because they have flagella, mastigophorans are called **flagellates**. This phylum incudes trypanosoma, leishmania, giardia and trichmonas. See figure 7.3.



Figures 7.3: a) Trypanosoma, b) Leishmania, c) Giardia) and d) Trichmonas.

Trypanosomes

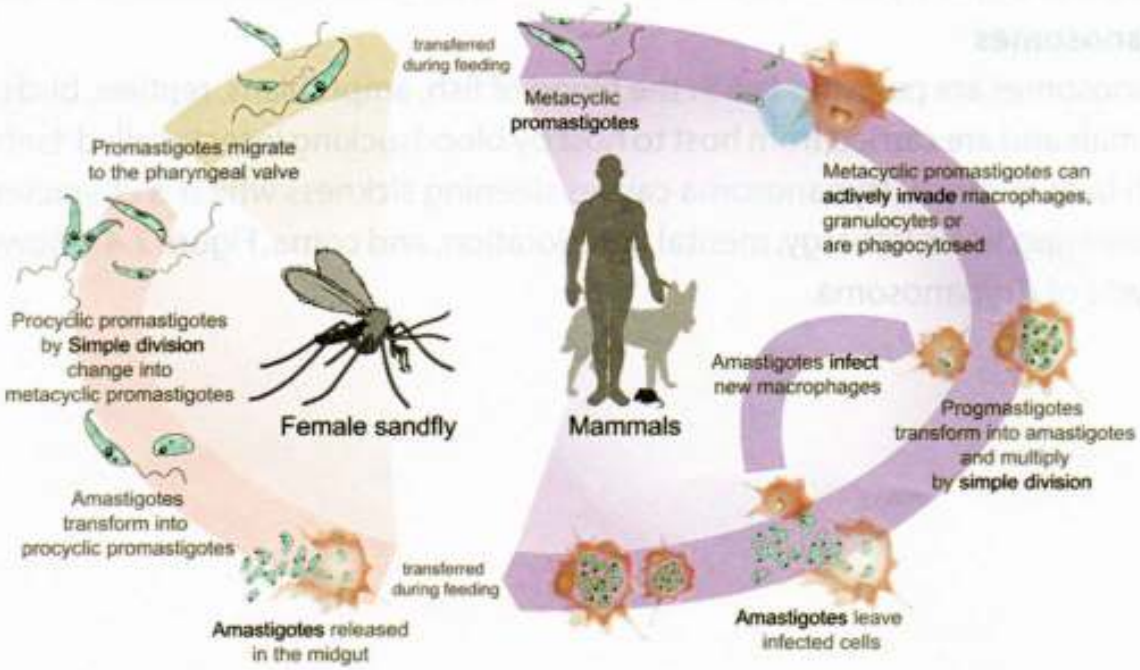
Trypanosomes are parasites live in the blood of fish, amphibians, reptiles, birds, and mammals and are carried from host to host by bloodsucking insects called tsetse fly which lives in Africa. Trypanosoma causes sleeping sickness which is characterized by increasing fever, lethargy, mental deterioration, and coma. Figure 7.4 Shows the life cycle of Trypanosoma.



Figures 7.4: Life cycle of Trypanosoma

Leishmania

Leishmania is a parasite that causes a disease called Leishmaniasis which is characterized by skin sores,swollen glands, fiver and swollen spleen and liver. Figure 7.5 shows the life cycle of Leishmania.



Figures 7.5: Life cycle of Leishmania

Activity 4:

Look the figure 7.5, then answer the following questions

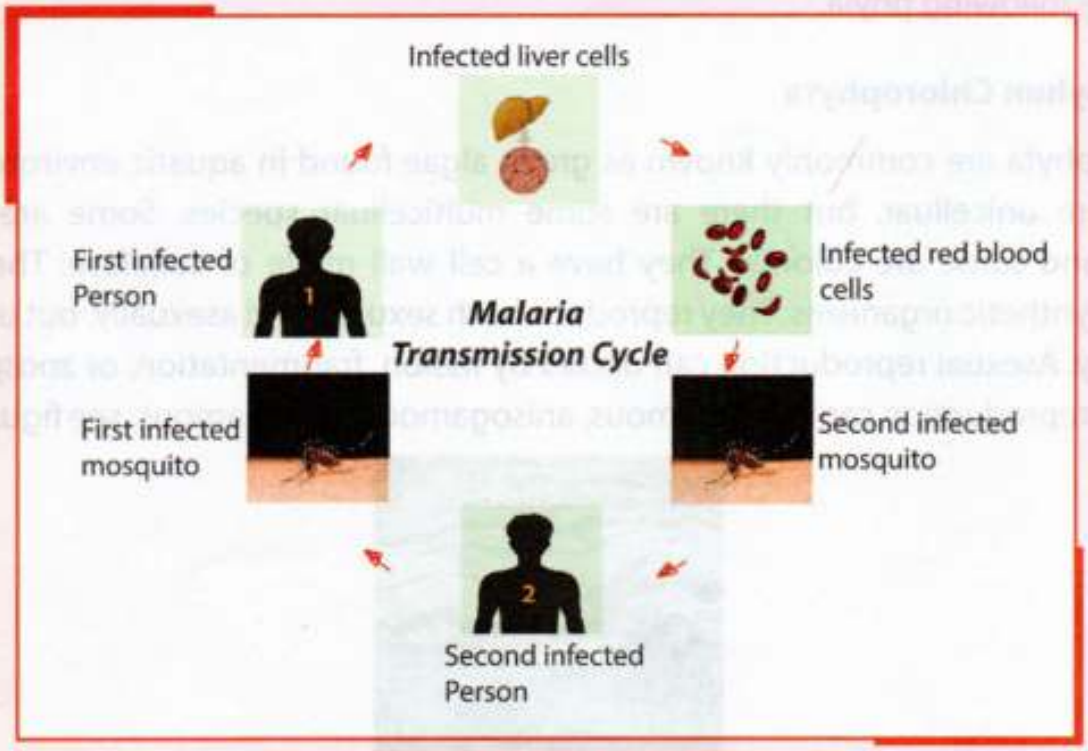
1) How does leishmania transmitte to a health individual?
2) How many hosts deose leishmania require to complete its life cycle?

Reasrch Question:

Name the disease causeb by giardia and trichmonas and describe their symptoms, mode of transmitions and where these diseases spread

4. Phylum Soporozoa

The members of the phylum sporozoa are non-motile, which means that they do not move. All sporozoans are parasites on a wide variety of other organisms, including worms, insects, fish, birds, and humans. Many sporozoans have complex life cycles that involve more than one host. Sporozoans reproduce by means of spores. A typical sporozoan is Plasmodium, which causes the human disease malaria. see figure 7.6



Figures 7.6: Life cycle Plasmodium

Activity 5:

With the help of internet source search the following:

1) How malaria diseas transmits from infected person to health person
2) Signs and symptoms of maleria and methods of prevention
3) The names of the four species of plasmodium

7.3. Plant-like Protists

Plant-like protists, also called algae are a large and diverse group of unicellular or multicellular organisms that have a threadlike shape. The plant-like protists have chlorophyll and are able to photosynthesize like plants .They are considered "simple" because they do not have the distinct organization of higher plants such as leaves and vascular tissue.

Biologists rely on three characteristics to classify them: type of chlorophyll and secondary pigments, type of stored food, and cell wall composition. They include into the following phyla.

1) Phylum Chlorophyta

Chlorophyta are commonly known as green algae found in aquatic environment. They are unicelluar, but there are some multicelluar species. Some are free-living and some are colonial. They have a cell wall made of cellulose. They are photosynthetic organisms. They reproduce both sexually and asexually, but usually sexually. Asexual reproduction can occurs by fission, fragmentation, or zoospores. Sexual reproduction can be isogamous, anisogamous, or oogamous. see figure 7.7.

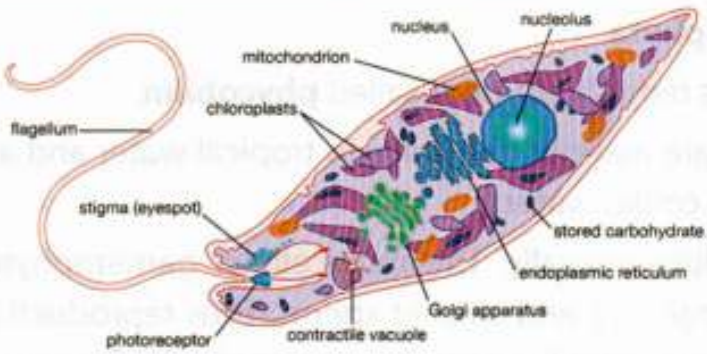
Figures 7.7: green algae

2) **Phylum Euglenophyta**

Euglenophyta is of the smallest phylum of the kingdom Protista.

It is a unicellular aquatic algae. Euglenophyta live in freshwater.

They are motile with the use of flagella. The eugela doesn't have a cell wall, but has a flexible outer layer called a pellicle. They are autotrophic and sometimes heterotrophic when sunlight is absent. **A euglena reproduces asexually by binary fission. See figure 7.8**



Figures 7.8: euglena

Activity 6:

Look at figure 7.8 which represent the euglena cell structure, then answer the following questions

1) What is the name of the organelles that contains the chlorophyll pigment?.
2) How does it respond to sun light?

3. Phylum chrysophyta

Members of the phylum chrysophyta are of three general kinds; yellow-green algae, golden-brown algae, and diatoms. The cell walls of chrysophytes contain the carbohydrate pectin. They reproduce asexually and sexually. Most are solitary, but some form threadlike colonies. Some have flagella and others do not. And some live within cell walls of glasslike due to presence of silicon. Diatoms are photosynthetic and are among the most abundant species in the oceans. see figure 7.9 .

Figures 7.9: Diatoms

4. Phylum Rhodophyta

Rhodophyta contains reddish pigment called **phycobilin**.

Almost all red algae are marines, most live in tropical water and also are common along rocky coasts in colder water.

All red algae reproduce sexually. The multicellular gametophytes produce two types of gametes, large egg and smaller sperm. Thus reproduction is oogamous. Some red algae are important food plants in parts of Asia. Some red algae are used in puddings, preserves and ice-cream.

Red algae are also used to manufacture agar. see figure 7.10

Figures 7.10: red algae

5. Phylum phaeophyta (Brown algae)

Phylum phaeophyta contain a brown pigment called fucoxanthin most brown algae are marine. They are common in coastal areas. Specially in cold water. As in red algae, sexual reproduction is oogamous. see figure 7.11.

Figures 7.11: Brown algae

6. Fungus-like protists

Biologists recognize two groups of funguslike protists: **slime molds** and **water molds**.

Slime molds are typically found on moist, decaying matter. They appear as glistening white, yellow, or red masses of slime. Figure ---

A water mold is a funguslike protist composed of branching filaments of cells. Water molds are found mainly in bodies of fresh water but sometimes live in soil or as parasites. see figure 7.12

Figures 7.12: Slime molds

Importance of protists

1) Plant-like protists produce the oxygen on the planet through photosynthesis.
2) Protists decompose and recycle nutrients that humans need to live.
3) Many protists are also commonly used in medical research. For example, medicines made from protists are used in treatment of high blood pressure, digestion problems, and ulcers.

Question

By using the Internet all biology reference books search for other points on the importance of protists

CHAPTER QUESTIONS

Q1: Circle the letter of the best suitable Answer

1) All protists are

a) Solitary. c) Motile.

b) Colonial. d) Eukaryotic.

2) Which organism causes malaria?

a) Paramecium c) Plasmodium

b) Trypanosoma d) Euglena

3) Short hairlike projections that produce movement in certain protists are:

a) Cilia. c) flagella.

b) pseudopods. d) microtubules,

4) Diatoms belong to the phylum

a) Ciliophora. c) Pyrrophyta.

b) Chrysophyta. d) Myxomycota.

5) Which of the following organisms are not placed in the phylum Sarcodina?

a) amebas c) heliozoans

b) radiolarians d) flagellates

6) A euglena moves by means of:

a) pseudopods. c) spores.

b) cilia. d) flagella.

7) 7. Which organism is not associated with a disease in humans?

a) Trichonympha c) Trypanosoma

b) Entamoeba d) Plasmodium

8) A paramecium excretes excess water through the

a) gullet. c) contractile vacuole.

b) trichocysts. d) micronucleus.

9) Which group of animal like protist captures its food using pseudopods?

a) Zoofalagets c) Ciliates

b) Sporozoans d) Sarcidnes

10) Unlike Algae, Euglen

a) Can be heterotrophic under certain conditions

b) Do not have pigments

c) Can make their own food

d) Can move from place to place

11) A type of unicellular plant-like protist with beautiful glass like cell walls is a

a) Green algae b) Diatoms

c) Water mold d) Ciliate

12) The contractile vacuole is used to

a) Maintenance water balance b) Contract into a ball shaped

c) Control reproduction d) Form a cyst under unfavorable condition

13) Which term best describes this protist?

a) acellular b) multicellular

c) eukaryotic d) prokaryotic

14) Which organism has silica walls?

a) brown alga b) dinofl agellate

c) diatom d) euglenoid

15) Which structure does this organism use for movement? Use the diagram below to answer question.

a) cilia b) contractile vacuole

c) flagella d) pseudopodia

Q1. Are the categories animallike, plantlike, or fungus like useful in classifying protists? Explain your answer.

Q2. Make a table that contains the following information about euglena, amoeba, diatom and plasmodium:

Name of Phylum; Animallike or Plantlike; Means of Locomotion; Relationships with Other Organisms

Q3. Describe the general characteristics of kingdom Protista.

Q4. Classify protists according to their mode of nutrition.

Q5. Identify the diseases caused by some varieties of protists.

Q7. State the importance of protists?

Q8. Differentiate between freshwater algae and marine algae?