Biology

Teacher's Guide

Grade 10

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Contents

INTRODUCTION TO THE TEACHER'S GUIDE

The introduction of the teacher's guide provides relevant information on learning in general and learning Biology atthe secondary level in particular. It includes the following sections

- Basic learning principles
- A shift in learning approaches
- Learning approaches in Biology
- Objectives of secondary level Biology
- Active learning methods in Biology
- Model lesson plan

I. BASIC LEARNING PRINCIPLES

1. **Learning is an active engagement of learners.**
   The learner uses sensory input and constructs meaning out of it. Students learn to learn as they learn. Learning consists both of constructing meaning and constructing systems of meaning.
2. **The crucial action of constructing meaning is mental: it happens in the mind.**
   Physical actions, hands-on experience may be necessary for learning, but it is not sufficient; we need to provide activities that engage the mind as well as the hands.
3. **Learning involves language: the language we use influences learning.**
   On the empirical level.researchers have noted that people talk to themselves as they learn.
4. **Each learner is a unique individual in terms of needs, interests, and abilities.**
   A teacher should recognize and handle the individual difference during the lesson. Individual difference is a good opportunity to learn;It should not be taken as a weakness of the learner
5. **Learning is a social activity**
   Learning is intimately associated with our connection with other human beings, our teachers, our peers, our family as well as casual acquaintances
6. **Learning is contextual:**
   we do not learn isolated facts and theories in some abstract form. We can notseparate what we have in mind from the rest of our lives: we learn in relationship to what else we know, what we believe, our prejudices, and our fears. We cannot divorce our learning from our lives.
7. **One needs the knowledge to learn**
   It is not possible to assimilate new knowledge without having some structure developed from previous knowledge to build on. Therefore any effort to teach must be connected to the state of the learner, must provide a path into the subject for the learner based on that learner's previous knowledge
8. **It takes time to learn:**
   Learning is not instantaneous. For significant learning, we need to revisit ideas, ponder them try them out, play with them and use them. For example, a drawer cannot accomplish this in

the 5-10 minutes it takes to visit him/her in a museum. If you reflect on anything you have learned, you soon realize that it is the product of repeated exposure and thought.

9. **Motivation is a key component in learning.**
   Not only motivation helps to learn, is it essential for learning. It helps the learner to be very much involved in learning and inspired more to learn

II. A SHIFT IN LEARNING APPROACHES

A twofold major shift of emphasis in learning approaches includes

- A major shift of emphasis in terms of the **learning process**.
- A major shift of emphasis in terms of **learning outcome.**

❑ **A shift in the learning process is from**

- depositing knowledge in students to making students construct their knowledge
- learning by listening to multi-sensory learning.
- teacher-centered approaches to student-centered approaches
- transmission - or expository-oriented approaches to discovery- or inquiry-oriented approaches.

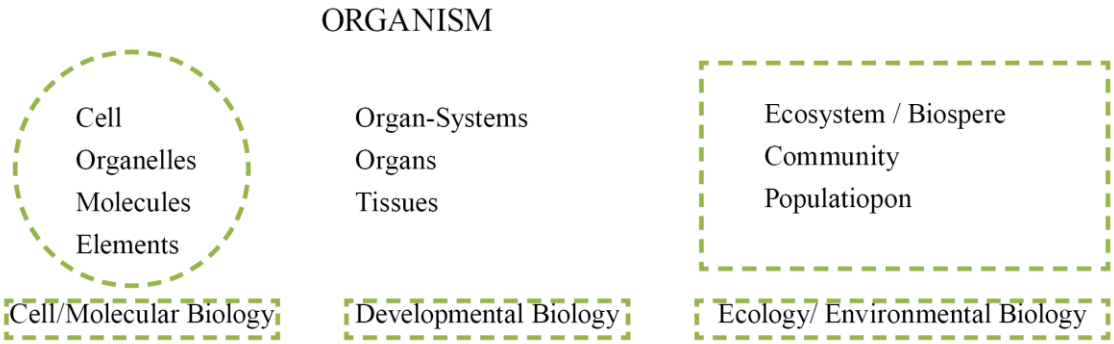
❑ **A shift in learning outcome is, in turn, two-fold**

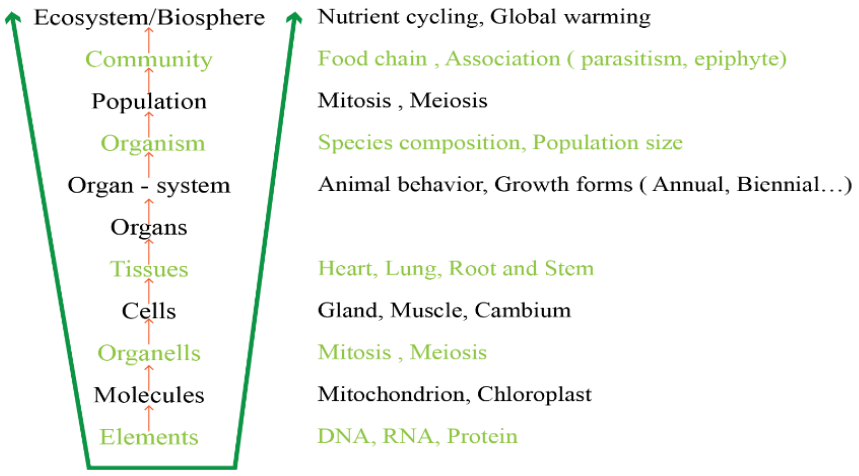
- A shift from over emphasizing the cognitive type of development to giving *equal emphasis* for all the three types of development, i.e., cognitive, psychomotor, and affective.
- A shift is in the *levels* of learning outcomes i.e, from lower levels to higher levels of learning outcomes in all three domains. For instance, under the cognitive domain, emphasis should be given to engaging learners in higher-order thinking tasks such as analysis, synthesis, and evaluation

III.LEARNING APPROACHES IN BIOLOGY

1. Approaching in terms of the level of organization /hierarchy of life

(Increasing complexity in structure and function)





2. Approaching the subject matter of Biology in terms of unifying themes - There are nine Biological unifying themes, with the wider application at a different level in the hierarchy of life. They include:

2.1 Change of living things with time

the characteristics of living thingsare the product of evolutionary processes through time

2.2 Genetic continuity

generations are interlinked by genetic material passed from parents to offspring. This is the perpetuation and avoids extinction of the species.

2.3 Biological roots of behavior

the behavior of the individual not only arises through learning but also innate and inherited from ancestors stored in hereditary material.

2.4 Diversity of type and unity of pattern

although organisms show differences (diversity), there is the unity of pattern (basic similarity) in structure and function.

2.5 Energy, matter, and organization

living things are highly ordered and complex matter, which is ensured through a continuous supply of matter and energy by metabolism.

2.6 Growth, development, and differentiation

2.7 Living things grow, develop and differentiate by a genetic plan and influenced by the environment

2.8 Complementarity of structure and function

the function of any part of an organism is closely related to its structure and from its structure, the function can be inferred.

2.9 Regulation and homeostasis

living things prefer the optimum and have a regulatory mechanism to adjust in the face of changing environment.

2.10 Complementarity of organism and environment

the interaction between organism and environment at all level of organization modifies both the organism and the environment

IV. OBJECTIVES OF THE SECONDARY BIOLOGY

The broad competencies of secondary biology in Ethiopia include:

Knowledge

- Demonstrate an understanding of indigenous knowledge and practices and their relevance in today's world
- Understand the applications of biological knowledge in society and their social, ethical, health, economic and environmental implications;
- Interpret and apply their biological, technological, and environmental knowledge to make decisions about real problems and challenges in the context of their daily lives

Skill

- Analyze and interpret data, graphics, and other forms of information using scientific methodologies to solve biological problems.
- Develop skills such as identification, observation, recording, making predictions, synthesis, analysis, and concluding the identified issue or phenomena of investigation
- Demonstrate life skills and 21 st century skills efficiently and effectively to cope up with problems in their life and contemporary world

Values and attitudes

- Show an interest in the study of biology, appreciate the wonders and complexity of Nature, and show respect for all living things and the environment;
- Stimulate intellectual curiosity, increases awareness of the fragile ecosystem, and stimulates critical thinking
- Recognize their responsibility for conserving, protecting, and maintaining the quality of the environment for future generations; and develop positive values and attitudes and a healthy lifestyle.
- Appreciate and respect for the natural world, its diversity, fragility, and finite nature, especially when harvesting from the environment

Learning outcomes and specific learning objectives for grade 10 Biology are listed at the beginning of each unit, both in the students' text and teacher's guide. They will serve as a checklist concerningthe content, instructional resources, learning methods, and assessment as part of the teaching-learning process.

V. SUGGESTED ACTIVE LEARNING METHODS IN BIOLOGY

Active Learning Methods (ALM)	Description
Gapped/Enhanced lecture	This is a series of short, mini-lectures, punctuated by specific active learning such as mid- lecture brainstorming or active learning events designed to meet lesson objectives.
Group discussion	This is useful to share ideas and expose students to the viewpoints, beliefs, values, and practices of others
Questioning	This is used to increase student engagement and helps to pull information from students by making them focused
Brainstorming	is an activity encouraging students to generate as many ideas as possible. This reveals prior knowledge, misconception, and misunderstanding
Assignment	This is giving specific tasks to students to read, write and find out solutions to problems
Jigsaw	This is cooperative group learning or peer learning that allows each student to participate actively
Modelling	This allows students to use models which can be understood as three-dimensional imitations or copies of real objects. Computerized systems Biology seeks to create and apply efficient algorithms, data structures, visualization, and communication tools in order to computer model biological systems.
Demonstration	Teachers perform activities in front of their students if materials/equipment is inadequate; the procedure is too complex or unsafe/risky. Students observe actively to perform the same when materials are available.
Practical activity	Students perform activities individually or in groups; The teacher should provide activities to students which engage the mind as well as the hands. This should be highly encouraged
Field work	This is outdoor activity exposing students to real-life experiences and problems.
Case study	This is in depth investigation of a particular event, phenomenon or situation, to apply the findings to similar settings.
Debating	This is an organized discussion on a controversial issue
Think –Pair –Share	This involves students in critical thinking first individually, then they exchange and assess their ideas in pairs and finally share summaries to the whole class
Short notes	At an appropriate interval of lecturing, the teacher stops the lecture and ask students to take two or three minutes to write short notes related to the lecture in their own words
Mind mapping	Systematically presenting related ideas as visual representation manner and remember ideas longer.
Interview	This allows students to generate first-hand information from experts or key informants from the relevant subject area

VI. MODEL LESSON PLAN

Lesson Topic: Food chain and food web

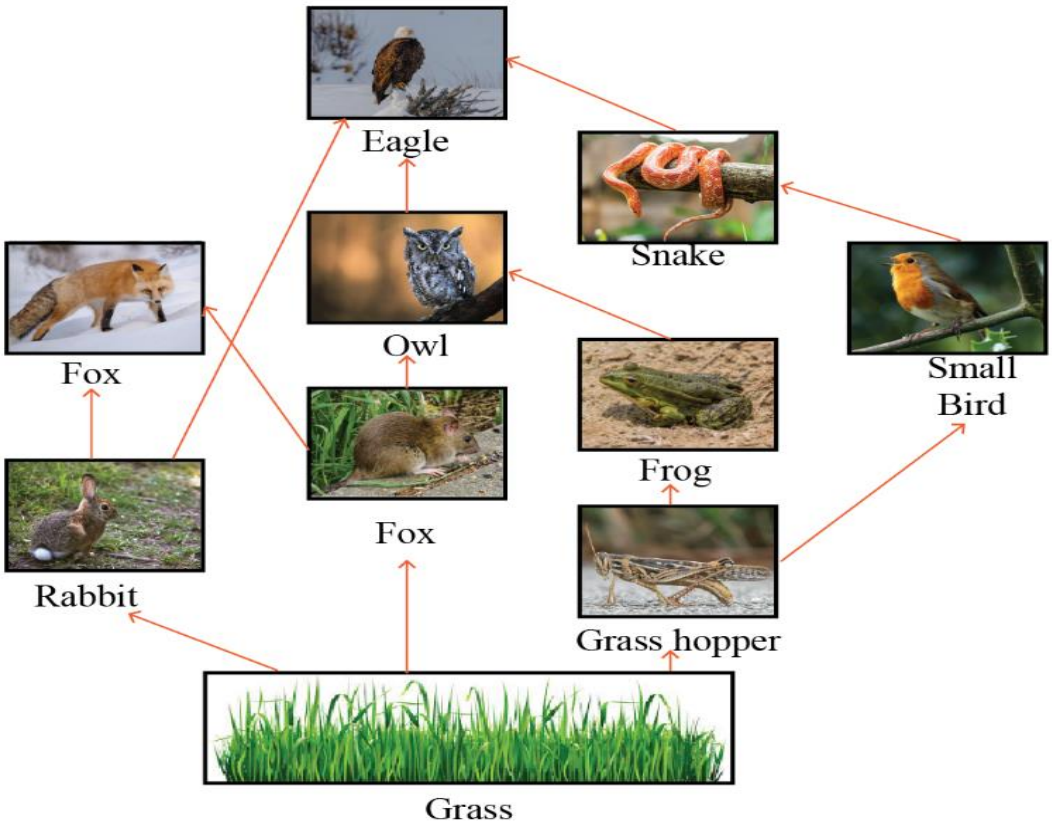
Minimum learning competency (MLC): Ability to identify trophic level, feeding level and construct food chain and food web

Lesson Objectives: At the end of this lesson, students will be able to

- tell the difference between food chain and food web
- arrange organisms in the order of trophic or feeding level
- identify as many food chains as possible from a given food web

Time: 40 minutes

Instructional resources: Diagrams and charts that show food chains and food web
The following diagram of terrestrial (Grass land) food web can be used for the two groups (pair of students) in front and back seats.



Evocation (10 minutes)	Formative continuous assessment	
Teacher's activities	**Students' activities**	
Brainstorm: Ask students what they know about feeding relationships (Who eats what/whom) in their locality Use students' ideas on feeding interaction to introduce the food web diagram and ask them whether they are familiar with the organisms included in the food web	Tell the teacher what they know about feeding relationship Listen to the teachers' introduction and tell them which organisms they are familiar with and which organisms they do not know	Identify students' conception (prior knowledge) and misconceptions through oral questions
Realization (20 minutes)		
Presentation: Use the chart on the food web to show to students that ✓ thefood chain and food web starts with green plants/producers (the grass) followed by herbivores (primary consumers) that eat the grass. ✓ herbivores are eaten by carnivores (secondary consumers). Ask students to name the organisms from the chart ✓ organisms are arranged in the order of receiving energy (trophic level) and eating one another (Feeding level). Ask students to tell the position of a particular organism on second or third trophic level or feeding level Pair two neighbouring students and form two groups, Group I at the front desk and Group 2 at the back desk. Give a brief instruction on what each group perform (Task for the group) Group I: identify as many food chains as possible from the given chart Group II: Select a food chain with three trophic levels and four feeding levels from the given chart Facilitate and assist pair or group discussion After finishing their respective task let the two groups pair (regroup) and share ideas Invite students who accomplished the two tasks effectively for whole-class discussion	Follow the presentation and explanation of the teacher Be a member of nay one of the group and listen to the teacher's instruction Perform the given tasks through pair discussion and cooperative learning as instructed by the teacher within 8 to 10 minutes Ask for assistance as they encounter difficulties Two groups share ideas and take note of what they discussed Accept teacher's invitation to share ideas In the whole class discussion	Ask students to give examples of herbivores and carnivores from the food web Ask students the order of food or energy transfer in the given food web Follow the participation of the individual student in a group by moving around the groups Conduct peer assessment by exchanging/sharing results Comment and give feedback to the whole class discussion

Reflection (10 minutes		
Stabilisation: ▪ Use the chart and summarize what food chain and food web are , ▪ how trophic and feeding levels can be specified ▪ Respond to questions from students Checking and Evaluation ▪ Ask questions related to the objective Eg: What is the similarity and difference between food chain and food web; between feeding level and trophic level?	Pay attention to teacher's summary and take summary notes Respond to questions forwarded to them	

VII. ORGANIZATION OF UNITS IN THE TEACHER'S GUIDE

Units of the teacher's guide contain the following sections

- Learning competencies
- Specific learning objectives
- Learning strategies
- Suggested active learning methods
- Suggested formative continuous assessment
- Feed back to activities
- Answer to review question

Unit 1: Sub-fields of Biology

Contents	Learning Competency
1.1. Sub-fields of biology 1.2. Pure and applied fields of biology 1.3. Major discoveries in Biology 1.4. The contributions of biological discoveries to society and the environment (e.g. microscope, penicillin, inheritance, etc.) 1.5. Major discoveries by Ethiopian Biologists (e.g. Aklilu Lemma, Gabissa Ejeta)	At the end of this unit, the student will be able to: • list the Sub-fields of biology • classify the different Sub-fields of Biology into pure and applied • discuss at least five major discoveries that revolutionized Biology • appreciate the contribution of biological discoveries to society/environment e.g. microscope, penicillin, inheritance, etc. • appreciate Ethiopian scientists and their discoveries

1.1 Subfields of biology

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- list sub-fields of biology
- define sub-fields of biology

Learning strategies

Start the lesson by asking the following question;

Which sub-fields of Biology do you know?

Students may respond to this question by naming various branches of biology, their definitions and applications, and so on. Their replies could be correct, but with some misunderstandings or even erroneous. As a result, the teacher should direct students to the proper answers and rectify what they missed using what is given in the textbook and reading further.

Students are expected to study several fields of biology in this subsection. Define them and provide as many examples as possible. The teacher will assist and motivate them as they participate in the activities, group and individual studies outlined in the textbook. Some key fields are described here for the teacher. Furthermore, the instructor is required to read more and assist his or her students' learning.

Hints for teaching

Biology is widely described as the study of living organisms and the vital processes that take place within and around them, including the molecular and chemical processes that keep these species alive. Biology is the study of human, animal, plant, fungus, and microbe evolution and development, as well as their interactions with their surroundings. These categories contain a plethora of specialized sub-fields, and new disciplines emerge regularly.

Every living thing consists of at least one cell, which is composed of molecules. Biochemistry and molecular genetics are two fields of biology that study the molecules found within cells and how they work. A biochemist investigates the structure and reactivity of specific molecules, whereas a molecular geneticist investigates how chemicals such as deoxyribonucleic acid, or DNA, influence inheritance. Cellular biologists are scientists who examine the cell as a whole. Tissues arise when cells collaborate inside a larger organism. Histologists are tissue scientists that analyze the distinctions between different types of tissue using a microscope.

Whole-organism biologists span from those who research microscopic bacteria to those who study trees or elephants. Microbiology studies organisms that are too small to view with the naked eye, whereas zoology studies all animals. Mammology, ornithology, and ichthyology are zoology subfields that study mammals, birds, and fish, in that order. Some biologists, known as botanists, specialize in plants. People who research fungi are known as mycologists.

Ecology, environmental science, and engineering are all biological fields that investigate how organisms interact with their surroundings. Limnologists study lakes and rivers, whereas oceanologists research the ocean. Conservation biologists investigate how humans impact the environment and how to best maintain and protect it. There are even scientists in the United States who study environmental policy and aid government officials in developing and implementing environmental legislation.

Biotechnology and synthetic biology are two of biology's more recent and developing topics. The International Genetically Engineered Machine Foundation defines synthetic biology as "the design and fabrication of novel biological parts, devices, and systems for beneficial purposes." Biotechnology is a branch of biology concerned with the sequencing, modification, and engineering of DNA. They are also referred to as biomedical engineers.

Suggested Active Learning Methods:

Brainstorming, think-pair-share, question and answer

Suggested Formative Continuous Assessment:

- Written/verbal test, homework, observation, and reflections.
- Assess students' prior knowledge, their misconception, and misunderstanding about the sub-fields of Biology
- Ask students how we can divide biology into different fields of study
- Ask questions during your teaching-learning processes

Feedback to Activity 1.1 THINK-PAIR-SHARE

Make a group of three students and write down the names of organisms you know that would be categorized under the three major divisions of Biology. Share what you have written with other group and compare with yours.

After this activity students may come up with a different list of organisms. Now, let them group them under the three major subdivisions of Biology and discuss among themselves whether their divisions are correct or not, and finally, the teacher should help them to correctly put the organisms to their respective fields.

Feedback to Activity1.2

The goal of this activity is to assist pupils in studying microorganisms of various varieties on their own. Allow children to draw and label common microorganisms mentioned in the activity. In addition, the teacher could ask his or her students to write out the essential characteristics of each typical bacterium.

Do you know how different branches of biology are related to the structure we study?

Let the students explore the fact that different branches of biology are related to the type and structure they study. Request the students to give examples and fill the gap.

What other branches of biology do you know?

As has been briefly mentioned above, there are other branches of biology. Encourage students to use the internet, books, and other sources to identify as many. Fields of Biology as they can, and then fill in the gaps that they may miss.

Do you have any idea about the relationship between biology and other sciences?

Request the students to mention fields of biology that are related to other sciences. Here the students can mention chemistry, physics, etc. Besides, they can mention biophysics, biochemistry, biogeography, etc that show close interrelationship between biology and other science

Feedback to Activity 1.3

Aside from the knowledge gained from the activities and answers to the questions above about the various fields of biology, they should also understand the relationship of biology to other sciences such as chemistry, physics, and so on. As a result, encourage the students to use the internet, books, and other resources to find an answer to this question.

As a strategy for completing Activity 1.3, let the teacher form a group of 2-4 students and ask them to investigate the relationship between Biology and other sciences. Allow them to present to their classmates what they have learned from books, the internet, and other resources.

Some of the connections between biology and other sciences are listed below for your consideration.

The interrelationships between biology and other scientific disciplines are undeniable. Every branch of science is related to every other branch of science in some way. Finally, Biology was centred on the morphology of living things and their classifications based on similarities and differences in their characteristics. Biology has now taken our understanding of living things to the molecular level. Biology research confirms that living organisms are made up of molecules, atoms, and organic macromolecules. It also justifies the fact that life processes occur within the body of a living thing as a result of particle interactions.

Why does biology rely on other disciplines of physical sciences to gain knowledge?

i. All living organisms contain organic and inorganic substances or compounds that dissolve in water, and these inorganic substances or mixtures exist in the bodies of living things as ions. These ions have an impact on the living organisms' life processes and internal environment.
ii. The capillarity and surface tension formed by water as a result of adhesion and cohesion force is beneficial in certain life processes of living things.
iii. The acid-base equilibrium maintains a specific pH for a living organism to survive in various environments due to their various biochemical reactions.
iv. The processes of osmosis and diffusion allow molecules and atoms to move.
v. Biology and Chemistry: The study of matter and its composition is known as chemistry. It aids in our understanding of the reactions that occur during various processes in our human body. Chemistry has aided biologists in describing metabolic processes in our bodies such as digestion, and breathing..
vi. Biology and Mathematics: Biology employs mathematical rules to process, analyze, and present experimental research on a wide range of phenomena in living organisms.
vii. Biology and History: Biology employs historical knowledge to date the evolution of species. History is also an important subject that biologists use to create specific species based on seasons and historical eras.
viii. Biology and Geography: Biology applies Geography knowledge to explain the Earth's elements, which are essential when studying the evolution, structure, and origin of our planet.

1.2 Pure and applied fields of biology

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- classify the different sub-fields of Biology into pure and applied
- define each subfield of Biology

Learning strategies

Before discussion on pure and applied fields of biology ask the students to answer the following question.

What do we mean by pure and applied of biology?

Further, request the students to search for different sub-fields of Biology using any sources and further made to classify them based on either pure or applied sub-fields. Give them chances to choose their field of future careers. Emphasis is made to develop thinking, exploit students' prior knowledge and personal meaning, wording and use common sense knowledge rather than strict adherence to standard definition

Then the teacher recommends the students the parts written in the textbook: The words pure and applied sciences are used to refer to all sciences. These are colloquial phrases used to differentiate between work on fundamental findings in a science known as "pure" and work on applications of what is known as applied science.

A pure area of biology, for example, is the study of the structure of a plant or animal (anatomy and morphology), whereas applied biology is the application of what we know about the anatomy and physiology of organisms to treat their malfunctioning as a result of infectious illness. Based on this background information, ask the students to answer the textbook questions and complete the tasks.

Suggested Active Learning Methods:

Brainstorming, Think – Pair - Share, Mind mapping

Suggested Formative Assessment:

- Written/verbal test, homework, observation, presentation, and reflections.
- Assess students' prior knowledge, their misconception, and misunderstanding about the pure and applied fields of Biology
- Ask students how we can divide biology into pure and applied areas
- Ask questions during your teaching-learning processes

Feedback to Activity 1.4

Fields of Biology		Pure Biology (A)	Applied Biology (B)
Agriculture	Biotechnology	Morphology	Agriculture
Morphology	Molecular Biology	Taxonomy	Horticulture
Taxonomy	Evolution	Cytology	Poultry
Horticulture Cytology	Pathology	Embryology	Agroforestry
Embryology	Physiology	Histology	Apiculture
Histology	Forestry	Molecular Biology	Animal husbandry
Poultry	Pharmacognosy	Evolution	Biotechnology
Agroforestry	Pisciculture	Pathology	Forestry
Apiculture	Paleontology	Physiology	Pharmacognosy
Animal husbandry	Bacteriology	Paleontology	Pisciculture
	Entomology	Bacteriology	Sericulture
	Sericulture	Entomology	
	Agroforestry		

Description to terminologies

When students complete activity 1.4, they may struggle to understand the meaning and descriptions of some terminologies. As a result, definitions and descriptions of some of these terminologies are provided here. You may assist the students further by giving them with this and other information in their study.

Terminologies	Definition/description
Apiculture	The keeping of bees especially on a large scale
Pisciculture	Pisciculture is the branch of animal husbandry concerned with the cultivation of fish or sea animals. The creatures are kept in a controlled aquatic environment to do this. It assists in the quick production of disease-free fish.
Sericulture	In simple terms, sericulture is the process of an insect producing silk. Sericulture is the commercial production of silk from silkworms through rearing practices on a large scale. Sericulture is a type of agriculture. It entails raising silkworms for the purpose of producing raw silk, which is a yarn made from cocoons spun by particular insect species. Sericulture's main tasks include growing food plants to feed silkworms that spin silk cocoons and reeling the cocoons to unwind the silk thread for value-added applications like processing and weaving.

Horticulture	Horticulture is the science and art of growing, producing, marketing, and using high-value, highly grown food and ornamental plants. Annual and perennial species, fruits and vegetables, attractive indoor plants, and landscape plants are all examples of horticultural crops.
Agroforestry	Agroforestry is the deliberate incorporation of trees and shrubs into crop and animal production systems in order to generate environmental, economic, and social benefits. For generations, it has been practised in Ethiopia (e.g., smallholder farms of Gedeo, Sidama, and others) and around the world.
Pharmacognosy	The study of medical drugs obtained from plants, animals, and microbes

Feedback to Activity 1.5 THINK-PAIR-SHARE

Ask the students to pair and take at least 3 subfields of Biology (pure and applied) and think of their interrelationship with other sciences. Finally, let them share their ideas. These will help the students to discover the horizontal and vertical relationships of biology with other disciplines such as, for instance, biology, and technology, genetics and engineering, etc. Some examples are given in the student text. Students can find out some more.

1.3 Major discoveries that revolutionized Biology

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- discuss at least 5 major discoveries that revolutionized biology

Learning strategies

For motivation and appreciation, students are introduced to the various educational goals of the history of biology. Form groups and assign them the task of compiling a list of major biological discoveries, explaining how these discoveries impacted biology as a discipline, and presenting it to the class. The teacher will assign each student to a different discovery and then ask them to form groups to argue why their discovery is the most important.

Group discussion before the lesson

In this activity, students will learn about the major discoveries that revolutionized biological studies. Beginning with the earliest discoveries, students can progress to the most recent modern discoveries, which used complex methods of study and instruments such as the electron microscope. Allow groups of 4-5 students to write down at least 5 discoveries (modern and ancient) that revolutionized the world and present them to their classmates as a warm-up activity before moving on to activity 1.6.

Hints:
Since its start, biology appears to have progressed through a succession of stages, culminating in contemporary biology, which is characterized by an extraordinary level of sophistication as a result of countless scientific discoveries made over the last 200 years.

This tremendous growth of biology has resulted in the emergence of new disciplines, and discoveries in DNA, evolution, cell biology and biotechnology are thought to be the primary drivers of scientific advancement, particularly in biological systems. However, it is worth emphasizing that the pace of scientific discoveries has accelerated dramatically since the mid-twentieth century, and it has advanced significantly, resulting in a huge breakthrough in agricultural output, industrial biochemistry, health, and medicine.

It's also worth noting that several of the discoveries achieved since the 1950s paved the way for more sophisticated discoveries like genetic engineering, vaccine development, and environmental control. The majority of the most astounding discoveries that have contributed significantly to the advancement of modern biology are based on cell biology. For example, when McLeod, Avery, and McCarty established in 1944 that DNA controlled hereditary effects in organisms, the genetic recombination process was proven in 1946. Later, in 1953, Watson and Crick created the helical structure of DNA, which was followed in 1958 by Lederberg's discovery of plasmids.

These discoveries have resulted in important improvements in biology, particularly in genetic engineering, which appears to be acquiring extraordinary popularity in the current world. Because scientific discoveries have a big impact on human life, it is considered that modern biology has a significant social impact on modern living. "As our understanding of biological processes, such as inheritance, grows, so do the potential of utilizing these insights for good and ill, such as disease treatment, age management, behavior, and genetic engineering," writes Watson (2011).

Suggested Active Learning Methods:
Gapped /enhanced lecture, Group Discussion

Suggested Formative Continuous Assessment

- Written/verbal test, homework, observation, presentation, and reflections.
- monitoring group discussion and cooperative learning
- give students quick and relevant feedback
- peer assessment and reflection on group work

Feedback to Activity 1.6
Form groups of two students and ask them to create a list of at least ten other biological discoveries, which they should then present to their classmates. Then, ask them to consider how they feel about the discoveries and whether they have any plans to conduct scientific investigations that could lead to a discovery. Encourage them to read and learn about other scientific contributions that have altered the course of history.

1.4 The contributions of biological discoveries to society and the environment

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- appreciate the contribution of biological discoveries to society/environment e.g. microscope, penicillin, inheritance, etc.

Learning strategies

Section 1.3 taught students about biological discoveries that changed the world. The purpose of this section is to encourage students to keep reading and to recognize the contributions of biological discoveries to society and the environment. Throughout the long history of biology, there have been countless notable discoveries. Biology is one of the favorite fields because of advances in the beginnings of life, the mechanisms of life, treatments, new (and some rediscovered) ailments, and a variety of other intriguing topics. While almost all scientific discoveries help us comprehend a little bit more about this wonderful world we live in, certain discoveries help us discover even more. The following are 15 scientific advances that have allowed scientists to obtain a deeper knowledge of life, the cosmos, and everything. The teacher might further read about each of the 15 findings to help his students studying better.

Inheritance/Evolution (the 1800s)
Antibiotics (1928)
Gel Electrophoresis (1931)
HeLa cell Discovery (1951)
The structure of DNA (1952-1953)
DNA polymerase (1956)
Reverse transcriptase (1970)
Restriction enzymes (1970)
E. coli transformation (1970)
PCR (1983)
Bioluminescent markers (1986)
Gene Therapy (1990)
Fluorescent protein markers (1992)
RNAi (1998)
CRISPR-Cas9 (2012)

Suggested Active Learning Methods:

Brainstorming, gapped/enhanced lecture, questioning & answering

Suggested Formative Continuous Assessment:

- Written/verbal test, homework, observation, presentation, reflections
- Assess students' prior knowledge, their misconception, and misunderstanding about the scientific discoveries and their contribution to society and the environment
- Ask students their feeling about the biological discoveries and their interest
- Raise oral questions on some basic discoveries that they have studied previously.

Feedback to Activity 1.7

After the students come up with their list of discoveries in medicine and their importance to human wellbeing, you can conduct a shot-minute discussion with the whole classroom. Finally, correct points the students may miss while writing the list and during discussion**.**

Feedback to Activity 1.8

Type of discovery	Who discovered and year of discovery	Benefits
The Circulatory System	1242 by the physician **Ibn al-Nafis**, and first brought to prominence in **1628 by William Harvey**.	A far better understanding of the human body in general and to many of the treatments and techniques we now take for granted
Vaccination	Jenner' France, 1799	only thanks to vaccinations that we have managed to stop the spread of many epidemics and even completely eradicate some of the world's most deadly diseases
Cell theory	Theodor Schwann and Matthias Schleiden, 1838	It helps us in biology because cells form the basis of all life. We can have unicellular organisms, like bacteria, like yeasts. The division of a cell from one, to two, to four, forms the basis of the growth and development of all living things.
DNA	Swiss physician FrieDr.ichMiescher in 1860/70	This has led to a much better understanding of a range of diseases and illnesses but is likely to lead to many more discoveries in the future as gene therapy becomes more widely used. Of course, the discovery of DNA has also lead to many important discussions on the nature of humanity and our role in our evolution
Germ Theory	Louis Pasteur's Louis Pasteur, 1861	shed light on the causes of diseases and lead to many of the hygiene practices we now take for granted.
X-Ray	Conrad Rontgen in 1895	Before x-rays repairing broken bones and identifying the cause of many other problems would have been hugely more difficult and has played a role in colouring our understanding of the human body even further

Vitamins	Frederick Hopkins The 1900s	Led to a far better understanding of nutrients and helped to prevent many illnesses and conditions that resulted from deficiencies.
Insulin	Frederick Banting, 1920	Diabetic patients manage to live normal and full lives which have affected the lives of millions of people around the world.
Penicillin – in 1928	Discovered by Alexander Fleming, 1928	Was the big 'game changer' for modern medicine. Essentially the discovery of penicillin is responsible for the development of all the antibiotics that we use today to combat bacteria.
Aesthetic	Sigmund Freud and Karl Koller 1st clinical use in 1884; Albert Niemann extracted from leaves of Coca in 1860	If you ever had to have an operation without any form of aesthetic then you would likely have a whole new appreciation for just how important this discovery was.
HIV	Robert Gallo and Luc Montagnier The 1980s	to a greater awareness of the dangers of unprotected sex

Feedback to Activity 1.9

Application of genetic discoveries in agriculture:
The current tools for investigating the structure and operation of the plant genome have given us a much better understanding of plant development and function than we had previously. We know about key genetic controls that repress or stimulate gene expression cascades that move a plant through stages in its life cycle, allowing for the morphogenesis of vegetative and reproductive tissues and organs. The new technologies allow for the identification of key gene activity responses to a variety of biotic and abiotic challenges that plants face.

Plant breeders used to produce new varieties with changes in developmental phases, changes in plant architecture, and improved levels of tolerance and resistance to environmental and biotic challenges by identifying the required phenotypes in a few plants among a large number of plants in a breeding population. Our increased understanding and powerful gene sequence-based diagnostics now provide plant breeders with more precise selection objectives and assays to use in rationally planned crop improvement programs. We can expect yield potential to rise and harvested product quality portfolios to better meet the growing diversity of market demands. The new genetics will link agriculture to industries other than food, feed, and fiber; agri-business will contribute to public health by providing high-value products to the pharmaceutical industry as well as industries previously reliant on petroleum feedstocks and chemical modification processes.

Application of genetic discoveries in Medicine:

A medical geneticist is a physician who works as part of a clinical team that includes other physicians, nurses, and genetic counsellors to evaluate patients and their relatives for possible hereditary diseases. They assess risk and possible modes of inheritance indicate diagnostic testing; manage prevention, treatment, and surveillance; and participate in communicating with other family members at risk for the disorder.

Improvements in all areas of medicine, particularly public health and therapeutics, have resulted in the modification of disease patterns and a better understanding of the role of genetic factors in most common disorders and even susceptibility to infectious diseases.

Application of genetic discoveries in Biological diversity:

The significance of plant and animal genetic diversity is now being recognized as a distinct area, as rising population with urbanization and shrinking cultivable lands are critical factors contributing to food insecurity in the developing world. Agricultural scientists discovered that plant and animal genetic diversity can be captured and stored in the form of plant and animal genetic diversity genetic resources such as gene banks, DNA libraries, and so on, in a biorepository that preserves genetic material for a long period of time. Conserved plant genetic diversity, for example, must be used for crop improvement in order to meet future global food and nutritional security challenges. As a result, it must consider four critical areas: (i) the importance of plant genetic diversity (PGD) and PGR, particularly on agriculturally important crops (mostly field crops); (ii) the risk associated with narrowing the genetic base of current commercial cultivars and climate change; (iii) an analysis of existing PGD analytical methods in the genomic and genomic era; and (iv) modern tools available. This point will be studied as a baseline for the plant scientist community to use new methods and technology for better and faster assessment, as well as for utilizing germplasm from gene banks in their applied breeding programs.

With the introduction of new biotechnological techniques, this process of genetic manipulation is now being accelerated and carried out with greater precision (while ignoring environmental effects) and speed than traditional breeding techniques. It is also worth noting that gene banks investigate a variety of issues in order to improve levels of germplasm distribution and utilization, plant identity duplication, and access to the database for breeding activities. Because plant breeding research and cultivar development are essential components of improving food production, the availability and accessibility to diverse genetic sources will ensure that the global food production network becomes more sustainable.

Application of genetic discoveries in immunity:

Immune responses to infectious disease agents are known to be influenced by both genetic and nongenetic factors in terms of magnitude and breadth. The discovery and validation of genetic determinants in hosts and pathogens is critical for better understanding the basis of infectious disease

susceptibility and control. The interaction of these conjoined yet opposing multiple, varying factors produces an impressive dynamic phenotypic diversity in hosts. The precise mechanisms underlying observed inter-individual variation in control of, resistance to, and/or susceptibility to infectious diseases remain unknown. This special issue includes three original research papers and five reviews aimed at stimulating future research efforts into medical and veterinary applications of genetic variation with well-defined genetic roles in host immune response and susceptibility to infectious diseases. Overall, population genetics on candidate genes has dominated this field of study through small-scale inter-individual susceptibility association studies. Inter-individual variation is caused in part by risk-modifying polymorphisms (rare and common) in agonist and antagonist genes of the innate and adaptive immune responses. Some host gene variants have a strong association with disease control or susceptibility to infectious agents or disease progression. According to the outlook, both small-scale replication and genomewide association studies (GWAS) will benefit the field, first by validating the statistical strength of observed associations in different population backgrounds, and secondly by discovering significant associations with newly investigated variants with translational potential into practical tests.

Application of genetic discoveries in inheritance:

Since 2004, the European Society of Human Genetics and the European Society for Human Reproduction and Embryology have collaborated to assess the impact of rapid research advances at the interface of assisted reproduction and genetics, including their application in clinical practice. The expert panel met for the third time in September 2016. The topics covered included the effects of expanded carrier screening, direct-to-consumer genetic testing, advanced genetic testing voiding the presumed anonymity of gamete donors, advances in the research of genetic causes of male and female infertility, the use of massively parallel sequencing in preimplantation genetic testing, and non-invasive preimplantation genetic testing.

1.5 Ethiopian biologists and their contributions

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- appreciate major discoveries contributed by Ethiopian scientists
- discuss the importance of discoveries contributed by Ethiopian scientists to human beings

Learning Strategies

Made individualized independent study, discuss in groups and appreciate the works and contributions of Yalemtsehay Wodajo, Aklilu Lemma, and Gabissa Ejeta. Form groups ask them to use existing literature to come up with the lists of major contributions of Ethiopian biologists to the development of Biological sciences and the society at large. The teacher will assign each student to a different contributor and then ask them to form a group to argue the case for their contribution being most

significant. Students are introduced to the various educational aims of the history of biology-motivation, appreciation.

In this section let the students perform activity 1.10 and present it to the classroom. You can help them in the process of collection of information and biographies of the scientists that contributed to Ethiopian biological science and the community at large. Finally, you can form a forum for the whole classroom discussion.

Suggested Active Learning Methods:
Brainstorming, gapped/enhanced lecture

Suggested Formative Continuous Assessment:

- Written/verbal test, homework, observation, presentation, and reflections.
- Assess students' prior knowledge, their misconception, and misunderstanding about the discoveries of Ethiopian scientists
- Ask students their feeling about the Ethiopian biological discoveries and their interest
- Raise oral questions on some basic Ethiopian discoveries that they have studied previously.

Feedback to Activity 1.10

Let the teacher request the students to fill-in the right column of the table 1.6 in the textbook, with appropriate contributions of the Ethiopian biologists mentioned in the left column. Encourage the students to use internet resources, personal interviews with the mentioned biologists and gathering information from people accustomed with their activities.

ANSWERS TO REVIEW QUESTIONS

I. True-False Items

1. F
2. T
3. F
4. F
5. T
6. F

II. Matching items

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

III. Multiple Choice Item

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

II. Short answer items

1. How biology and chemistry are interrelated in biochemistry?
   Biochemistry is a discipline of science that investigates the chemical processes that occur within and are related to living organisms. It is a laboratory science that combines biology and chemistry. Biochemists can comprehend and address biological problems by applying

chemical knowledge and procedures. Biochemistry is concerned with processes that occur at the molecular level. It investigates what happens inside our cells, researching components such as proteins, lipids, and organelles. It also investigates how cells communicate with one another, such as during growth or when Figurehting illness. Biochemists must understand how a molecule's structure relates to its function in order to predict how molecules will interact.

2. Discuss the role of genetic discoveries in agricultural development.
   Since World War II, the application of genetics to agriculture has led in significant improvements in the production of several crops. This has been especially noticeable in hybrid maize and grain sorghum strains. Simultaneously, crossbreeding has resulted in significantly more productive wheat and rice cultivars.

3. How biological studies help human to keep healthy life?
   Biology has an impact on our daily lives since it is linked to our basic needs for food, clothing, fuel, and many other things that enable us live healthy lifestyles. It teaches proper fitness, personal hygiene, nutrition, and disease prevention, among other things.

4. What are the major discoveries of Louis Pasteur?
   Louis Pasteur (1822-1895) was a brilliant scientist who heralded a new age in medicine and biology. Beginning with investigations on crystals of by-products of wine fermentation, he first recognised a separate chemistry between dead and live matter. He then demonstrated the role of living bacteria in the fermentation and putrefaction processes. This prompted him to use exceptionally well-designed experiments to dispute the two-millennium-old idea of spontaneous creation. His studies on silkworm epidemics enabled him to illustrate the function of particular germs in infectious diseases. His discovery of a vaccine against poultry cholera is regarded as the beginning of immunology. Finally, his famed immunizations against anthrax and rabies helped him earn worldwide recognition.

5. How does biology and physics interrelation form a study termed biophysics?

   Biophysics is a branch of physics that studies biological systems using physics ideas and methodologies. Biophysics, in general, attempts to explain many of the same phenomena as biochemistry and molecular biology, but does it numerically, by developing equations that can describe what is observed. Some of these observations can also be explained using physics technologies, such as spectroscopy, x-ray crystallography, scattering effects, and the use of electron microscopes. All of these tools are common in physics research but are less common in the life sciences. Understandings of statistical mechanics and thermodynamics from physics can be applied to biophysics to better understand biological systems.

Unit 2: Plants 23 periods

Contents	Learning Competency
2.1. Characteristics of plants 2.2. Non-flowering and flowering plants 2.3. Structure and function of plant parts 2.4. Reproduction in plants 2.4.1. Non-flowering 2.4.2. Flowering 2.4.3. Pollination 2.5. Seeds (monocots, dicots) 2.6. Seed Dispersal and Germination 2.7. Photosynthesis 2.8. Transport in plants 2.9. Response in plants 2.10. Medicinal plants 2.11. Renowned Botanists in Ethiopia	At the end of this unit, the student will be able to: ▪ explain the characteristics of plants ▪ differentiate between flowering and non-flowering plants ▪ draw and label the internal and external structure of angiosperms ▪ draw and label the floral parts ▪ list different types of agents of pollination ▪ draw and label the reproductive cycles of flowering and non-flowering plants using typical examples ▪ infer seed dispersal mechanisms by looking at the nature of seeds ▪ discuss the process and mechanisms of photosynthesis ▪ experiment on germination of dicot and monocot seeds ▪ discuss the mechanism of water, mineral, and organic molecules transport in plants and its implication on agricultural productivity ▪ conduct experiments to demonstrate plant responses (geotropism, hydrotropism, phototropism) ▪ investigate medicinal plants used by the local people to treat different ailments ▪ appreciate the works of Ethiopian Botanists

2.1 Characteristics of plants

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- list down major characteristics of plants
- tell characteristics that plants share with other living things
- recognize plants as living things

Learning strategies

In order to understand characteristics of plants , it may be worthwhile to start with defining life and then list down the characteristics of living things dealt in grade 9 biology under unit two (cross refer to content 2.1 and 2.2). As brainstorming activity, let students say anything about life and characteristics of life and proceed to plants as living things. Using "Think – Pair - Share" technique

let students reflect about characteristics of plants. The teacher may ask them to distinguish plant characteristics which they share with other living things and characteristics that are unique to plants.

Suggested Active Learning Methods:
Brain storming, gapped/enhanced lecture, Questioning

Suggested Formative Assessment:

- Assessing students' prior knowledge, their misconception and misunderstanding about life and living things
- Asking students how we can consider plants as living things
- Raising oral questions on characteristics of plants and give feedback to students' response

Feed back to Activity 2.1

- The answer to "What would happen to life in the absence of plants" should not be simple "Yes" or "No". Encourage students to start dialogue and justify or defend their ideas. For instance, one can say that there would not be life in the absence of plants, if we consider only animal life. Animals need oxygen and food to live, but they cannot produce both of these essential materials by themselves. They are supplied by green plants with food and oxygen through photosynthesis. Therefore, animals cannot survive in the absence of plants. However, if we consider plant life, plants are self feeding and can survive by their own as long as they get water from nature and CO_2 from other plants released from cellular respiration.

- Plants are living things, which are important for survival of animals including human beings. Using nails to fix notice board or notice plate is failure to recognise them as living. Moreover, fixing with nail will expose the plant to infection or attack by pests.

- Tying metal wire or plastic string around the stem or branch of a plant will cause ringing or girdling and interrupt food transport through the phloem.

2.2 Flowering and non – flowering plants

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- differentiate between flowering and non – flowering plants
- use plant reproductive structure for classifying plants
- realize floral structure as a strong marker for classification

Learning strategies
The teacher can start asking students to know what comes to their mind when they think about plants. They may associate concept of plant with having roots, stems, leaves, flowers, seeds or fruits. Use Figure. 2.1 in student's text to show that there are huge number plants with

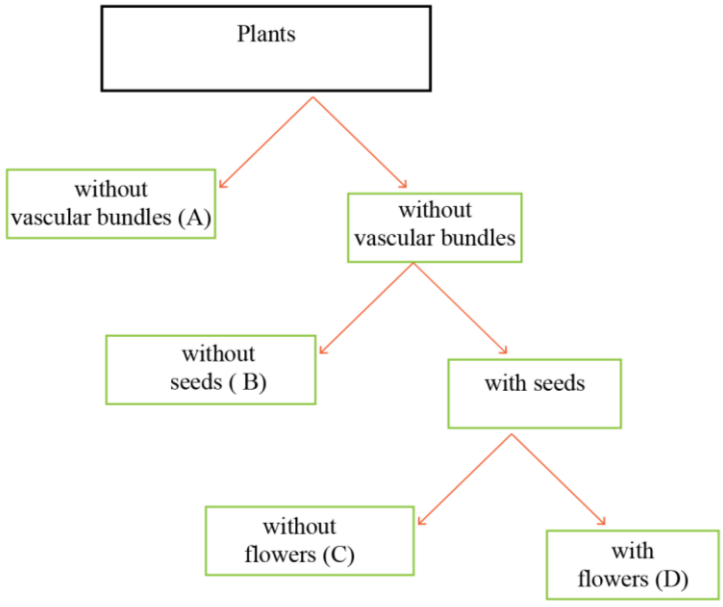
- root like , stem like and leaf like structures without water and minerals transporting system called vascular bundles
- Without flowers, fruits or seeds

Suggested Active Learning Methods:

Brain storming, Think – Pair - Share, Mind mapping

Suggested Formative Continuous Assessment:

- Asking students about the criteria used to classify group plants
- Questioning - Let the teacher draw the next mind map that goes with Figure. 2.1 in students' text on the black board and ask students to label (A to D) and give example for each group.



Feedback to Activity 2.2

- Plant groups include under non – flowering plants with seeds are Gymnosperms (Cone bearing plants with naked seeds). In addition to gymnosperms Bryophytes (mosses and liverworts) and Pteridophytes (Ferns) do not have flowers and are seedless.

- Floral characters (infloresence, floral parts and flower colours) are the same among flowers of the same species. A particular plant has flower unique to it - having the same colour, shape and floral structure that is consistently the same for that specific plant. Thus, flower is strong marker to identify and classify plants.

Similarities and differences between gymnosperms and angiosperms

Similarities	Differences	
	Gymnosperms	**Angiosperms**
▪ Presence of vascular bundles	▪ Have no flowers, instead have cones	▪ Have flowers
▪ Presence of seeds	▪ Have naked seeds (have no fruit or fruit coats as a cover)	▪ Have seeds enclosed in fruit

Further readings

- https://www.diffen.com/difference/Angiosperms_vs_Gymnosperms
- https://www.vedantu.com/question-answer/similarity-between-gymnosperms-and-angiosperms-class-11-biology-cbse-5f830522766fc5381bd0a2a5

2.3 Structure and function of plants

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- draw the external and internal structure of angiosperms
- label the external and internal structure of angiosperms
- relate the structure of plants with the function they perform

Learning strategies

In this section, students will learn about the different structures of a typical flowering plant. The teacher can start the lesson with describing the external structure of a typical plant, which includes the root and shoot system. This can be clearly presented by using life specimen (real plant), which is carefully uprooted from school garden or nearby farmlands or parks. Let the teacher asks students to name and show the different parts of the root and shoot system of the real plant using Figure. 2.2 in students' text as a guide. He/she can engage students prepare table of summary listing down the different parts of the root and shoot systems and the corresponding functions briefly.

As to the internal structure of leaf , shoot and root the teacher can show prepared slides using a microscope if these are available in the school . The task can be done as laboratory activity or demonstration in class. If there is no such opportunity, the teacher can arrange group work and peer discussion, where students will identify the different layers of leaf, stem and root using Figure, 2.4, 2.5 and 2. 6 of the students' text.

The lesson on plant structure gives opportunity to verify the unifying principle "**COMPLEMENTARITY OF STRUCTURE AND FUNCTION**", in that the function of any part of an organism is closely related to its structure and from its structure, the function can be

inferred. In line with this principle, the teacher guides students to understand how the structure of leaf and root are best suited to their function. Students should be encouraged to consolidate what they have learned by giving different active learning tasks, where they employ peer discussion. The following tasks can be given to a group of students to discuss and prepare summary note that can be presented to the whole class

Task 1: What are the different structures (internal and external) that enable leaf to photosynthesize, exchange gas, and control water loss (transpiration)? – Refer to Figure. 2.3 and Figure. 2.4 in the student textbook.

Task 2: Describe the different parts or layers of internal structure of a dicot stem - Refer to Figure. 2.5 in student's text).

Task 3: Describe the different parts of dicot root. What makes root best suited for absorption? – Refer to Figure. 2.6 in student's text

Hints for teaching

The following cells/structures between the epidermis and endodermis of stem cross section illustrated in Figure 2.5B are not described in the student text. The teacher can use the description on the nature and function of these cells/structures as given here under

- **Parenchyma cells** – are thin walled cells, occurring in the form of continuous masses as parenchyma tissue in the hypodermis and cortex of stems, mesophyll of leaves, and the flesh of succulent fruits and endosperm of seeds. Parenchyma cells perform most of the plant's metabolic function such as storage of energy (mainly in the form of starch and fat) and wastes or by products (tannin, resins, gums, etc), involved in gaseous exchange (which takes place in the intercellular spaces) and support photosynthesis (as are the cells containing chlorophyll)

- **Collenchyma cells** – have thick deposits of cellulose in their cell walls and appear polygonal in cross section. They are commonly found in stems and leaves of many herbaceous and woody plants. Collenchyma cells provide support, mechanical strength, and flexibility to the petiole, leaf veins , and stem of young plants , allowing for easy bending without breakage.

- **Chloronchyma cells** – are parenchyma cells containing chloroplasts. As they contain chlorophyll, they can carry out photosynthesis. They are abundant in the mesophyll layer of leaves. They are also found in photosynthetic stems of young seedlings and herbaceous plants.

- **Cambium** – is a layer of actively dividing cells between xylem and phloem. It is responsible for secondary growth (growth in diameter or thickness) of the stem.

Suggested Active Learning Methods:

Gapped /enhanced lecture, Group Discussion, Cooperative learning

Suggested Formative Continuous Assessment

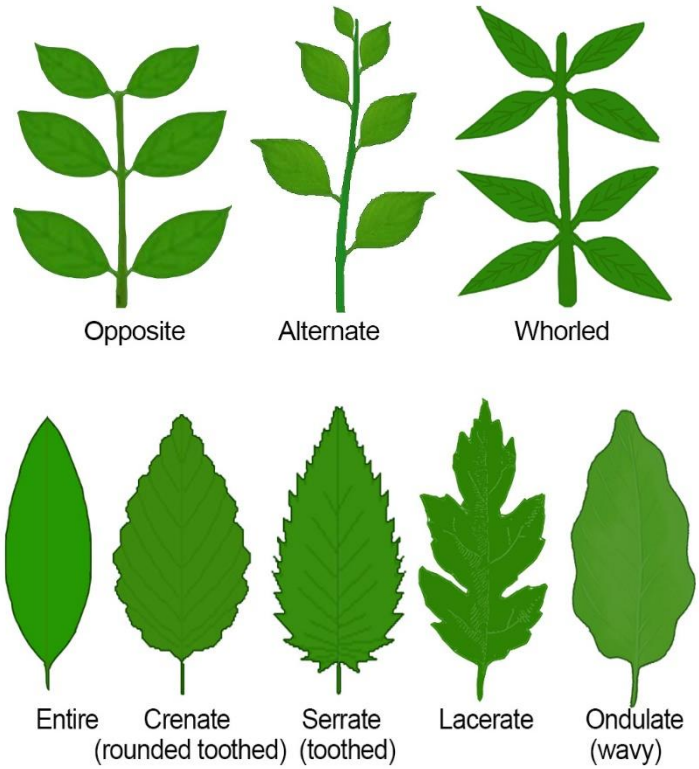
- Monitoring group discussion and cooperative learning
- Giving students quick and relevant feed back
- Peer assessment and reflection on group paired work

Feedback to Activity 2.3

- We can differentiate underground stem from roots in that underground stem has nodes and buds. Roots do not have nodes and buds , instead they have root hairs and root caps

Feedback to Activity 2.4

- Leaves show difference in their morphology. Look at the following illustrative diagrams that show difference in leaf arrangement and leaf margin



- Leaf veins represent the transporting vessels (xylem and phloem). They transport water and nutrients as well as synthesized food between leaf and stem.
- The tiny pores, particularly located on the lower side of a leaf, are stomata. They are openings for gas exchange.

- A root hair is elongated single cell providing large surface area. It is best suited for absorption of water and minerals. The cell contains cell sap (cell solution) of higher concentration than the surrounding soil water. This allows water to enter to the root passively (without additional expenditure of energy from the cell).

Feedback to Activity 2.5

Refer to Biology books in your library or the suggested website to complete the table of difference between the internal structure of dicot and monocot stem.

https://www. pediaa.com/what-is-the-difference-between-monocot-stem-and-dicot-stem

Feedback to Activity2.6

Refer to Biology books in your library or the suggested website to complete the table of difference between the internal structure of dicot and monocot root.

https://www.visiblebody.com/learn/biology/monocot-dicot/roots

2.4 Reproduction in plants

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- outline the reproductive cycle /pattern of non – flowering and flowering plants
- draw and label floral parts
- list different types of pollinating agents
- appreciate the diversity in floral colour to attract pollinators

Learning strategies

The teacher can start the lesson with brainstorming questions about the Christ – mass trees which most students are familiar with. Students can be asked about the nature and shape the leaf of these trees as evergreen and needle shaped. The teacher should focus on Figures. 2.7 and 2.8 in student's text and give explanation on the external structure and reproductive pattern of gymnosperms, particularly pine tree as typical representative of gymnosperm.

With regard to flowering plants the teacher can:

- Use the diagram (Figure. 2.9 in students' text), model or real flower for demonstration. If he/she is to use real flowers it is good idea to bring different flowers, varying in size, colour, parts present or absent, etc. This will help for class discussion on pollination and pollinating agents.

- Use a complete flowers having both the essential parts (Stamen and Pistil) and accessory structures (Petals and Sepals). The flower can be used to explain the different types of flowers, such as perfect/imperfect flower and complete /incomplete flowers. The teacher should tell students about self and cross-pollination and ask them to identify type of flowers that cannot exhibit self-pollination.
- Invite some students to show the floral parts of the different flowers they collected. Students should recognise the importance of having brightly coloured petals and fragrance as compared to flowers with dull colour. They should identify flowers pollinated by insects and wind.
- Advised students to focus on stamen (male part) and pistil (female part), as these are directly involved in reproduction. Be sure that students identify filament and anther of the stamen as well as stigma, style and ovary of the pistil.
- Allow students to perform dissection of the anther and ovary of a flower. They should be advised to take care as they are doing dissection with sharp objects, the dissection will allow students to see the pollen grains and the ovules using a hand lens. Students should be told that the pollen grains landing on the stigma form pollen tube, which contain male gametes while ovules contain the female gametes.
- Guide students to execute dissection of the anther and ovary in group as follows

Materials per group : Flower, Sharp razor – blade, Hand lens

Method:

- ✓ Provide each group of students (4 to 5 in number) with the above materials It will be better if one kind of flower, having all floral parts is used for all groups.
- ✓ Demonstrate the floral dissection to the whole class and let each group perform the dissection in the same way
- ✓ Make sure that each group has observed the pollen grains and the ovules. Ask one or two groups to draw what they have observed on the black board.
- ✓ Students should compare the number pollen grains per anther and ovules per ovary. The teacher should give concluding remark emphasizing the large number of pollen grains. This has an advantage for the plant, because it will increase the chance of successful pollination, particularly by wind where the chance of pollen grains to land on the stigma is little.

Suggested Active Learning Methods:

Modelling/showing real flowers, Demonstration, Observation, Practical discussion

Suggested Formative Continuous Assessment

- Monitoring and consolidating practical activity
- Give students quick and relevant feed back
- Peer assessment and reflection on group work

Feedback to Activity 2.7

- The teacher should allow students to present their field report on what they observed about the gymnosperms they collected from parks or recreational or along street walkways. Let students show life specimen (real plant part) they collected or pictures they may have taken to whole class. Consolidate the class discussion with description and concluding remarks

Feedback to Activity 2.8

- The teacher has to comment on students' response. Expected answers with regard to development stages in the reproduction of pine tree (Figure. 2.8 in students' text) denoted by numbers include; 1 = Pollination and seed formation, 2 = Seed dispersal, 3 = Seed germination, 4 = Formation of seedling, 5 = plant growth, 6 = Maturation of pine tree (formation of cones).

Feedback to Activity 2.9

- A complete flower has all the four floral parts (Stamen, pistil, petals and sepals). If any one of the floral parts is missed, it is called incomplete flower.
- A flower is said to be perfect if it has both stamen and pistil. If one of the two, either stamen or pistil, is missed it is known as imperfect flower.
- An imperfect flower is incomplete but an incomplete flower may or may not be imperfect flower
- Petals of some flowers are brightly coloured, which makes them visible to insects that serve as pollinating agents.

Feedback to Activity 2.10

- In general, flowers pollinated by insects have brightly coloured petals - visible at a distance. They produce nectar (sweet carbohydrate), where insects will receive pollen on their body while sucking the nectar. As a result, the insects will serve as agent of pollination in transferring pollen grain to the stigma of flowers on one plant (Self-pollination) or to the stigma of flowers on another plant (Cross-pollination) on their visit to a flower. Flowers pollinated by insects are usually scented (fragrance/attractive smell) and may even open at the time of day when insects are searching for nectar.

- As opposed to insect pollinated flowers, wind pollinated is dull in colour. They have small petals or none at all, no scent and no nectar. In contrast, they produce huge number of pollen, since many can be lost on the way with little chance to land on the stigma. The feathery stigma maximizes the chance of catching pollen. The flowers are well above the leaves as in grasses, or they may be produced while the plant is leafless.

2.5 Seeds

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- describe the structure of seed and embryo
- list down the difference between dicot and monocot seed

Learning strategies

This section requires students to bring Bean (dicot) and Corn or maize (monocot) seeds from their home. The teacher should tell students that 3 to 4 seeds of beans and maize should be soaked in water for at least 3 days ahead. Students should be asked to tell the difference between dicot and monocot seeds using the real seeds and diagram (Figure 2.11) in student's text. They should also be allowed to differentiate between the two types of soaked seeds by checking which one, bean or maize, can easily be divided into two halves. This will give them chance to see the two cotyledons of a bean seed. The teacher can ask students why it is difficult to get cotyledon of maize. Here, they can refer to Figure. 2.11 of their text to identify endosperm of the maize. Students should tell the role of cotyledon and endosperm in seeds. Here, the self-test question asked at the end of section 2.2 of the student text: Monocot seeds like wheat and maize are best source of flour to make bread. Explain why this is so? can be asked (Hint: monocots have large and well-developed endosperm to store food mainly in the form of carbohydrate)

The teacher can encourage students to examine the soaked seeds they brought for more structures visually with their naked eyes or observe very closely through a hand lens.

Suggested Active Learning Methods:

Gapped /Enhanced lecture, Demonstration, Showing real seeds, Observation, Practical discussion

Suggested Formative Continuous Assessment

- Monitoring and consolidating practical activity
- Giving students quick and relevant feed back
- Peer assessment and reflection on group work

2.6 Seed dispersal and germination

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- relate nature of seeds with the mechanism of dispersal
- explain the process of seed germination
- conduct experiment that demonstrates the germination of seed

Learning strategies

As starter, the teacher may ask students brainstorming questions like

- ✓ What will happen if all seeds fall very near to the parent plant?
- ✓ How can seeds be scattered away the parent plant?

In this section, the teacher should explain seed dispersal relating it to agents of dispersal. A display of variety of seeds or fruits is essential to point out the different methods of dispersal. Students should prepare a summary table that tabulates the different seeds in one column and description of dispersal method in another column. They should be guided towards comparing wind and animal pollinated flowers.

Before dealing with seed germination let the teacher ask students the following brain storming question: "What will happen to seeds falling or landing on farm land?". Then, he/she can present the lesson indicating that seeds landing at certain farmland may germinate or enter a period of dormancy. It will germinate if conditions are favourable; otherwise will remain dormant (in active) until conditions for germination are fulfilled. The favourable conditions for germination include optimum temperature (warmth), air and water (moisture). Activity 2.13 in student's text, particularly "Three bean seeds germination experiment", demonstrates that temperature (warmth), air, and water (moisture) are needed for germination. Use Figure. 2.12 in student's text let students show the different stages of germination from seed embryo until leaf bearing seedling emerges and the young plant starts making its own food by photosynthesis. Students should tell difference in the position of the cotyledon, during germination of a dicot seed (epigeal germination) as opposed to a monocot seed (hypogeal germination).

Suggested Active Learning Methods:

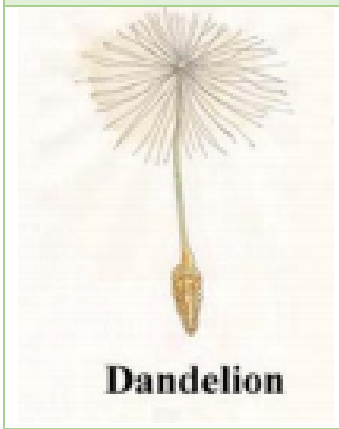
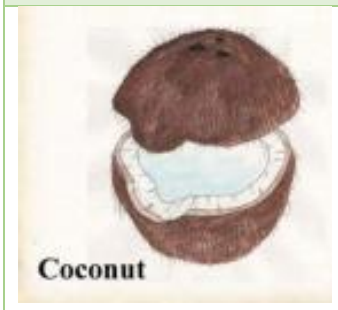
Diagram /showing real seed, Think – Pair – Share, Demonstration, Observation, Practical discussion

Suggested Formative Continuous Assessment

- Monitoring and consolidating practical activity
- Giving students quick and relevant feed back
- Peer assessment and reflection on group work

Feedback to Activity 2.11

Students can be invited to identify mechanism of dispersal based on the nature of each seed included in the table. Expected answer is summarized with the next table

Nature of seed	Mechanism of dispersal
Seeds that stick or cling to fur or clothes	Animals , including human being
	Wind
Seeds within fruits act as kites or propellers	Wind
	Water

Feedback to Activity 2.12

The teacher should give priority to students to describe the experimental design /arrangement for testing the essential conditions for seed germination. They should answer questions included therein. The teacher should give feed back to their response.

The following are the expected answers to the questions asked in the activity:

- Experiment 1,2,3 demonstrate the need for optimum temperature (warmth), air and water (moisture), respectively

- Boiling water will force air to go out of the water while covering the surface with oil prevent air from entering back to the water. Students should understand that air is needed for germination (reserve food in cotyledon will generate energy through aerobic respiration)

- In the **"Three bean seeds experiment"**, i.e. seed above the water, seed partially in the water and seed in the water verify that water, warmth and air are respectively required for germination.

2.7 Photosynthesis

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- outline the process or mechanism by which food is synthesized in green plants
- identify inputs and outputs of photosynthesis
- recognize the importance of photosynthesis to life
- appreciate leaves of green plants in their function as food factories

Learning strategies

The teachers can start the lesson with brainstorming questions indicated in the **"Start-up"** box in the student's text. Let a pair of neighbouring students be encouraged to think and discuss on the start-up questions and share their prior knowledge to the whole class. After the brain storming the teacher is expected to define what photosynthesis is and revise previous lesson on leaf to show where it takes place and how leaf is best suited for photosynthesis.

The teacher should form two different groups (4 to 5 students per group) a head of delivering lesson on 2.7.1 and 2.7.2. in student 's text. Then, he/she can distribute the topics listed here under randomly and instruct the group to take part in reading assignment. Let each group discuss, prepare short notes and present the notes in the class by their group leader.

Assignment I: Photosynthetic apparatus and light absorbing system (sub topic 2.7.1 and 2.7.2 in student's text)

Assignment II: Mechanism of photosynthesis (Sub – topic 2.7.3 in student's text)

After the presentation, the teacher should consolidate the lesson and wrap up the key points under each assignment.

With regard to mechanism of photosynthesis, let the teacher discuss the sub reactions (Light and dark reactions) of photosynthesis - where and how they take place in the chloroplast (Granum and stroma) and discuss the overall reaction, Here, students should clearly be informed that breaking of water molecule into H^+ and O_2 is the result of light reaction (photoreaction). It is the result of sunlight absorbed by chlorophyll. It occurs in the granum of the chloroplast. Beside O_2 released to the atmosphere, the light reaction generates H^+ and energy in the form of ATP (harvested by photophsphorylation). Both are essential for the dark reaction, known as carbon fixation (converting CO_2 to carbohydrate). This reaction takes place in the stroma of the chloroplast. It is very important for students to know that the dark reaction is dependent on the light reaction. While discussing the overall equation of photosynthesis, it is important that students point out the inputs and out puts of photosynthesis. It is also needed to show the net balanced chemical equation of photosynthesis, i.e.

$$6CO_2 + 6H_20 \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2$$

It should be known that the above reaction has come from the following overall reaction by showing net amount of water used and generated .

$$6CO_2 + 12H_2O \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

Testing leaf for starch can be either demonstrated by the teacher or performed as group practical activity by the students in the laboratory. The teacher should tell students that starch accumulated in leaf is a product of photosynthesis. Thus testing leaf for starch; which is food test is an indirect way of testing leaf for food synthesis (photosynthesis). Here, students should know why the leaf is first boiled in water and then placed in hot alcohol. The teacher should advise students to apply safety rules while working with hot water and flammable alcohol.

Suggested Active Learning Method:

Think – Pair – Share, Self learning, Demonstration, Observation, Practice

Suggested Formative Continuous Assessment

- Monitoring and consolidating practical activity
- Asking oral questions to identify learning difficulties
- Peer assessment and reflection on group assignment
- Consolidating key points of the assignment and lesson delivered

Feedback to Activity 2.13

- The source of oxygen is water. It is light reaction that splits water molecule into H^+ and O_2
- Inputs of photosynthesis are : Carbondioxide, water and sunlight
- Outputs of photosynthesis are : Carbohydrate and Oxygen
- It is H^+ of water that is included in our food or carbohydrate ($C_6H_{12}O_6$). Likewise, it is oxygen that we breathe in, which is used for cellular respiration.

Feedback to Activity 2.14

The purpose of each step in testing leaf for starch is presented as follows

- **Step 1**: The leaf is boiled in water to dissolve the cuticle. This waxy substance is impermeable to iodine, which is used to test the presence of starch
- **Step 2**: The leaf is treated with alcohol to dissolve the pigment chlorophyll. This removes the green colour, which otherwise cover the colour change by iodine.

- **Step 3**: The leaf is immersed in water to wash away the dissolved cuticle and the pigment or green colour. This will expose the leaf to iodine
- **Step 4**: Iodine is added to leaf to confirm the presence of starch (food). A blue-black colour is positive test for the presence of starch.

While testing leaf for starch, you should turn the Bunsen burner before using alcohol. This is done to avoid danger of burning, because alcohol is flammable. For safety, purpose you should remind students to use forceps while inserting or taking out the leaf from boiled water or hot alcohol. They should use forceps and first unlit alcohol flame.

2.8 Transport in plants

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- identify routes of water, mineral, and organic matter transport in plants
- discuss the mechanism of transport in plants
- tell the importance of transport in plants
- demonstrate water transport in plants using simple experiments

Learning strategies

- In this section, students should understand the need for transport; routes or ways materials are transported around plants.
- They should realize the mechanism of water and materials uptake and transport from roots to leaves via the stem. They have to realize the translocation of food synthesized in the leaf
- The teacher can start the lesson on "Transporting systems in plants" by asking students brain storming questions such as "why is transport needed? What is transported and where is the destiny of transport? "
- The teacher should focus on the dyed celery experiment, which enables students to see how water rises up in stem. The experiment will also allow students to learn about transpiration and how water loss from plant helps to pull water from roots to leaves. It is this mechanism of water transport, which is called transpiration pull.
- Being in pair students can be given 5 to 10 minutes to read the section dealing on the mechanism of transport (Sub – topic 2.8.2 in student's text) including active transport of mineral ions from the soil to root of plants and translocation of food through the phloem. Encourage them to share ideas and write short note. The teacher should invite students to reflect ideas during lesson delivery.

Suggested Active Learning Methods:

Think – Pair – Share, Self learning, Demonstration, Observation

Suggested Formative Continuous Assessment

- Monitoring and consolidating reading and note taking
- Giving students chance to share and reflect their idea
- Asking oral questions to identify learning difficulties

Feedback to Activity2.15

- The teacher should tell students about the importance of water to a plant (Cross refer to **hint** given in the activity box of the student text)
- Drought is excessive shortage of water due to prolonged absence of rainfall. Agricultural productivity or food production will decline, because water is essential raw material for photosynthesis (food production). Irrigation serves as continuous supply of water, particularly during dry seasons.
- Rainy season is best for farming, because there is continuous supply of water from rainfall. Moreover, loss of water by transpiration is less, because of low solar heating.

Feedback to Activity 2.16

- The classic **dyed celery experiment** is designed to show how water rises up in the stem and how transpiration helps to suck up water. As the celery, plant has a transparent stalk or stem, students can easily observe as coloured water rises up.
- If the teacher does not get celery plant, he/she can substitute it by another locally available plant of similar nature. Be sure that students should not only observe the rise up, they should also focus on the effect of light (solar heating) by comparing results from the three beakers.
- Students should anticipate what should happen in Beaker "A" (placed in dark), Beaker "B" (put in partially sheltered place) and Beaker "C" placed where there is bright sunlight.

2.9 Response in plants

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- recognize that plants are capable of giving response
- explain some common responses in plant
- tell the importance response in plants
- demonstrate response in plants using simple experiments

Learning strategies

- Plants show responses to different changes in the environment. They start flowering and fruiting in response to duration of light (photoperiod). Plants also show nastic and tropic response, to all sided (uniformly distributed) and unilateral (one – sided) stimuli respectively, including response to touch, to water, light and gravity.

- In this section, before dealing the different types of tropism, the teacher should give prior information about growth hormones based on the sub – topic 2.9.1 in student text (Tropism as growth response). Students should clearly know that tropism is bending or curving towards (positive response) or away (negative response) from the stimulus. Let students know the cascading effect of unilateral (one sided) stimulus, which causes unequal growth hormone distribution followed by unequal growth ultimately resulting in bending or curving response. Here, the teacher can use how, auxin as growth hormone affect root and shoot response. Students can be encouraged to use critical thinking to interpret Figure. 2.18 and 2.19, so that they can predict the response of root and shoot to different unilateral stimuli, such as light, water and gravity.
- Even, though , there are different types of plant responses such as nastic response and photoperiodism the teacher should focus on tropic responses to light, water and gravity (at seedling stage), which are biologically more important to the survival of the plant. However, the teacher should make prior readings on the other plant responses if at all discussion in class leads towards any one of these responses.
- Students can use seeds they have previously germinated for experiments under activity 2.16 (hydrotropism), 2.17 (phototropism) and 2.18 (Geotropism) in the students' text. It is also possible for students to watch you do the experiments as demonstration.
- The teacher should tell students that tropic response is slow. Better to inform them that the primary cause of the response is a unilateral stimulus that causes unequal production or distribution of growth hormone. This in turn makes one side to grow more than the other side and bending (curving) will occur towards or away from the stimulus.
- It should be noted here that certain statements like "The shoot grows towards light **so that** it may get enough light for photosynthesis" should be avoided. Such statement, especially the clause "so that" suggests purposive action (done knowingly), which is very absurd. Such purposive actions are the quality of human brain. It will better to say, "the bending towards light, has positive effect enabling the plant to get sufficient light for photosynthesis.

Suggested Active Learning Methods:

Group discussion, Cooperative learning, Demonstration, Observation, Practice

Suggested Formative Continuous Assessment

- Monitoring and consolidating group work
- Giving students chance to share and reflect their idea
- Asking oral questions to identify learning difficulties

Feedback to Activity 2.17

The teacher should first describe the experiment designed to investigate the effect of unilateral light and the results carefully to the students. Let students try to interpret the results and draw conclusions.

The teacher should be sure that students relate bending is the result of unequal growth and let them identify which side of a shoot grows more.

Feedback to Activity 2.18

- In the experiment that shows the effect of water on the growth of root, bending occurs in root of seedling grown in Beaker "B", because one side is wet (with moisture/water) while the other side is dry.
- Because of one-sided stimulus (water), bending has occurred towards water. This verifies that root is positively hydrotropic. As opposed to Beaker "A", the root in Beaker "B" grows straight, because there is water from all sides.
- The teacher can have a third beaker , where she/he should fill the whole beaker with dry soil and put wet blotting paper on one side of the top of the dry and allow the seedling to grow. After one or two days, the radicle grows upwards towards the wet blotting paper. From this, it can be concluded that bending of the radicle has occurred towards water present in the blotting paper. The growth of roots up wards against the force of gravity also suggests that water as a stimulus has more influence on root growth than gravity.

Feedback to Activity 2.19

- Gravity affects the distribution of growth hormones and this is mainly observed in a horizontally placed seedling. Due to effect of gravity, growth hormones tend to move from upper part to lower part of the horizontally placed seedling.
- In a horizontally placed seedling, the radicle (future root) bends downwards while the plumule (future shoot) turns upwards. This also confirms that the concentration of growth hormone that promotes shoot growth inhibits root growth.
- From the experiment, students should be able to understand that roots are positively geotropic and shoot is negatively geotropic

2.10 Medicinal plants

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- tell the importance of medicinal plants
- list down locally available medicinal plants

Learning strategies

The teacher brain – storms students "with what they know or their parents say about medicinal plants and traditional healers". This will allow you to identify students' prior knowledge, misconception and misunderstanding about medicinal plants and traditional healers.

Let the teacher ask students if their parents use medicinal plants and what they say about medicinal plants as compared to modern medicines sold at pharmacies. Then he/she can use the misconceptions and misunderstanding and guide the lesson to provide essential information for the students to understand the reality.

The teacher is advised to use table 2.3 in students' text to explain the role of medicinal plants. Select at least one plant to show different growth forms (herb, shrub and trees), plant parts used (leaf , seed, tuber), route of administration (oral, nasal) and diseases treated.

Suggested Active Learning Methods:
Brainstorming, Cooperative learning, Questioning, Reflection

Suggested Formative Continuous Assessment

- Giving students chance to share and reflect their idea
- Asking oral questions to identify students' understanding

Feedback to Activity 2.20

- The teacher can allow students to present information collected about medicinal plants. They should following Table 2.2 of their textbook to summarize results.

2.11 Renowned botanists

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- appreciate the work of a renowned botanist
- look for more Ethiopian Botanists who contributed a lot to plant science

Learning strategies
The whole purpose of this section is to inspire students about outstanding contribution of Ethiopian scientists to their profession, to their country and to the whole world. The teacher can give brief description on the contribution of the renowned Ethiopian Botanist Professor Sebsebe Demissie. Let students in pair carefully read the work of Professor Sebsebe Demissew and share their impression about him and his work to the whole class.

Suggested Active Learning Methods:

Think – pair – Share, Cooperative learning, Questioning, Reflection

Suggested Formative Continuous Assessment

- Giving students chance to share and reflect their idea
- Asking oral questions to reinforce students' understanding

Feedback to activity 2.21

- The teacher should arrange time for two or three groups to present what they collected from books, internet or other sources about additional renowned Ethiopian botanists
- The teacher should give comment and final remark.

ANSWER TO REVIEW QUESTIONS

I. TRUE – FALSE ITEMS

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

II. Multiple Choice Items

1. D 2. B 3. B 4. C 5. D 6. D

III. Matching Items

1.B 2. D 3.E 4.G 5. F 6. A

IV. Short Answers

1. Unlike underground stem, root does not have buds from where leaf and flower originate
2. Incomplete flower does not have all the four floral parts. It can have stamen and pistil but may not have either sepal or petal. A flower is known as imperfect flower if it does not have either stamen or pistil. An imperfect flower is an incomplete flower but an incomplete flower can be perfect or imperfect.
3. Rainfall is huge source of water. Water is raw material photosynthesis (for food production). Thus, rainfall is essential for increasing agricultural yield.
   The correct order of tropic response represented by the diagrams in student text from left to right is: Geotropism, Phototropism, Hydrotropism and Geotropism

Unit 3: Biochemical Molecules

Content	Learning Competency
3.1. Biochemical molecules 3.1.1. Inorganic molecules: water 3.1.2. Inorganic ions 3.1.3. Organic molecules ▪ Carbohydrates ▪ Lipids ▪ Proteins ▪ Nucleic acids	At the end of this unit, the student will be able to: ▪ identify inorganic and organic biochemical molecules ▪ explain the properties of water and its importance for life ▪ discuss different inorganic ions and their contribution to the cell ▪ classify organic molecules based on their constituent elements and the monomers from which they are constructed. ▪ discuss the role of biological molecules in the cell structure ▪ elaborate the functions of carbohydrates, proteins, lipids, and Nucleic acids to the body. ▪ conduct experiments to identify nutrients in different foodstuff ▪ appreciate why Ethiopians use malting seeds to make local drinks (Tella, Areke)

3.1 Biochemical molecules

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- identify inorganic and organic biochemical molecules
- discuss different inorganic ions and their contribution to the cell
- explain the properties of water and its importance for life

Learning strategies

Ask students whether they knew about Biochemical molecules; or led them to make educated guess [about what they are] from the term, and let them speculate their role in the cell structure. Given the different molecules, using question and answer, students are helped to classify them into organic and inorganic.

Short description of Biochemical molecules

In addition to the teaching notes given in the student textbook, the teacher can also use the following description for the biochemical molecules. A biochemical molecule, also known as a biological molecule, is any of the numerous substances produced by living organisms and cells. Biomolecules come in a wide range of sizes and structures, and they serve a variety of functions. The four major types of biomolecules are carbohydrates, lipids, nucleic acids, and proteins.
Nucleic acids, specifically DNA and RNA, are biomolecules that have the unique function of storing an organism's genetic code—the sequence of nucleotides that determines the amino acid sequence of proteins, which are critical to life on Earth. 20 different amino acids can occur within a protein, and the order in which they occur is critical to protein structure and function. Proteins are important structural components of cells. They also function as transporters, transporting nutrients and other molecules into and out of cells, as well as enzymes and catalysts for the vast majority of chemical reactions that occur in living organisms. Proteins are also involved in the formation of antibodies and hormones, as well as the regulation of gene activity.

Carbohydrates, which are primarily made up of molecules containing carbon, hydrogen, and oxygen atoms, are also essential energy sources and structural components of all life, and they are among the most abundant biomolecules on Earth. They are made up of four different types of sugar units: monosaccharides, disaccharides, oligosaccharides, and polysaccharides. Lipids, another important biomolecule in living organisms, serve several functions, including acting as a source of stored energy and as chemical messengers. They also form membranes that separate cells from their surroundings and compartmentalize the cell interior, giving rise to organelles such as the nucleus and mitochondria in higher (more complex) organisms.

Suggested Active Learning Methods

Brainstorming, Gapped/enhanced lecture/ questioning/ answering

Suggested Formative Continuous Assessment

- Written/verbal test, assignment, homework, observation, presentation, and reflections.
- Assess students' prior knowledge, their misconception, and misunderstanding about biochemical molecules
- Ask students how we can divide the biochemical molecules: inorganic and organic
- Ask about the importance of the different types of inorganic ions and inorganic molecules
- Ask questions during your teaching-learning processes

Feedback to Question:

What are biological molecules, and how would you define them? Make a list of all the biological molecules you are familiar with and divide them into two categories: inorganic and organic. Finally, talk about how they affect cell structure and function. After that, do activity 3.1, which is given below.

s
are expected to list all types of biochemical molecules into inorganic and organic. Finally, they should

explain how these biochemical molecules affect the structure and function of the cell. Now, they should proceed to activity 3.1 in that they have a basic understanding of biochemical molecules. In this case, the teacher is expected to guide his/her students through their studies.

Feedback to activity 3.1

After the students have created their list of inorganic and organic biochemical molecules, the teacher will add possible biochemical molecules to their list. Some of them are listed below:

Inorganic compounds

Salts, metals, substances made from single elements and any other compounds that do not contain carbon bonded to hydrogen are examples of inorganic biochemical molecules. Carbon can be found in some inorganic molecules.

- table salt or sodium chloride, NaCl
- carbon dioxide, CO_2
- diamond (pure carbon)
- silver
- sulfur

Organic compounds

Organic molecules are those that are associated with living organisms. Nucleic acids, fats, sugars, proteins, enzymes, and hydrocarbon fuels are examples of these. Carbon is present in all organic molecules, as is hydrogen in nearly all of them, and oxygen in many of them.

- table sugar or sucrose, $C_{12}H_{22}O_{11}$
- benzene, C_6H_6
- methane, CH_4
- ethanol or grain alcohol, C_2H_6O, etc are all organic

3.1.1 Inorganic molecule: Water

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- mention properties of water
- discuss the importance of water for the living organisms

Learning strategies

Before the start of the lesson raise the following question, let the students try to answer and then proceed;

What are inorganic molecules?

Then, raise another question for the students to reflect "**Why water is considered as a biochemical molecule?**" and then, in groups let them list down the properties of water and how these are related to its importance to life.

Feedback to activity 3.2

Encourage students to write down as many properties of water as they can, and assist them in relating the value of the properties of water they wrote down to their lives. Finally, ask them to respond to the following question.

What typical properties of water do you know?

The properties of water

In the students' text, detailed descriptions of the water molecule are given. They are listed here below, however. The teacher should try to teach using live examples during his instructions:

i. Water as a solvent
ii. Water as a transport medium
iii. High specific heat capacity
iv. High latent heat of vaporization
v. Density and freezing properties
vi. High surface tension and cohesion
vii. Water as a reagent

Feedback to activity 3.3

- Plants during hot and windy days loose much water as a result of the transpiration pool of water from the depths of the soil. Accordingly, water can be transported to the leaves at the top as one of the raw materials during photosynthetic process.
- The movement of some small animals on the surface of water is possible as a result of the cohesion and adhesion properties of water molecules.
- Water temperature has a significant impact on the quality of aquatic life and habitats. Heat flow in water is indeed much slower than on land. During cold temperatures, organisms in water benefit far more than organisms on land. This is because heat loss in water bodies is much slower than on land and organisms, particularly below the surface layer, and the water remains cool, allowing aquatic organisms to survive even during extremely cold seasons.

3.1.2 Inorganic ions

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- mention important inorganic ions that are necessary for life
- mention diets that contain inorganic ions
- discuss the effect of deficiency of nutrient elements in our body
- elaborate the importance of each nutrient element to the anatomy of the human body
- explain the importance of each nutrient element to the physiology of the human body

Learning strategies

Let students discuss in groups what inorganic ions are and their contribution to the body.

What are inorganic ions?

Because they are atoms with unshared electrons in their outer shell, inorganic ions are charged entities. They have either a positive or a negative charge. They are almost always coupled with an oppositely charged ion. Inorganic ions can be found in living bodies in two states: free and dissolved in the cytoplasm, where they are associated with complex organic substances. They perform a variety of vital functions in living beings. Even though they are only found in trace amounts in our bodies, their importance cannot be overstated. Any changes in their concentrations within the human body can have disastrous consequences.

Active Learning Methods:

Brainstorming, Gapped/enhanced lecture.

Suggested Formative Continuous Assessment:

- Written/verbal test, assignment, homework, observation, presentation, and reflections.
- Assess students' prior knowledge, their misconception, and misunderstanding about inorganic ions
- Ask students how we can divide the inorganic ions
- Ask about the importance of the different types of inorganic ions
- Ask questions during your teaching-learning processes

Feedback to activity 3.4

After discussion, students are expected to come up with definitions of inorganic ions, their roles in the human body, and effects during lower or higher consumption of the inorganic ions. Here, they can raise issues such as deficiency disease, malnutrition, etc effects because of hypo or hyper concentration of inorganic ions in the body.

What is the difference between inorganic ions and minerals?

Ask students whether these two terminologies are to describe the same thing or not. Finally, tell them that this is to mean the same ions differently.

Why macronutrients are required more than micronutrients in our diet?

The nutrients required by your body to promote growth and development and control biological activities are classified as macronutrients and micronutrients. Macronutrients are nutrients that your body requires in bigger quantities, such as carbs, protein, and fat. These give our bodies energy, or calories. Micronutrients are nutrients that your body requires in smaller amounts, such as vitamins and minerals. We need macronutrients for energy and micronutrients for our bodies to be healthy and digest those macronutrients.

Together, macro and micronutrients give our bodies with everything they require to be healthy. Macronutrients are the nutrients found in food that your body requires to grow and function normally. Because the body cannot synthesize all macronutrients, they must be acquired from nutrition. The three basic sources of nutrients in your diet are carbohydrates, protein, and fat. While all macronutrients give important energy to your body, they serve various purposes.

What is the importance of the hydrogen ion?

The amount of hydrogen ion present in a water solution is used to determine a substance's acidity; the higher the hydrogen ion concentration, the more acidic the solution and the lower the pH. Further, the importance of hydrogen ions in cells is given below. As the following importance are not well treated in the textbook, let the teacher explain in the way the students can easily understand.

Importance of hydrogen ions in cells:

i. Enzyme action

The pH of the fluids in the human body is normally around 7.4. The preservation of normal pH is critical for all of the metabolic processes that occur in a cell. Any change in the normal pH affects the structure of the enzymes, rendering them ineffective. Abnormal amounts of hydrogen ions interact with the side chains of amino acids, altering their secondary and tertiary structures and causing enzyme denaturation.

ii. ATP synthesis

Hydrogen ions are also used in the cellular synthesis of ATP. Using electron energy, they move against the concentration gradient from the mitochondrial matrix to the intermembranous space. As they return to the mitochondrial matrix, they release energy that is used by ATP synthase to phosphorylate ADP to ATP.

iii. Oxygen delivery

The presence of hydrogen ions in the blood aids hemoglobin in delivering oxygen to the cells. Carbon dioxide produced by cells during metabolism enters the blood as blood passes through tissues. It produces hydrogen ions when it reacts with water. As the concentration of hydrogen ions rises, they bind to amino acid side chains, lowering hemoglobin's oxygen affinity. This causes hemoglobin in tissues to release oxygen. In the lungs, the opposite occurs. Bohr's effect refers to the specific effect of hydrogen on hemoglobin's oxygen-carrying capacity. Any changes in the normal pH of blood will affect the delivery of oxygen to cells.

How much is the body requirement of Sodium ions for a human being?

= between 5 and 10 grams per day

What is the other importance of Sodium ions?

Importance of sodium ions

i. Conduction of Nerve impulses

Sodium ions, along with potassium ions, play a role in the transmission of nerve impulses in our bodies. Nerve impulses are transmitted in the form of a depolarization wave that travels along the nerves. Sodium ions move into the nerve and depolarize the cells during this process. Nerve impulses cannot be properly conducted if the sodium concentration on either side of the nerve cell membrane is disturbed.

ii. Fluid Balance

Sodium, as an abundant extracellular cation, is essential for maintaining fluid balance in our bodies. The volume of extracellular fluids, such as blood, is determined by the sodium concentration in these fluids. As sodium ions are pumped out of the cell, water follows, increasing the fluid volume. When the sodium concentration decreases, water moves into the cells and the fluid volume decreases.

iii. Absorption of nutrients in the intestine

Sodium ions are required for glucose and amino acid absorption in the small intestine. These molecules are absorbed into the intestinal cells via sodium-ion-driven co-transport channels. Sodium ions are actively transported out of the intestinal cells and into the lumen for this purpose. The stored energy

in the concentration gradient is then used to power the sodium-glucose or sodium-amino acid co-transporters.

iv. Heart contraction

Sodium ions play a role in both initiating and controlling the heart's rhythmic contractions. Due to the slow influx of sodium ions, rhythmic nerve impulses are continuously generated in the SA node in the absence of any stimulus. The SA node is the heart's pacemaker, controlling the heart rate. Any changes in the normal sodium ion concentration will result in an abnormal heart rate.

c. Potassium

How much is the body requirement and from where do we get Potassium?

= between 3 to 4 grams per day. We get it from **banana, oranges, vegetables, meat, chicken**, etc

What is the importance of Potassium ions?

The importance of potassium ions include:

i. Osmotic pressure maintenance

Potassium ions perform the same function in maintaining intracellular fluid volume and osmotic pressure that sodium ions do in extracellular fluid. Water enters the cells along with the sodium ions. Water and fluid balance are thus maintained within the cells.

ii. Electrolytes and acid-base balance

Potassium ions play a role in maintaining electrolyte and acid-base balance within cells. Because they are the most abundant cations in cells, their positive charge neutralizes the negative charges of organic ions and proteins, allowing the cell to remain neutral as a whole. If the concentration of potassium ions within the cells falls, hydrogen ions rush in to maintain electrical neutrality. This lowers the pH of the cell, causing the acid-base balance to be disrupted.

iii. Nerve impulse transmission

Potassium ions are also required for nerve impulse conduction. The outflow of potassium ions during the fourth phase of a nerve impulse repolarizes the cell, restoring the negative charge within the membrane. It is necessary for preparing the cell to conduct additional impulses after the first impulse has been completed.

iv. Cardiac contractions

Potassium ions also play a role in repolarizing cardiac muscles after they have been contracted. Any changes in the concentration of extracellular potassium ions have a significant impact on cardiac contractions and can result in cardiac arrest.

d. Calcium

How much is the body requirement and from where do we get Calcium?

= around 800mg per day

What is the importance of Calcium ions?

Importance of calcium ions to humans:

i. Development

Calcium, along with phosphate ions, is required for the formation, growth, and development of bones and teeth. When stored in the form of a hydroxyapatite matrix, it provides strength to the skeletal tissues.

ii. Muscle contraction

Normal muscle contraction necessitates the presence of calcium ions. Calcium ions are released from the sarcoplasmic reticulum of muscle fibers when a nerve impulse reaches them. These calcium ions bind to troponin C, removing tropomyosin from actin's myosin-binding sites. As a result, actin-myosin cross-bridges are formed, and muscle fiber contraction occurs.

iii. Blood coagulation

Calcium is an important clotting factor that is required to form blood clots to prevent blood loss from the site of injury in a blood vessel.

iv. Enzyme activation

Some enzymes, such as ATPase, pancreatic lipase, and succinate dehydrogenase, are activated directly by calcium. It also interacts with calmodulin, activating enzymes such as adenylatecyclase, Ca+ dependent protein kinase, and others.

v. Cardiac Impulse and Contraction

The depolarization of cardiac conduction fibers and cardiac muscles is caused by the influx of calcium ions. After calcium interacts with troponin C, cardiac muscle contraction is also possible.

e. Phosphate ions

How much is the body requirement and from where do we get Phosphate ions?

= 800 mg of phosphate per day as that of Calcium

What is the importance of phosphate ions?

Importance of phosphate ions to humans:

i. Development

Phosphate ions, along with calcium ions, are involved in the formation of the matrix of bones and teeth, which gives them strength. Phosphate ions are required for the formation of teeth and bones.

ii. ATP synthesis

Phosphate ions are required for the synthesis of high-energy compounds like ATP, GTP, etc. The bonds between the phosphate ions in ATP release a high amount of energy when they are broken.

iii. Nucleic acid synthesis

One of the three components of nucleotides is phosphate ions. As a result, they participate in the synthesis of nucleic acids such as DNA and RNA.

iv. Protein and Enzyme activation

Phosphate ions are required for the activation of a wide range of enzymes and proteins. When phosphorylated by kinases, they become activated.

v. Acid-Base balance

Phosphate ions are the most important intracellular buffers, regulating the pH of cells' cytoplasm.

g. Chloride ions

What are the sources and body requirements of Chloride ions?

= Chloride ions exist in the form of NaCl and are found in the foodwe eat. Average requirement is 5-10 grams per day.

What is the importance of Chloride ions to human beings?

Chloride ions serve in the maintenance of osmotic pressure, fluid balance, and acid-base balance in our body just like sodium. Other details are given in the student textbook.

g. Iron ions

What is the importance of Iron ions to human beings?

Iron is needed for the transport of oxygen and carbon dioxide in our bodies.

What could be the consequence of abnormal Iron metabolism in our body?

= Iron deficiency anemia, hemosiderosis, and hemochromatosis. Details are given in the students' textbook.

h. Copper ions

What are Copper ions?

Copper ions are the positively charged inorganic ions that are present in our bodies. Details are given in the student's text.

What happens during abnormal Copper metabolism?

Wilson disease is a rare clinical condition caused by abnormal copper metabolism in our body

Let the students do this activity by themselves. After they tried, let the teacher fill the gap.
Activity 3.5 Fill in the blank spaces in the table with appropriate answers

Type of Inorganic Ions	Source of inorganic ions	Amount required	Importance	Type of deficiency disease	Excess intake results in
Hydrogen ions					
Sodium ions					
Potassium ions					
Calcium ions					
Phosphosphate ions					
Chlorine ions					
Chloride ions					
Iron ion					
Copper ions					
Iodine ions					

3.1.3 Organic molecules

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- discuss the role of biological molecules in the cell structure
- Classify organic molecules based on their constituent elements and the monomers from which they are constructed.
- elaborate the functions of carbohydrates, proteins, lipids, and Nucleic acids to the body.
- conduct experiments to identify nutrients in different foodstuffs
- appreciate why Ethiopians use malting seeds to make local drinks (Tella, Areke)
- appreciate the significance of local drinks prepared from malting seeds in Ethiopia

Learning strategies

- Let students explore if there are different kinds of organic molecules; whether or not they could be sorted out into different types, and then let them give names to their types.
- Using diagrams/models, let the students explore the contribution of organic molecules (carbohydrates, proteins, lipids, and Nucleic acids) as structural components of cell structure and their functions
- Let one member from each group reflect on their classification, introduce how constituent elements are being used for classification, as they are further introduced into the structure and functions of carbohydrates, proteins, lipids, and Nucleic acids to the body
- After recalling balanced diet activity in grade 9 and introducing that different foodstuff vary in their nutritional values; let students in groups conduct food tests (in a laboratory) on different traditional staple foods.
- Let students appreciate why malting seeds are used to make local drinks in Ethiopia.

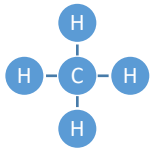
What are organic molecules?

The large molecules necessary for life that are built from smaller organic molecules are called biological **macromolecules**. There are four major classes of biological macromolecules (carbohydrates, lipids, proteins, and nucleic acids), and each is an important component of the cell and performs a wide array of functions. Combined, these molecules make up the majority of a cell's mass. Biological macromolecules are organic, meaning that they contain carbon. In addition, they may contain hydrogen, oxygen, nitrogen, phosphorus, sulfur, and additional minor elements.

The central element in organic molecules is carbon. Here below is given the structure of the carbon atom that enables it to bond with hydrogen atoms and other elements in organic molecule formation.

Carbon Bonding

Carbon contains four electrons in its outer shell. Therefore, it can form four covalent bonds with other atoms or molecules. The simplest organic carbon molecule is methane (CH_4), in which four hydrogen atoms bond to a carbon atom.



Methane (CH4)

Carbon, on the other hand, is used to make more complex structures. Any of the hydrogen atoms can be replaced by another carbon atom that is covalently bonded to the first carbon atom. Long and branching chains of carbon compounds can be formed in this manner. Carbon atoms can form bonds with atoms of other elements such as nitrogen, oxygen, and phosphorus. The molecules can also form rings, which can then connect to other rings. This diversity of molecular forms accounts for the diversity of functions of biological macromolecules and is largely based on carbon's ability to form multiple bonds with itself and other atoms.

Suggested Active Learning Methods:

Brainstorming, Gapped/enhanced lecture, questioning/answering

Suggested Formative Continuous Assessment:

- Written/verbal test, assignment, homework, observation, presentation, and reflections.
- Drawing and labelling, Laboratory activities
- Assess students' prior knowledge, their misconception, and misunderstanding about organic molecules
- Ask students how we can divide the organic molecules based on their component elements and their roles in cells and the structure of an organisms
- Ask about the importance of the different types of organic molecules
- Ask questions during your teaching-learning processes

Feedback to Activity 3.6

The students may come up with a different list of food items that can be grouped into one or another category of organic molecules. The teacher should ask questions; why did you put this bread for example, to carbohydrates, or butter to Lipids? etc, and ask them of which type of elements they are made of? After the students attempt to answer these questions, the teacher will guide them to correct the classification of the food items to the respective organic molecules they are made of.

What monomers make up organic molecules?

Organic molecules such as carbohydrates, lipids, proteins and nucleic acids are made of monomers joined together by covalent bonds. Accordingly, carbohydrates, lipids, proteins and nucleic acids are made of glucose, fatty acid and glycerol, amino acids and nucleotide monomers respectively.

Carbohydrate

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- name the different types of carbohydrates
- discuss the importance of monosaccharides, and disaccharides
- explain which food items are sources of carbohydrates
- tell the types and importance of polysaccharides

Learning strategies

In addition to the learning strategies given under 3.1.2, ask the following question before starting the lesson and let the students perform the activities given hereunder.

What are carbohydrates?

Ask the students to answer the above question before starting the lesson. You can use the following description as the start up. Carbohydrates are a class of macromolecules that serve as an energy source for cells as well as structural support for plant cells, fungi, and all arthropods such as lobsters, crabs, shrimp, insects, and spiders. Carbohydrates are classified as monosaccharides, disaccharides, or polysaccharides based on the number of monomers in the molecule. Glycosidic bonds form as a result of dehydration reactions, forming disaccharides and polysaccharides while eliminating a water molecule for each bond formed. Common monosaccharides include glucose, galactose, and fructose, while common disaccharides include lactose, maltose, and sucrose. Polysaccharide examples include starch and glycogen, which are the storage forms of glucose in plants and animals, respectively.

The long polysaccharide chains may be branched or unbranched. Cellulose is an example of an unbranched polysaccharide; whereas, amylopectin, a constituent of starch, is a highly branched molecule. Glucose storage, in the form of polymers like starch or glycogen, makes it slightly less accessible for metabolism; however, this prevents it from leaking out of the cell or creating a high osmotic pressure that could cause the cell to uptake excessive water.

Suggested Active Learning Methods:

- Brainstorming, Gapped/enhanced lecture, questioning/answering, Drawing and labelling, Laboratory activities

Suggested Formative Continuous Assessment:

- Written/verbal test, assignment, homework, observation, presentation, and reflections.
- Assess students' prior knowledge, their misconception, and misunderstanding about carbohydrates
- Ask students how we can divide the carbohydrates based on their component elements and their roles in cells and the structure of an organisms
- Ask about the importance of the different types of carbohydrates

Which types of monosaccharide do you know? Mention and discuss the roles of commonly known monosaccharide for cells.

The most common monosaccharides are **Glucose, galactose, and fructose**.

Here, let us discuss the functions of one of the most common monosaccharides, glucose. Glucose serves as:

- a primary fuel to generate energy the body cells use to carry out their metabolic and biological functions. Through a series of complex biochemical reactions, the breakdown of glucose yields high-energy molecules called adenosine triphosphate (ATP). ATP molecules then provide the energy to drive the cellular activities that ultimately keep the body functioning and
- important for the brain, red blood cells, and muscle cells during exercise

The teacher will also state the functions of other monosaccharides.

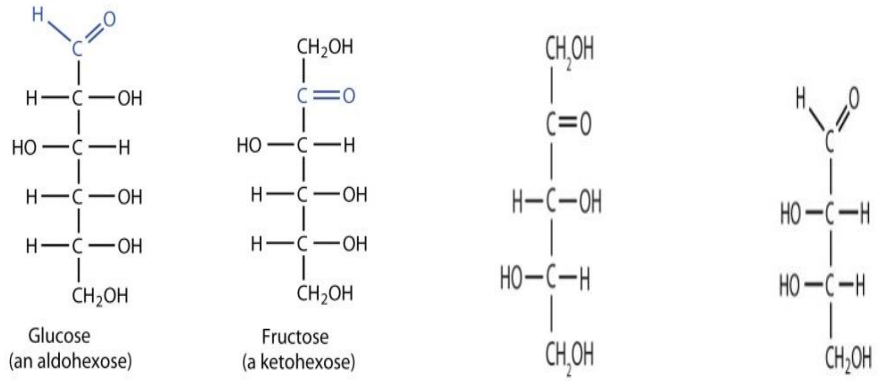
Feed back for Activity 3.7

The formula for a hexose is $C_6H_{12}O_6$ or $(CH_2O)_6$. What would be the formula of :

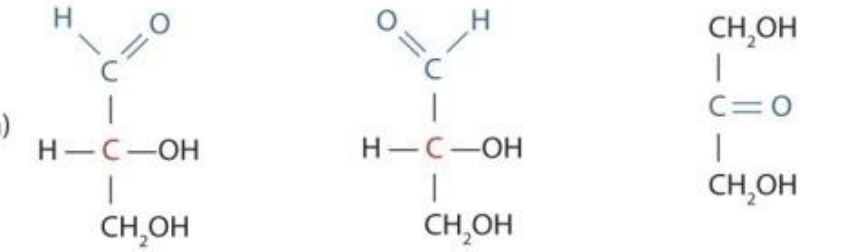
a. triose sugar? = $C_3H_6O_3$

b. tetrose sugar? = $C_4H_8O_4$

c. pentose sugar? = $C_5H_{10}O_5$

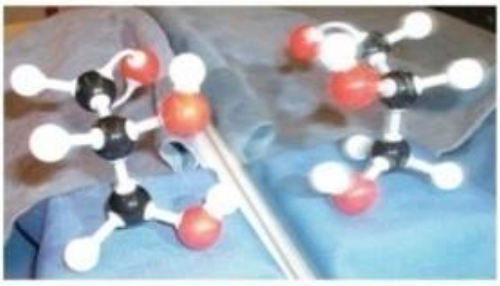


(a)



D–(+)–Glyceraldehyde L–(–)–Glyceraldehyde Dihydoxyacetone

(b)



Feedback to activity 3.8

In this activity, the teacher can give the student's pre-lesson assignment to study the structure and function of carbohydrates and prepare their diagrams and/or models of carbohydrates. During the lesson, if the student can't produce their own diagrams/models the teacher can provide the students with diagrams and/or models (as available) to the students, let them study the structure of the different types of carbohydrates, and state their functions for cells in the human body. A detailed teaching note is given in the students' textbook. The teacher can also broaden the lesson including locally available monosaccharides (glucose-containing food items such as honey), disaccharides (table sugar), and polysaccharides (starch containing maize, and glycogen containing liver), etc as an example.

Feedback to Activities 3.9

When performing this activity, students should be careful not to hurt their eyes with the vapours of the heating solution. The teacher should help them demonstrating how to hold the test tubes during heating in a water bath.

a) **Reducing sugar**
   Result: If a reducing sugar is present, the solution will gradually turn through green, yellow, and orange to red-brown as the insoluble copper (I) oxide forms a precipitate.
b) **Non-reducing sugar**
   Result: If the solution goes red now but didn't in the first stage of the test, there is no reducing sugar; If there is still no colour change, then there is no sugar of any kind present.

Feedback to activity 3.10

Here, the students are expected to do their survey on how the traditional beverages are prepared in different communities of Ethiopia. The ingredients used, the composition and processes of tella production are given here. The students can take the same or different type of local beverage and do their survey and present to the classroom. The teacher will finally, summarize the whole process of local beverages production and the ingredients used.

i) What is the process of malting?

Malting converts the grain, for instance, barley into malt, which provides the carbohydrates and sugars, and activates the necessary enzymes, that will be used in the fermentation process (the brewer's yeast will interact with the sugar solution and enzymes of the malt product).
Malting is a multi-step process involving: 1) soaking raw barley in water, which begins to break down the structure of the barley and release the desired sugars and enzymes; 2) steeping of the resultant barley seeds/kernels/ovens, which occurs in a controlled, sanitized tank environment where the air is passed through the barley (thus allowing the seeds/kernels to sprout and germinate); and 3) the drying of the sprouted barley in a heated kiln/oven. Malting creates malted barley. Brewers can purchase malted barley and subsequently soak and mash the malt in hot water, which will spark the enzyme activity in the malted barley, this gives the brewer access to fermentable sugar content, which the brewer's yeast will interact with.

ii) Why they use Gesho (*Rhamnus prinoides*)

In Ethiopia, gesho (*Rhamnus prinoides*) is particularly used to provide a special aroma and flavor. The chemical substances such as emodin, physcion, rhamnazin, prinoidin, and many other emodin-derived compounds were reported from *Rhamnus prinoides*. Among different chemical substances found in *Rhamnus prinoides*, naphthalenicglucoside, geshoidin is the basic bittering agent for beverages. Although gesho may have an antibacterial effect against some groups of bacteria, its main purpose in the process is believed to impart the typical bitter taste to tella. However, there is no in vivo test of gesho extract against pathogenic bacteria to determine the antimicrobial activity of gesho.

iii) Discuss the content of Difedef and the process that takes place in it.

Difedef is the final phase of local beer (Tella) production in Ethiopia. Tella brewing requires largely malted barley (*Hordeum vulgars*), Enkuro, gesho (*Rhamnus prinoides*) leaves and stems chopped to small pieces, kita (from different grains), or enkuro and derekot. Generally, tella is brewing from substrates such as barley, wheat, maize, millet, sorghum, teff, or other cereals. Commercial beer is mostly made from malted barley and adjunct like corn, rice or wheat provide the carbohydrate substrates for ethanol production by *Saccharomyces carlsbergensis* or *Saccharomyces cerevisiae*. Concerning the substrate, there is no such basic difference between tella and beer.

Tella brewing process is traditionally divided into three phases, namely tejet, tenses, and difedef. i) the milled bikil and the pounded gesho (stems and leaves) are added to the water and covered with net cloth and then allowed to ferment for 1-2 days in a big Earthen pot, ii) fermentation (tejet), either enkuro or kita will be added and ferment for about 5-7 days depending on environmental conditions, which is commonly known as tenses. iii) (difedef), the derekot flour will be mixed with the entire content of tenses and can be kept for 10 - 12 or more days depending on the use.

What do you think about the plant cells wall? Which biochemical molecules form cells wall?

The plant cell wall is made of cellulose. The whole strength of the plant is a result of the presence of cellulose in its cell structure. Plant cells maintain their shape as a result of cellulose. During turgor pressure plant cells would not burst because the cell wall is made of cellulose, strong enough to withstand the turgor pressure.

Feedback to activity 3.11

Answers for the questions:

1. Deep blue
2. Black
3. Reddish-brown

Lipids

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- discuss what are lipids
- tell the importance of lipids for our cells
- describe the structure of glycerol and fatty acids
- explain the importance of phospholipids in the cell membrane

Learning strategies

In addition to the learning strategies given under 3.1.2, ask the following question before starting the lesson and let the students perform the activities given hereunder.

What are lipids?

Lipids include a diverse group of compounds that are united by a common feature. Lipids are hydrophobic ("water-fearing"), or insoluble in water because they are nonpolar molecules. This is because they are hydrocarbons that include only nonpolar carbon-carbon or carbon-hydrogen bonds. Lipids perform many different functions in a cell. Cells store energy for long-term use in the form of lipids called **fats**. Lipids also provide insulation from the environment for plants and animals. For

example, they help keep aquatic birds and mammals dry because of their water-repelling nature. Lipids are also the building blocks of many hormones and are an important constituent of the plasma membrane. Lipids include fats, oils, waxes, phospholipids, and steroids.

A fat molecule, such as a triglyceride, consists of two main components—glycerol and fatty acids. Glycerol is an organic compound with three carbon atoms, five hydrogen atoms, and three hydroxyls (–OH) groups. Fatty acids have a long chain of hydrocarbons to which an acidic carboxyl group is attached, hence the name "fatty acid." The number of carbons in the fatty acid may range from 4 to 36; the most common are those containing 12–18 carbons. In a fat molecule, a fatty acid is attached to each of the three oxygen atoms in the –OH groups of the glycerol molecule with a covalent bond.

Feedback to activity 3.12

This is a good survey and scientific method. It will support the skills and knowledge of the students. Interactive and hands-on-minds-on teaching and learning approach. However, the teacher must guide during their study and briefly discuss why unsaturated fatty acids are healthier than saturated fatty acids. Some information on both fatty acids are given here below.

Saturated fatty acids elevate cholesterol, boost the risk of heart disease, and have a number of other negative health effects. They are distinguished by the fact that they are solid at room temperature. Saturated fat is found in a variety of animal-based foods including red meat, whole milk dairy products, butter, and egg yolks.

Unsaturated fatty acids are a type of fat that is good for you. Monounsaturated fatty acids and polyunsaturated fatty acids are the two types of fatty acids. These fats, contrary to popular opinion, can help lower cholesterol, lower your risk of heart disease, and enhance overall heart health.
Both types of unsaturated fatty acids can be found in a variety of nutritious meals. The majority of nuts and seeds are good choices. Many oils, such as avocado, peanut, olive, and canola oils, come into this category. Because they are liquid at ambient temperature, you can visibly identify them.

Suggested Active Learning Methods:

- Brainstorming, Gapped/enhanced lecture, questioning/answering, Drawing and labelling, Laboratory activities

Suggested Formative Continuous Assessment:

- Written/verbal test, assignment, homework, observation, presentation, and reflections.
- Assess students' prior knowledge, their misconception, and misunderstanding about Lipids
- Ask students how we can divide the lipids based on their component elements and their roles in cells and the structure of an organisms
- Ask about the importance of the different types of lipids

Feedback to activity 3.13

Pre lesson assignments can be given for the students to draw/construct their diagrams/models of lipids and study the structure and function of lipids independently. The next day when they come with their assignment complete, ask the students to form a group of 2-3 students and using diagrams/models, explore the contribution of lipids (Glycerol and fatty acids) as structural components of cells and their functions for cells and the human body as a whole.
Finally, you can summarize the lesson:

- Lipids are fats and oils made up of glycerol and fatty acid molecules
- Lipids are one of the major sources of energy for cells
- There are two types of fatty acids: saturated and unsaturated
- Fats are saturated fatty acids while oils are unsaturated, etc

Where in our body do we encounter fats?

Where in our body do we encounter fats?

In humans, fats/adipose tissue is located: beneath the skin (subcutaneous fat), around internal organs such as kidney (visceral fat), in bone marrow (yellow bone marrow), intramuscular (muscular system) and in the breast (breast tissue).

Feed back to Activity 3.14

Answers to the questions:

1. A milky-white emulsion forms if the test substance contains lipids.
2. Mixture of lipid droplets of microscopic or ultramicroscopic size, are distributed throughout the alcohol.
3. The whitish emulsion will not be formed

Feed back to Activity 3.15

Answers to the questions:

1. The paper immersed in a pure water dries and maintain its opacity
2. The paper in which the food is wrapped will turn translucent/ transparent to light.

Proteins

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- mention the importance of proteins to cells and the body of living things
- elaborate formation of proteins by amino acids
- differentiate proteins according to their structure
- difine what are amino acides
- group proteins according to their function

Learning strategies

In addition to the learning strategies given under 3.1.2, ask the following question before starting the lesson and let the students perform the activities given hereunder.

What are proteins?

Proteins are one of the most abundant organic molecules in living systems and have the most diverse range of functions of all macromolecules. Proteins may be structural, regulatory, contractile, or protective; they may serve in transport, storage, or membranes; or they may be toxins or enzymes. Each cell in a living system may contain thousands of different proteins, each with a unique function. Their structures, like their functions, vary greatly. They are all, however, polymers of amino acids, arranged in a linear sequence.

The functions of proteins are very diverse because there are 20 different chemically distinct amino acids that form long chains, and the amino acids can be in any order. For example, proteins can function as enzymes or hormones. **Enzymes**, which are produced by living cells, are catalysts in biochemical reactions (like digestion) and are usually proteins. Each enzyme is specific for the substrate (a reactant that binds to an enzyme) upon which it acts. Enzymes can function to break molecular bonds, rearrange bonds, or form new bonds. An example of an enzyme is salivary amylase, which breaks down amylose, a component of the starch.

Hormones are chemical signalling molecules, usually, proteins or steroids, secreted by an endocrine gland or group of endocrine cells that act to control or regulate specific physiological processes, including growth, development, metabolism, and reproduction. For example, insulin is a protein hormone that maintains blood glucose levels.

Proteins have different shapes and molecular weights; some proteins are globular in shape whereas others are fibrous. For example, hemoglobin is a globular protein, but collagen, found in our skin, is a fibrous protein. Protein shape is critical to its function. Changes in temperature, pH, and exposure

to chemicals may lead to permanent changes in the shape of the protein, leading to a loss of function or denaturation (to be discussed in more detail later). All proteins are made up of different arrangements of the same 20 kinds of amino acids.

Suggested Active Learning Methods:

- Brainstorming, Gapped/enhanced lecture, questioning/answering, Drawing and labelling, Laboratory activities

Suggested Formative Continuous Assessment:

- Written/verbal test, assignment, homework, observation, presentation, and reflections.
- Assess students' prior knowledge, their misconception, and misunderstanding about Proteins
- Ask students how we can divide proteins based on their component elements and their roles in cells and the structure of an organisms
- Ask about the importance of the different types of proteins

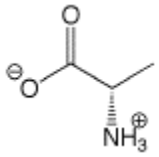
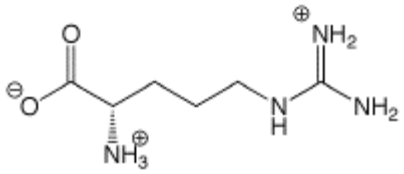
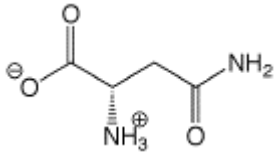
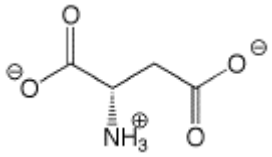
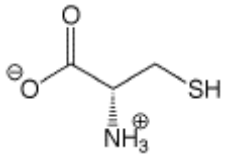
Activity 3.16 THINK-PAIR-SHARE

Dear teacher, the organic molecule, protein, is discussed in detail, and important points to know in grade 10 are mentioned. Besides, the structure and formation of proteins from monomers are illustrated in the student's textbook. Therefore, before you start the lesson on proteins let the students form a group of 2-3 students, write down what they know about proteins independently and discuss in the group they form. Then, you can start your lesson and finally, summarize focusing on those points the students may miss and those points they are discussed shallow.

Amino acids

What are amino acids?

Amino acids are the monomers that makeup proteins. There are about 20 most common amino acids. Each amino acid has the same fundamental structure, which consists of a central carbon atom bonded to an amino group ($–NH_2$), a carboxyl group (–COOH), and a hydrogen atom. Every amino acid also has another variable atom or group of atoms bonded to the central carbon atom known as the R group. The R group is the only difference in structure between the 20 amino acids; otherwise, the amino acids are identical. The structures of some amino acids are given below.

name	three letter code	one letter code	structure
alanine	Ala	A	
arginine	Arg	R	
asparagine	Asn	N	
aspartic acid	Asp	D	
cysteine	Cys	C	

Amino acids are made up of a central carbon bonded to an amino group (–NH2), a carboxyl group (–COOH), and a hydrogen atom. The central carbon's fourth bond varies among the different amino acids, as seen in these examples of alanine, valine, lysine, and aspartic acid.

The chemical nature of the R group determines the chemical nature of the amino acid within its protein (that is, whether it is acidic, basic, polar, or nonpolar). The sequence and number of amino acids ultimately determine a protein's shape, size, and function. Each amino acid is attached to another amino acid by a covalent bond, known as a peptide bond, which is formed by a dehydration reaction. The carboxyl group of one amino acid and the amino group of a second amino acid combine, releasing a water molecule. The resulting bond is the peptide bond.

The products formed by such a linkage are called **polypeptides**. While the terms polypeptide and protein are sometimes used interchangeably, a polypeptide is technically a polymer of amino acids, whereas the term protein is used for a polypeptide or polypeptides that have combined, have a distinct shape, and have a unique function.

Do you have any idea about the structure of proteins?

Ask the students to form a group of 2-3 students and using diagrams/models, explore the contribution

of proteins (Globular and fibrous/Functional and structural) as structural components of cells and their functions for cells and the human body as a whole. Help the students during their study of the two types of proteins. Request them to give some examples of the two types of proteins and fill the gap if they miss any point.

Feedback to Activity 3.18

1. Milk is an easy food to test because it's a liquid. You can also test solids, such as meat, cheese, or vegetables. You must first grind the food by hand or by using a blender.
2. The creation of a chelate complex, or copper coordination complex, is responsible for its colour change. Using oxygen from water and the unshared electron pairs of peptide nitrogen, Cu (II) or cupric ions form a **violet-coloured chelate** complex. This compound appears violet because it absorbs light at 540 nm.
3. The Biuret reagents, which include a 1 percent solution of Copper II sulphate ($CuSO_4$), are used in a chemical test known as the Biuret test. The Cu^{2+} in the Biuret reagent binds to the peptide bonds in proteins, forming a complex. As a result, this test aids in the identification of peptide bonds in any substance.

Feedback to Activity 3.19

Answers to the questions

1. Yellow 2. Orange 3. Orange

Feedback to Activity 3.20

Answers to the questions

1. yellow precipitate of mercury-amino acid complex
2. Red colour
3. The phenol group in the side chain of tyrosine is nitrated in the test, and the resulting product subsequently forms a compound with Hg(I) or Hg(II) ions, resulting in a **red colouring** or precipitate.

Nucleic acids

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- describe the structures of nucleotides and nucleic acids
- differentiate between DNA and RNA
- explain the roles of DNA and RNA in transcription and translation

Learning strategies

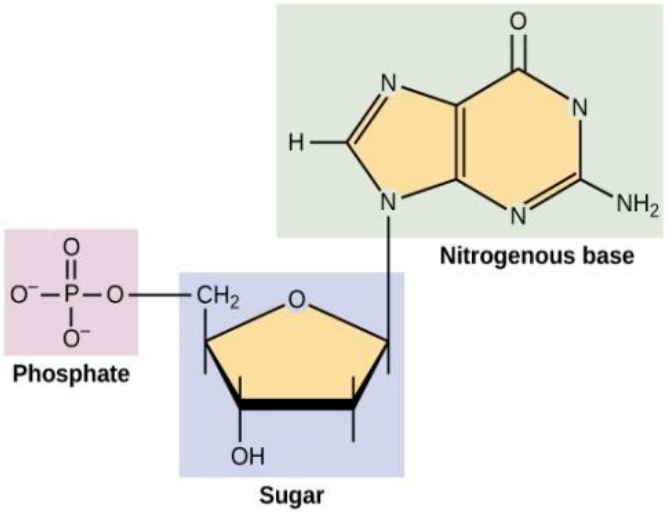
In addition to the learning strategies given under nucleic acids ask the following question before starting the lesson and let the students perform the activities given hereunder.

What are nucleic acids?

Nucleic acids are key macromolecules in the continuity of life. They carry the genetic blueprint of a cell and carry instructions for the functioning of the cell. The two main types of nucleic acids are **deoxyribonucleic acid (DNA)** and **ribonucleic acid (RNA)**. DNA is the genetic material found in all living organisms, ranging from single-celled bacteria to multicellular mammals.

The other type of nucleic acid, RNA, is mostly involved in protein synthesis. The DNA molecules never leave the nucleus, but instead, use an RNA intermediary to communicate with the rest of the cell. Other types of RNA are also involved in protein synthesis and its regulation.

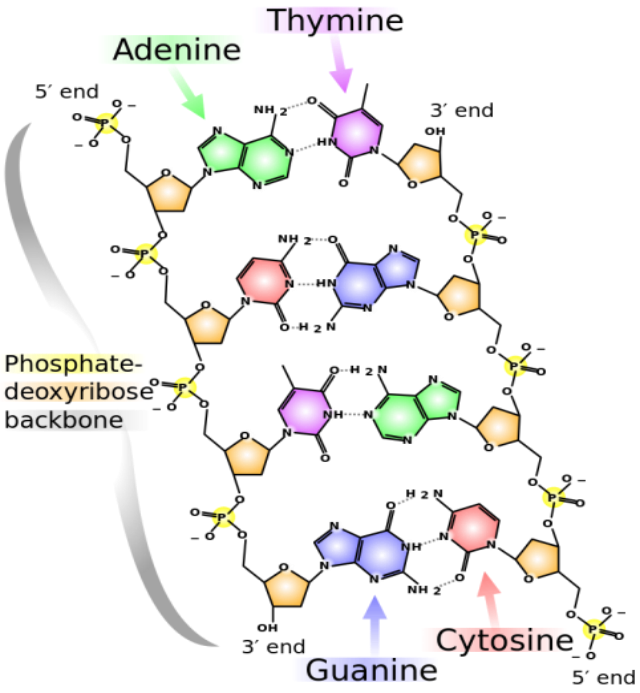
DNA and RNA are made up of monomers known as **nucleotides**. The nucleotides combine to form a polynucleotide, DNA, or RNA. Each nucleotide is made up of three components: a nitrogenous base, a pentose (five-carbon) sugar, and a phosphate group. Each nitrogenous base in a nucleotide is attached to a sugar molecule, which is attached to a phosphate group.



A nucleotide

DNA Double-Helical Structure

DNA has a double-helical structure. It is composed of two strands, or polymers, of nucleotides. The strands are formed with bonds between phosphate and sugar groups of adjacent nucleotides. The strands are bonded to each other at their bases with hydrogen bonds, and the strands coil about each other along their length, hence the "double helix" description, which means a double spiral.



Chemical structure of DNA, with a coloured label identifying the four bases as well as the phosphate and deoxyribose components of the backbone.

The alternating sugar and phosphate groups lie on the outside of each strand, forming the backbone of the DNA. The nitrogenous bases are stacked in the interior, like the steps of a staircase, and these bases pair; the pairs are bound to each other by hydrogen bonds. The bases pair in such a way that the distance between the backbones of the two strands is the same all along the molecule. The rule is that nucleotide A pairs with nucleotide T and G with C.

If you were asked to design a molecule that could act as the genetic material in living things, where would you start?

= with DNA and RNA. Because DNA is the genetic material that carries hereditary information from parents to offspring.

Feedback to Activity 3.21

Ask the students to construct DNA and RNA model from locally available materials. To do these activities form a group of 3-4 students. Let them construct the model and using their diagrams/models, explore the contribution of Nucleic acids (DNA and RNA) as components of cells and their functions (inheritance) for cells and the human body as a whole.

ANSWER TO REVIEW QUESTIONS

I. True- False Items

1. F 6. F
2. T 7. T
3. F 8. T
4. F 9. F
5. T 10. T

II. Answer for the review questions

1. A	6. D	11. C	16. A
2. A	7. A	12. D	
3. C	8. D	13. A	
4. D	9. D	14. A	
5. C	10. A	15. A	

III. Fill in the blank Items

	Globular protein e.g. Haemoglobin	Fibrous protein e.g.	Monosacchari	Disaccharide	Glycogen	Starch	Cellulose	Lipid
Monomer			x					
Polymer	x	x		x		x	x	x
Macromolecule					x	x	x	x
Polysaccharide					x	x		
Contain subunits that form branched chain					x	x		
Contains amino acids	x	x						
Made from organic acids and glycerol								x
Contain glycosidic bonds				x	x	x	x	
Contain peptide bond	x	x						
One of its main functions is to act as an energy store			x	x	x	x	x	x
Usually insoluble in water								x
Usually has a structural function		x					x	
Contain the elements Carbon, Hydrogen and Oxygen only	x	x	x	x	x	x	x	x

IV. Short answer questions

1. Why biological macromolecules are considered organic?

Biological macromolecules are considered organic **because they contain carbon**

2. Describe the similarities and differences between glycogen and starch.

Glycogen is composed of only one molecule, whereas starch is composed of two. While both are glucose polymers, glycogen is produced by animals and is referred to as animal starch, whereas starch is produced by plants. Glycogen has a branched structure, whereas starch has both a chain and a branched structure.

3. Explain at least three functions that lipids serve in plants and/or animals.

A) lipids serve in the storage of energy,

B) serve as a structural component of hormones, and

C) serve as signalling molecules.

4. Food items that contain calcium are:

= leafy vegetables, egg yolk, fish, and beans, etc.

5. The importance of high latent heat of vaporization

= The latent heat of vaporization is a measure of the thermal energy required to vaporize a liquid, converting it from a liquid to a gas.

6. How cohesion and adhesion are different?

= cohesion is when the water molecules stick to each other, while adhesion the condition in which the water molecules adhere to the wall of the container or the capillarity

7. Plants must get water from their roots to their branches. Explain how cohesion and adhesion might help plant get water from the ground to its upper leaves?

= water moves upward through xylem vessels. When the leaves release water molecules in the form of water vapour, the other water molecules are attracted upwards continuously. In the process the effect of cohesion and adhesion of water molecule are effective. The phenomena are called transpiration pool.

8. Why do phospholipids form lipid bi-layers in aqueous conditions?

= Being cylindrical, **phospholipid molecules spontaneously form bilayers** in aqueous environments. In this energetically most-favorable arrangement, the hydrophilic heads face the water at each surface of the bilayer, and the hydrophobic tails are shielded from the water in the interior.

9. Unlike glycogen storage in human body, fat storage is unlimited. Why?

= Fat is the body's most concentrated source of energy, providing more than twice as much potential energy as carbohydrate or protein (9 calories per gram versus 4 calories each per gram). During exercise, stored fat in the body (in the form of triglycerides in adipose or fat tissue) is broken down into fatty acids. These fatty acids are transported through the blood to muscles for fuel. This process occurs relatively slowly as compared with the mobilization of carbohydrate for fuel. Fat is also stored within muscle fibers, where it can be more easily accessed during exercise. Unlike your glycogen stores, which are limited, body fat is a virtually unlimited source of energy for athletes. Even those who are lean and mean have enough fat stored in muscle fibers and fat cells to supply up to 100,000 calories enough for over 100 hours of marathon running.

Unit 4: Cell Cycle 13 periods

Contents	Learning competency
4.1 What is a cell cycle 4.2 Cell division 4.2.1 Mitosis 4.2.2 Meiosis 4.3 Renowned Geneticist in Ethiopia	At the end of this unit, the student will be able to: ▪ outline the series of events taking place in the cell cycle ▪ identify the two types of cell division ▪ compare and contrast Mitosis and Meiosis ▪ explain the importance of cell division ▪ recognize the occurrence of cancer cells due to failure to control the cell cycle ▪ appreciate the works of renowned Ethiopian Geneticist

4.1 What is a Cell cycle?

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- define cell cycle
- outline the different stages of cell cycle
- collect information on cancer

Learning strategies

Before dealing cell cycle it is important that students should refresh their memory of grade 9 (Unit 3: Cells) about the cell organelles/structure. For this purpose, Activity 4.1 in the student's text is given as role-play to recapitulate the lesson on eukaryotic cell. In this activity students are instructed to construct two dimensional (2D) model of animal cell in a role play using local or home materials. They can be encouraged to construct a similar model of plant cell or 3D model cell using paper mashe, where they can easily show shape and arrangement of cell organelles/ structures in nucleus and cytoplasm of a cell.

Feedback to activity 4.1

✓ The nucleus is the main organelle of a cell containing the genetic material (chromosome) and the nucleolus. In eukaryotic cell, the nucleus is bounded by nuclear membrane. The chromosome is well organized with DNA (genetic material) covered by histone (protein cover). The nuclear division is actually arrangement and redistribution of duplicated chromosomes between daughter cells

- ✓ The nucleolus is a distinct structure covering nearly 25% volume of the nucleus. It is a sub organelle without membrane and plays an important role in the production of ribosomes and synthesis of protein.

With regard to cell cycle, the teacher can start the lesson with the common misconception that the cell cycle and mitosis are synonymous. It is important that students understand mitosis as just one part of the cell cycle. Let students realize there is interphase before mitosis and cytokinesis (cytoplasmic division) following mitosis. It should be noted that mitotic phase is the shortest portion of the cell cycle. It is interphase that accounts for about 90% of the cell cycle. Activity 4.2 in the student 's text allow students to estimate the proportion of the two phases From the activity students should point out why the cell spends the longest time on the interphase .

Let students realize that considering the interphase as "**resting stage"** is a misconception. The cell seems resting, particularly at the initial stage (G_1 stage), because from a microscopic aspect, little change is visible. However, even during G_1stage, the cell is quite active at the biochemical level. During its G_1 stage the cell slowly grows and accumulates the building units (nucleotides) of DNA and the associated proteins as well as sufficient energy reserves to complete the task of duplicating each chromosomes.

The teacher should elaborate the three phases of interphase (G_1, S, G_2) by clearly stating what the cell accomplishes before starting cell division. He/she should emphasize that the stages are continuous and there is nothing static. Students should not worry too much about terms or order of events, but should focus on what happens at each stage of the interphase and cell division. They should also point out the importance of each stage of the cell cycle. Be sure that students have removed their prior misconception and realized that the interphase is

- ✓ the phase of cell cycle in which a typical cell spends most of its life
- ✓ the "daily life" or "routine metabolic duty" of the cell , in which the cell assembles metabolites, grows , duplicates its DNA and its cytoplasmic structures in preparation for mitosis or meiosis as well as cytokinesis and conducts other cell functions . Thus, interphase is the time where a cell is very busy.

Suggested Active Learning Methods:

Brainstorming, Think – pair – Share, Gapped /enhanced lecture, Students' presentation (peer – learning)

Suggested Formative Continuous Assessment

- Giving students chance to share and reflect their idea
- Asking oral questions to reinforce students' understanding
- Consolidating key points flowing students' presentation.

Feedback to activity 4.2

- Cells spend most of their time in interphase. Assuming 24 hour cell cycle average duration of 4hr, 9hr, and 5 hr are needed to complete G_1, S and G_2 . The remaining 6 hrs will be devoted to cell division (nuclear division/mitosis followed by cytoplasmic division) with less than 1 hr for mitosis. Accordingly, percentage of time for interphase as compared to cell division (mitosis& cytokinesis) is 80% and 20% respectively , while cells spend only 5% of their cell cycle time in mitosis. Cytokinesis takes about 15% of the cell cycle time.
- Cell spends most of its time in the interphase , because it performs multiple activities including growing and preparing itself for cell division by
  - ✓ assembling the building blocks of chromosomal DNA and the associated proteins
  - ✓ completing the task of replicating each chromosome in the nucleus
  - ✓ synthesizing proteins necessary for chromosome manipulation and movement.
  - ✓ duplicating some cell organelles .

- Each stage of cell cycle is not static . This means the processes in the interphase and cell division is continuous and does not stop,. The distinct stages are indicated to show the specific changes that occur in the pattern of cell cycle.

Feed back to activity 4.3

The teacher has to arrange a session where at least two or three groups present their team work (field report) on cancer. Let the group summarize key points reflected on the following leading questions given to them with regard to cancer

- ✓ What is cancer?
- ✓ How does cancer affect a person?
- ✓ What should be done to prevent cancer?
- ✓ How can cancer patients be treated?

4.2 The Cell division

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- recognize the causes of cell division
- explain the importance of cell division

Learning strategies

Before learning about cell division, it is important that students refresh their memory on cell structure and function dealt in grade 9 and sub – section 3.3 in the students' text. The teacher can ask students

how they understand cell division and why a cell divides. In this sub - section he/she has to explain cell division as continuous process with discrete phases. The teacher should focus on understanding, not on memorization of phase names and unnecessary terms. The traditional approach that focuses too heavily on identifying the various phases of cell division, particularly those of mitosis and meiosis and placing them in their proper order is not an end by itself. The teacher shou;d rather inform students about the importance of cell division in living systems (E.g. maintenance of chromosome number, reducing chromosome number by half in sex cells, increasing variation and diversity, replacing dead cells and worn out tissues, increasing cell numbers for growth and reproduction, etc, and how the events of cell division lead to these results.

It is also essential to show cell division from cell cycle perspective including interphase, mitosis or meiosis and cytokinesis.

Suggested Active Learning Methods:
Brainstorming, Think – Pair – Share, Questioning, Reflection

Suggested Formative Continuous Assessment

- Giving students chance to share and reflect their idea
- Asking oral questions to reinforce students' understanding

Feedback to activity 4.4

- Cell division is a means to increase cell number. These cells are means of repairing the body and for tissue renewal as well as for growth. Tissue renewal is common in adults while growth is needed in a child. Hence, mitosis in adult is mainly for tissue renewal, while it is mainly for growth in children.

- Skin and hair are part of the body where cells are undergoing continuous replacement, because skin and hair cells are damaged frequently.

4.2.1 Mitosis

Specific learning objectives

By the end of this sub – topic, the student will be able to:
- outline the pattern of mitotic cell division
- tell how mitosis produces daughter cells as an exact copy of mother cell
- point out the importance of mitosis

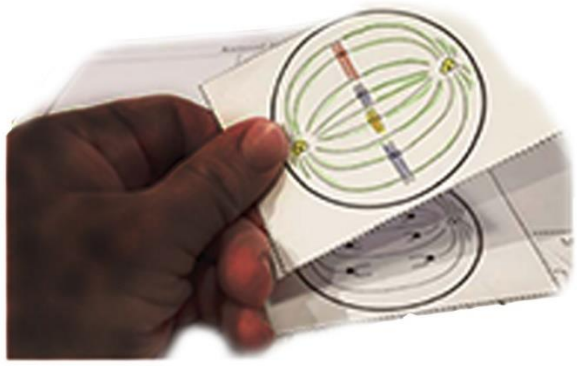
Learning strategies

The teacher can start the lesson with the misconceptions, which frequently interfere with students' learning. For instance, mitosis and cell division are widely considered as synonymous and used

interchangeably. Let students understand that mitosis is one type of nuclear division and there are distinct stages before and after mitosis, respectively known as interphase and cytokinesis (cytoplasmic division). Let the teacher inform students, that there is also another type of nuclear division known as meiosis, which they will learn in detail in sub – section 4.2.2 in the student's text.

The teacher should focus on the importance of mitosis as a mechanism of nuclear division that enables daughter cells to receive hereditary materials that are essentially identical in quantity and quality with one another and to the parental cell undergoing division.

The teacher has to use Figure. 4.2 in student's text to explain the four distinct yet continuous phases of mitosis: Prophase, Metaphase, Anaphase and Telophase. He/she can also arrange poster sessions, where students will be engaged in group activity. Students can use coloured threads to represent chromosomes (homologous and sister chromatids) and spindle fibers as shown in the next Figure. They can start the activity with a pair of homologous chromosomes (Our mother and father chromosomes represented by differently coloured threads). They can first start from interphase and create a copy (**duplication/doubling**), to represent sister chromatids. Next, they go for **aligning (**arranging in the central plane**)** as shown in the Figure below. Then do **separating** (sister chromatids separate and pulled to opposite ends of the cell).



The teacher should ask students to identify the importance of each phase. Students should avoid rote memorization of names of each phase and focus on brief descriptions as much as possible.

Students should know that all the cells in our body originate from the fertilized egg cell developing into multicellular zygote by repeated mitotic division. The zygote and all the descendent cells in our body, with the exception of the gametes (egg and sperm), have identical types and number of chromosomes.

The prokaryotic cells (E.g. Bacteria) lack a definite nucleus. Their genetic material is not organized into chromosomes. They do not divide by mitosis.

Suggested Active Learning Methods:

Brainstorming, Think – pair – Share, Questioning, Reflection

Suggested Formative Continuous Assessment

- Giving students chance to share and reflect their idea
- Asking oral questions to reinforce students' understanding

Feedback to activity 4.5

Letters "A" to "E" included in the Figure (in the activity 4.5 box in students' text) represent the following phases of mitosis

A = Prophase B = Interphase C= Anaphase D = Telophase

D = Cytokinesis (two daughter nuclei, before cell plate formation)

Let students know how cytokinesis in plant cell occurs differently from animal cell. Plant cells divide into two by constructing a cell plate in the middle plane between daughter nuclei after mitosis. A cell plate is deposition of hard carbohydrates (mainly cellulose), which will become the cell wall of the daughter cells.

4.2.2 Meiosis

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- outline the pattern of cell division by meiosis
- tell the importance of meiosis
- point out the difference between mitosis and meiosis

Learning strategies

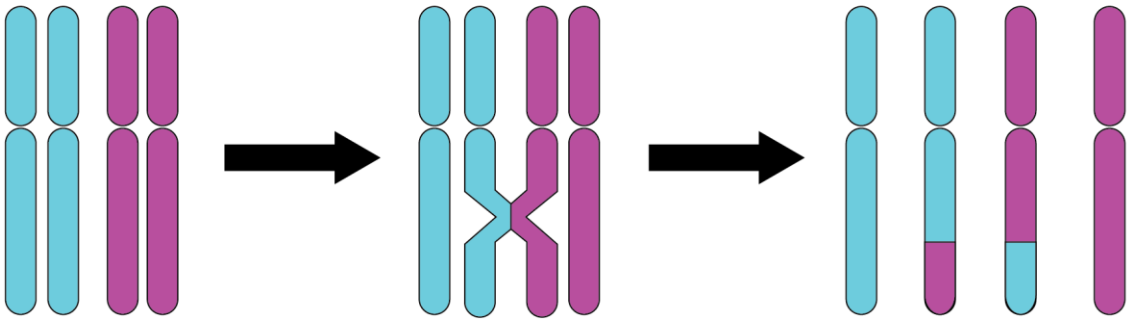
Meiosis is complicated and has more stages than 4.1.1 Mitosis. The cell divides twice and four daughter cells are formed. It should be clear to students that chromosomes occur in homologous pair, an in sexually reproducing organism one chromosome for each homologous chromosome pair is contributed by each parent (paternal and maternal chromosomes).

During gamete formation by meiotic division, the homologous chromosomes of each pair separate and as a result a gamete receive either the paternal or the maternal from each homologous pair.

What is very important in gametes is that there is only one chromosome representing either the mother or the father and each chromosome is represented once in each gamete.

The teacher can arrange a poster session to show **duplication, alignment and separation** of chromosomes as it was done for mitosis. Students can create a drawing for each stage of meiosis and explain their drawing to their classmates. However, follow up and identifying learning difficulties by the teacher should be done, because meiosis is a bit complex and difficult to understand. The following

illustration can help how crossing over occurs in meiosis. Crossing over, which creates variation (difference) in genetic make – up of the gametes (daughter cells) is absent in mitosis.



Suggested Active Learning Methods

Drawing, Think – pair – Share, Cooperative learning, Explanation

Suggested Formative Continuous Assessment

- Giving students chance to share and reflect their idea
- Following up and identifying learning difficulties

Feedback to activity 4.6

It is Meiosis II that is similar with mitosis because it is sister chromatids that separate and migrate to opposite ends. Each end receive one copy of the sister chromatids.

The similarities between mitosis and meiosis are as follows

- Both processes occur in the cell nuclei
- Both involves the interphase and cell division
- They have common stages – Prophase, metaphase , anaphase and telophase
- Synthesis of DNA occurs in both
- Both produce daughter cells based on their parent cells' DNA

Difference between mitosis and meiosis

Mitosis	Meiosis
▪ **Involves one cell division**	▪ Involves two cell divisions.
▪ Results in two daughter cells called somatic (body cells)	▪ Results in four daughter cells called sex cells (gametes)
▪ Daughter cells are diploid (2n), identical to one another and the diploid (2n) parent cell	▪ Daughter cells are haploid (n), chromosomes number is halved from the parent cell.
▪ Occurs where growth and replacement of damaged or worn out cells occur	▪ Restricted to gonads (testes and ovaries in animals), anthers and ovules of flowering plants
▪ No crossing over occurs in prophase	▪ Crossing over occurs in prophase I

4.2.3 Renowned Ethiopian geneticists

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- appreciate the work of a renowned geneticist
- look for more Ethiopian Geneticist who contributed a lot to their field

Learning strategies

The objective of this brief section is to inspire students based on the outstanding contribution of a renowned Ethiopian Geneticists to his profession, to his country and to the whole world. Let students read the contribution of Dr. Melaku Worede from their textbook and share their impression about his work to their classmates.

ANSWER TO REVIEW QUESTIONS

I. True – False items

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

II. Matching items

1. B 2. C 3. G 4. E 5. A 6. F

III. Short answer items

- Meiosis is important to sexually reproducing organisms because it is a means of getting gametes or sex cells. For instance, meiosis in human takes place in the reproductive organs known as **Gonads** - testes in male and ovaries in female. Meiosis in male is termed as spermatogenesis, and known as Oogenesis in female. occurs as part of a sexual process known as gametogenesis.

- Unlike normal cells, cancerous cells have the following features

✓ They have limitless replicative potential. They do not stop growing and dividing , this uncontrolled growth results in the formation of tumour

✓ They are insensitive to growth inhibitors (antigrowth) signals

✓ They have the capacity to migrate and invade other tissues and organs, resulting in their spread throughout the body.

- Interphase is a separate phase that takes place before mitosis. It is during the interphase that the cell show growth, DNA synthesis and replication of genetic material takes place. Metabolic changes assemble the cytoplasmic materials necessary for mitosis and cytokinesis occur during interphase.
- Prophase is one of the four phases of mitosis where
- Duplicated chromosome, composed of two sister chromatids and, containing identical genetic material pairs up.
- If there is no cytoplasmic division occurring at the end of telophase, the division will not end by giving daughter cells.
- If a cell is having 2n=40 divide by meiosis
- There will be two cells at the end of meiosis I and four cells at the end of meiosis II
- There will be 40 chromosomes in each daughter cells at the end of meiosis I and 20 chromosomes at the end of meiosis ii?
- There will be haploid sets of chromosomes at the end of both meiosis I and meiosis II
- the nuclear membrane breaks down, the nucleolus disappears
- chromosomes shorten, thicken and become visible.

Unit 5: Human Biology

Content	learning competency
5.1. Digestive system 5.2. Circulatory and Lymphatic system 5.2.1. Blood donation 5.2.2. Diseases of the circulatory and lymphatic systems (leukemia, varicose vein, elephantiasis, cardiovascular diseases) 5.3. Breathing system 5.4. The excretory system 5.5. The immune system 5.6. Renowned Physicians in Ethiopia	At the end of this unit, the student will be able to: • discuss the structure and function of the digestive system (alimentary canal and accessory organs). • classify the types of digestion along the alimentary canal • list the end products of carbohydrates, proteins, and fats after complete digestion • express the site of absorption of digested food, minerals, vitamins, and water • explore structural adaptations of the small intestine for the absorption • differentiate the absorption routs of different end products of digestion (hint: lacteals, capillaries) • group enzymes of the digestive system based on their roles and pH • demonstrate the structure of the heart using a heart model/ diagram • differentiate between pulmonary and systemic circulations. • compare and contrast arteries and veins based on their structures and functions • debate on the importance of blood donation and its health implications on the donors and recipients. • discuss the key functions and components of the lymphatic system. • define the immune system • discuss the types of immunity (innate and acquired). • relate the lymphatic system with the immune system • discuss the diseases of the circulatory and lymphatic systems (leukemia, varicose vein, elephantiasis, cardiovascular diseases) • draw and label the human breathing and excretory systems • show the link between the human breathing system and the circulatory system • demonstrate the mechanism of breathing using locally available materials • design a model of one of the systems (excretory, circulatory, digestive systems) using locally available materials ▪ examine the effects of smoking and cannabis on the normal functioning of the breathing systems.

5.1 The digestive system

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- discuss the structure and function of the digestive system (alimentary canal and accessory organs).
- classify the types of digestion along the alimentary canal
- list the end products of carbohydrates, proteins, and fats after complete digestion
- express the site of absorption of digested food, minerals, vitamins, and water
- explore structural adaptations of the small intestine for the absorption
- differentiate the absorption routs of different end products of digestion (hint: lacteals, capillaries)
- group enzymes of the digestive system based on their roles and pH

What do you know about the digestive system?

Learning strategies

Before beginning the lesson ask the students the above question and let them tell you what they know about the digestive system. And then you can briefly discuss what the digestive system is as given below. The main organs that make up the digestive system, in order of their function are **the mouth, oesophagus, stomach, small intestine, large intestine, rectum, and anus**. Helping them along the way are the accessory organs such as the pancreas, gall bladder, and liver. Finally, discuss how all organs work together and what the products of digestion at each stem are. In addition to these, you should discuss the enzyme teamwork beginning the mouth up to the small intestine. More to these:

- Let students discuss in the group the structure and functions of the digestive system; draw, label, and study the route of the alimentary canal and the types of digestion (mechanical and chemical) along the alimentary canal; digestion end products. Let them support this activity using a virtual lab (digestive system animation).
- Let the students sit in groups, and discuss the sites of absorption of digested foods, minerals, vitamins, water; the structural adaptation of the small intestine (villi with lacteals and capillaries) for absorption. Present their work to the class. Finally, the teacher will summarize the sites of absorption; adaptations of the small intestine for absorption, and the roles of lacteals and capillaries
- Let students conduct library/internet search on groups of enzymes associated with digestion of different food staffs, the sites of their action, and the required environment (pH) for each group. Present to the class for discussion

Suggested Active Learning Methods:

- Brainstorming, Gapped/enhanced lecture, questioning/answering, Drawing and labelling
- Lecture demonstration, models and practical activity

Suggested Formative Continuous Assessment:

- Written/verbal test, assignment, homework, observation, presentation, and reflections.
- Assess students' prior knowledge, their misconception, and misunderstanding about the digestive system
- Ask students how we can divide the digestive system based on their functions, their roles in the process of food digestion, absorption and excretion.
- Ask about the importance of the different types of enzymes involved in the digestive process beginning from the mouth to the small intestine.

Feedback to activity 5.1 **THINK-PAIR-SHARE**

In your previous grades, you have studied the digestive system of human beings. Now, being in groups of 2-3 students on the same desk discuss what you know about the digestive system and the process that takes place beginning from the mouth up to the anus and let one of you share it with the whole class.

Feedback to the Question:

What are the components and processes of the digestive system?

The component process of the digestive system includes ingestion, digestion, absorption, and ejection. The process begins in the mouth and ends up by the ejection of the indigestible part of the food through the anus.

How long is the human digestive system? Where in the alimentary canal does physical digestion begin?

The digestive tract of adult humans is normally 6.5m to 9m long. It stores and breaks down organic molecules into simpler components. Physical digestion begins in the mouth with the breakdown of the food entering the mouth into smaller pieces by our teeth.

Feedback to Activity 5.2

Here, according to activity 5.2, the students in groups of 3-4 discuss the digestive system, its structures, and function throughout the alimentary canal. In this activity, students are expected to prepare models of the digestive system and/or draw the digestive system, label it and talk about the type of digestion that takes place at each step in the alimentary canal. Mentioning the digestive end products at each step/part of the alimentary canal is worthwhile.

Besides model/ chart preparation, the students can use simulations/ virtual lab (digestive system animation using the internet and other resources. During this activity, the teacher should assist their

students. Help them where support is necessary. Finally, let the teachers motivate the students to present what they have prepared for the whole classroom.

Where in the alimentary canal does the chemical digestion begins?

In the alimentary canal, chemical digestion begins in the mouth.

What is the process of digestion that takes place in the mouth?

In the mouth, carbohydrate digestion begins. During mastication of the food we eat, salivary amylase secretes and mixes with the food. Salivary amylase begins the digestion of carbohydrates into simpler forms that are going to be further acted by other enzymes in the stomach and the small intestine.

Feedback to activity 5.3

Based on the information that is transported from the tongue to the brain, there are thought to be at least five basic qualities of taste. Many dishes are made up of a combination of different tastes. Some dishes taste sweet-sour, for example, while others are salty and savory. Food containing table salt is mainly what we taste as salty. The chemical basis of this taste is salt crystal, which consists of sodium and chloride. Mineral salts like the salts of potassium or magnesium can also cause a sensation of saltiness. We test salt when it is in a dissolved form to trigger the sense of taste.

If one ingests glucose, where will it be digested?

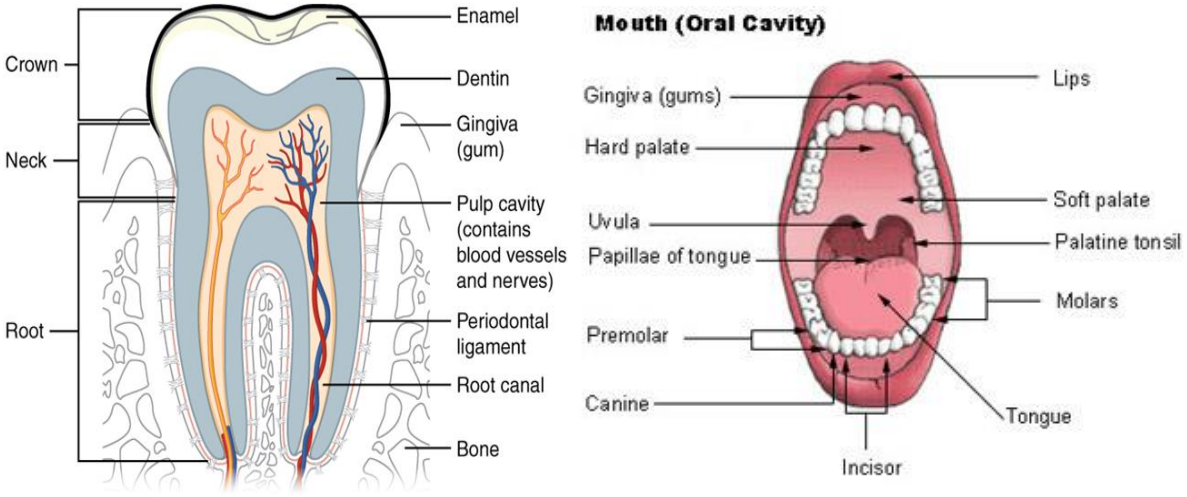
The digestion of starch begins as soon as it enters the mouth, where salivary amylase breaks down around 30% of the starch into disaccharides, with the rest of the digestion and absorption taking place in the small intestine with the help of pancreatic and intestinal juice.

What is the importance of teeth? Can you mention the different types of teeth?

The teeth are important structures for physical digestion. There are 4 different types of teeth: **Incisors, Canine, Premolar,** and **Molars** that perform different activities.

Feedback to activity 5.4

The feedback below is based on the diagram hereunder.



Functions of each teeth type

i) **Incisors** eight chisel-shaped teeth at the front of your mouth specialized for cutting.
ii) **Canine** teeth that are sharp, dagger-shaped specialized for tearing.
iii) **Premolar** teeth that are broad flattened specialized for grinding.
iv) **Molars** tend to be even broader and have cusps that are even more flattened. They are designed for crushing food. The last set of molars is the **wisdom teeth** that do note merge until we reach about 16 to 20 years of age. Each tooth is covered with enamel, which is the hardest substance in the human body.

Reasons for teeth decay includes:

i. Bacteria in the mouth feed on sugary, starchy foods and drinks (fruit, candy, bread, cereal, sodas, juice, and milk)
ii. Bacteria, acid, food, and saliva mix to form plaque
iii. Without proper brushing and flossing, acids in plaque dissolve tooth enamel, creating cavities, or holes.

Feedback to activity 5.5

After studying the digestive system in the mouth answer the following questions:

1. Discuss the structure and function of the teeth
   The teeth structurally have 4 parts: The root, the neck, crown, and Enamel. At the center of each tooth, there is a pulp cavity that contains blood vessels and nerves. The root is anchored to the upper and lower jaws. The basic function of the teeth is breaking down food particles into pieces.
2. What are the functions of saliva?
   Saliva moistens the food we eat and contains salivary amylase that digests carbohydrates in the mouth.

3. How does chewing assist in the digestion of food?

   As has been mentioned above chewing breaks down the food particles making them ready for chemical digestion.

4. What are amylase enzymes and why are they necessary?

   Amylase is a hydrolytic enzyme that breaks carbohydrates into lower-grade molecules such as disaccharides.

5. How is food moved along the esophagus?

   After food are digested travels from the mouth to the stomach by way of the esophagus. The **bolus** of food stretches the walls of the esophagus, activating muscles that set up waves of rhythmic contractions called peristalsis. Peristaltic contractions, which are involuntary, move food along the gastrointestinal tract. Peristaltic action will move food or fluid from the oesophagus to the stomach.

What are the processes of digestion that takes place in the stomach?

The stomach is the site of food storage and initial protein digestion. The stomach contains three layers of muscle, which run in different directions so that the muscle contractions can churn the food. The movement of food to and from the stomach is regulated by circular muscles called sphincters. Sphincters act like the draw stringsona bag. Contraction of the lower oesophageal sphincter (LES) closes the opening to the stomach, while its relaxation allows food to enter. The lower oesophageal sphincter prevents food and acid from being regurgitated up into the oesophagus. A second sphincter, the pyloric sphincter, regulates the movement of food and stomach acids into the small intestine.

The J-shaped stomach has numerous ridges that allow it to expand so that it can store about 1.5L of food. Millions of cells line the inner wall of the stomach. Activities in the stomach:

i) the cells secrete the various stomach fluids, called **gastric fluids or gastric juice**, that aid digestion,

ii) contractions of the stomach mix the food with the gastric fluids, and

iii) it is involved in both physical and chemical digestion.

What is the composition of gastric juice?

Gastric fluid includes:

- mucus,
- hydrochloric acid (HCl),
- pepsinogens, and other substances.

How does the stomach safely store the strong chemicals, both of which dissolve the proteins that make up cells?

A layer of alkaline mucus secreted by the gastric glands protects the stomach lining from being digested.

What do we call the partially digested food in the stomach?

Chyme

What is the reason for the release of small amount of chyme in to the small intestine at a time?

Chyme from the stomach is released in a small amount at a time though pyloric sphincter. The chime should be mixed with the bile from the liver and pancreatic juices from the pancreases. These secretions digest the partially digested food further into monomers in the small intestine. Therefore, if chime is released in a large amount at a time the digestive secretions released may not be sufficient for further digestion.

Feedback to Activity 5.6

Ask the students to form a group of 2-3 students and discuss the sites of absorption of digested foods, minerals, vitamins, and water, the structural adaptation of the small intestine for absorption. After their presentation, the teacher will summarize the sites of absorption; adaptations of the small intestine for absorption, and the roles of lacteals and capillaries.

What are accessory organs?

Accessory organs include:

- the salivary glands,
- the pancreas,
- the liver, and
- the gall bladder.

Let the teacher broaden the lesson and summarize mentioning their secretions and functions in the digestive process.

Feedback to activity 5.7

The thick mucus that is secreted by the intestinal glands protects the inner wall of the small intestine from the effects of the strong hydrolytic enzyme. Here the students are expected to discuss and present to their classmates.

Feedback to activity 5.8

Ask the students to form groups and let them conduct library/internet search on groups of enzymes associated with digestion of different food staffs, the sites of their action, and the required environment (pH) for each group. Finally, present to the class for discussion. The teacher summarizes the main points.

What is the importance of Liver?

The liver continually produces a fluid called bile. The function of bile include: emulsify or breakdown, large fat globules, stores glycogen and vitamins A, B_{12}, and D, and detoxify many harmful substances in the body.

Why liver is said to be unusual organ with regard to blood circulation?

The liver is unique in that it contains two blood vessels: the right and left hepatic arteries send oxygenated blood to the liver, while the portal vein transports venous blood from the gastrointestinal tract to the liver.

5.2. The circulatory and lymphatic system

Specific learning objectives

By the end of this sub – topic, the student should be able to:

- demonstrate the structure of the heart using a heart model/ diagram
- differentiate between pulmonary and systemic circulations.
- compare and contrast arteries and veins based on their structures and functions
- discuss types of blood
- debate on the importance of blood donation and its health implications on the donors and recipients.
- discuss the key functions and components of the lymphatic system.

What do you know about the movement of blood in your body?

Blood enters the heart through two large veins, the **inferior and superior vena cava**, emptying oxygen-poor blood from the body into the right atrium. The pulmonary vein empties oxygen-rich blood, from the lungs into the left atrium. Finally, blood from the left ventricle is pumped out to the body and each cell. The teacher can support his lesson with available models and charts as well. After your brief description of the movement of blood in our body follow the following hints for your teaching.

Learning strategies

- **You can a**ssign the students in groups, of 4-6 members to prepare diagrams /models of the heart and study each part with its functions and present for the whole class
- You can also ask the students to think and share ideas about the types of circulation. Finally, the teacher helps the students to classify circulations as pulmonary and systemic. Moreover, the teacher should encourage them to support this activity using virtual lab (circulatory system animation, video)
- Let the students compare and contrast arteries and veins based on their structures and functions by using diagrams and models and take their own summarized notes.

Suggested Active Learning Methods:

- Brain storming, Gapped/enhanced lecture, questioning/answering, Drawing and labelling

Suggested Formative Continuous Assessment:

- Written/verbal test, assignment, homework, observation, presentation, and reflections, model/chart preparation
- Assess students' prior knowledge, their misconception, and misunderstanding about the Circulatory system
- Ask students how we can divide the circulatory system based on their functions, their roles in the process of blood circulation.
- Ask about the importance of the different types of blood vessels, Heart structure, the vulves and the two types of blood circulation.

Have you ever heard about a live pump?

The heart is a remarkable live pump. The heart pumps blood throughout the life of the human being without stopping.

Feedback to activity 5.9

Ask the students to form a group of 4-6 students and construct a heart model/chart and present it to the whole class. Here the teacher should support his/her students during their group activities.

What are the chambers of the heart?

The heat consists of 4 chambers: 2 atrium and 2 ventricles. Now, perform activity 5.10 given below.

Feedback to Activity 5.10

Ask the students to form a group of 2-3 students to perform activity 5.10. A possible answer is given here. The heart consists of two (right & left) parallel pumps separated by the **septum.** The four-

chambered human heart is composed of two thin-walled **atria** (singular: atrium) and two thick-walled **ventricles**. Blood from the systemic system enters the right atrium, and blood from the pulmonary system enters the left atrium. The stronger, more muscular ventricles pump the blood to distant tissues.

What types of valves are there between the heart chambers?

Valves prohibit the backflow of blood. There are 4 types of valves in the heart: bicuspid valve (between the left atrium and left ventricle); tricuspid valve (between the right atrium and right ventricle); semi-lunar valve (between the left ventricle and aorta); and another semi-lunar valve (between the right ventricle and the pulmonary artery).

Feedback to Activity 5.11

Answers to the activity

- As they dissect and observe sections of the heart, help your students come to a conclusion about the heart's structure and function, as well as what makes it a constantly working live pump.
- Allow the teacher to assist the students during the laboratory activity, and afterward, ask the students whether what they noticed during the dissection of the heart corresponds to what they learned in class. Furthermore, while they dissect, have the teacher ask students to illustrate the various parts of the heart structure.
- Finally, let the students write a short laboratory report individually or in groups

Feedback to activity 5.12 THINK-PAIR-SHARE

Here the students are expected to study the movement of blood through the body and categorize the movement into two categories: systemic and pulmonary circulation. Let the students try to support their activity using a virtual lab (circulatory system animation, video). The teacher should guide the students' group activity.

What are the two types of blood circulation?

The two types of circulation are: pulmonary and systemic

Feed back to activity 5. 13: The pulse rate

Encourage the students to do this activity. This activity will help them to understand the function of heart and the difference of the pulse rate during the rest time and during intensive activities. But, advise the not to perform excessive activities that may hart them.

Feed back to activity 5.14 Heart sound

In order to perform this activity you can invite a health worker from the nearby health canters with their stethoscope and let them participate in the teaching-learning process. Encourage the students to do selected exercise and measure their heart sound immediately.

Do you have any idea about the lines of movement of blood in the body?

Let the teacher ask the students to draw a diagram of blood flow from the right atrium to the left ventricle, as well as blood flow to and from the lungs and the entire body.

Feed back to activity 5.15

Doing this activity, the students will be able to differentiate the structure and functions of arteries, veins and capillaries. Please, encourage them to perform this activity in groups and prepare their own notes.

What are adaptations of a red blood cell that equip it for efficient oxygen transport?

Red blood adaptation as efficient oxygen transport cell: not having a nucleus, biconcave shape, very thin cell surface membrane, and flexible cell surface membrane. Detailed information is given in the textbook.

What are platelets?

Platelets or thrombocytes are tiny cell fragments **without nuclei** enclosed in a membrane. Detailed information is given in the students' textbook.

What is plasma?

Plasma:

- are yellow-tinted water, sugar, fat, protein, and salt fluid that transports red blood cells, white blood cells, and platelets
- Plasma makes up 55 percent of our blood volume
- provides nutrients to cells while also removing metabolic waste
- blood clotting factors, carbohydrates, lipids, vitamins, minerals, hormones, enzymes, antibodies, and other proteins are all found in it
- includes some of every protein generated by the body; so far, only about 500 proteins have been discovered in human plasma.

Feedback to Activity 5.16

Answers for the questions in activity 5.16 are given in the students' textbook. What is recommended here is that students will be able toknow what their blood group is. Finally, the basis for blood grouping is the antigen on the surface of red blood cells. This is because; the types and features of antigens can vary between individuals, due to small genetic differences.

What types of blood, antigen and antibody do you know?

The two prominent types of antigens are antigen A and antigen B for blood groups A and B. Blood group AB has both A & B antigens. But blood group O does not have antigens. Another antigen is the Rh factor.

Can you tell your friends, what is the Rhesus factor?

Another antigen on the red blood cell is called **the Rhesus factor**. Like the ABO blood groups, the Rhesus factor is inherited. Individuals who have this antigen are said to be Rhesus positive (Rh^+). Approximately 85 % of the population has the antigen.

How does Rh^+ blood differ from Rh^- blood and what happens if the Rh factor of the blood transfused is incompatible?

Rhesus-factor incompatibilities become important for Rh^+ babies of Rh^- mothers. If the baby inherits the Rh^+ factor from the father, a condition called erythroblastosis fetalis can occur with the second and subsequent pregnancies. The first child is spared because the blood of the mother and baby are separated by the placenta (a membrane inside the uterus that exchanges materials between mother and baby). During birth, the placenta is shed from the uterus. Capillary beds rupture, and, for the first time, the blood of the baby comes into contact with the blood of the mother.

Why does a fetus with erythroblastosis fetalis develop anaemia?

A fetus with erythroblastosis fetalis develops anaemia, because the fetus bleeds continuously and loses blood.

5.2.1. Blood donation

Specific learning objectives

By the end of this sub – topic, the student should be able to:

- discus the reason for blood donation
- discuss blood type and Rh factor compatibility
- debate on the importance of blood donation and its health implications on the donors and recipients.

Learning strategies

Briefly discuss what do we mean by blood donation and when it is needed. During your discussion consider mentioning the types of blood and the compatibility criteria for blood donation. In addition

to these ask the students to go to the nearby Blood bank, Hospital, health centers, or posts and gather information on the importance of blood donation and its health implication (if any) on the donor and/or the recipients. Finally, the students, in groups report to the class for discussion.

Moreover, you can ask the students to debate on the importance of blood donation; form a group with pro and against ideas about blood donation/transfusion. This will help the students to master their public appearance and awareness of the importance of blood donation.

Suggested Active Learning Methods:

- Brainstorming, Gapped/enhanced lecture, questioning/answering, Drawing and labelling

Suggested Formative Continuous Assessment:

- Written/verbal test, assignment, homework, observation, presentation, and reflections, model/chart preparation
- Assess students' prior knowledge, their misconception, and misunderstanding about blood donation
- Ask students how we can divide the blood types based on the red blood surface antigens and the Rh factor.
- Ask about the importance of the different types of blood types and compatibility during blood transfusion.

Feedback to activity 5.17

Ask the students to form groups of 4-5 students and go to the nearby blood bank, hospital, health centres, or posts and gather information on the importance of blood donation and its health implication (if any) on the donor and/or the recipients. Finally, let them report to the classroom. The teacher should support their group activity closely and coordinate when necessary.

What is the lymphatic system?

The lymphatic system is a network of tissues, vessels, and organs that work together to move a colourless, watery fluid called lymph back into our circulatory system (our bloodstream). The lymphatic system protects our body against foreign invaders. It is also part of our part of the immune system. More notes that are detailed are given in the student textbook.

Feedback to Activity 5.18

Doing this activity, students are expected to outline the relationship between the lymphatic and immune systems. Let the teacher support them during the independent studies.

What are the functions of the lymphatic system?

The following are the key functions of the lymphatic system:

- returns excess interstitial fluid to the blood
- the absorption of fats and fat-soluble vitamins from the digestive system and the subsequent transport of these substances to the venous circulation. The blood capillaries absorb most nutrients, but the fats and fat-soluble vitamins are absorbed by the lacteals. The lymph in the lacteals has a milky appearance due to its high fat content and is called **chyle.**
- defence against invading microorganisms and disease. Lymph nodes and other lymphatic organs filter the lymph to remove microorganisms and other foreign particles. Lymphatic organs contain **lymphocytes** that destroy invading organisms

Which components of the lymphatic system do you know?

Components of the lymphatic system include a fluid (lymph), vessels that transport the lymph, and organs that contain lymphoid tissue.

Why the lymphatic system is an open system?

The lymphatic system is a system of vessels that runs all over the body. The heart does not pressurize these veins; therefore, they do not constitute a complete circulating system. The lymphatic system, on the other hand, is an open system in which fluid flows in one direction from the extremities to two drainage points in veins directly above the heart. Because they are not pressured, lymphatic fluids travel more slowly than blood. In the interstitial spaces of tissues, small lymph capillaries and blood capillaries interact. Lymph capillaries discharge fluid from the tissues. Lymph contains a lot of white blood cells.

Which types of lymphatic organs do you know?

Major lymphatic organs are: Lymph Nodes, Tonsils, Spleen, and Thymus

Have you ever encountered injury on your hands, legs or somewhere on your limbs and felt tenderness, pain, and unconformability at your groin area and armpits? What do you think is the reason?

A detailed answer to this question is given in the students' textbook. However, you can broaden your discussion with your students mentioning more examples, and the measures to be taken when such phenomena occur to each individual.

You may have experienced toncillites in your early child hood with red swollen tonsils. Do you know why the tonsils are swollen? What are the causative agents for this?

Bacteria and viruses cause tonsillitis. A common cause is bacteria from genera streptococcus. Other common causes include adenoviruses, influenza virus, etc. The swelling occurs as a result of immune cell activity in the lymph nodes.

Where in your body is located spleen and what is its function?

The spleen is found in the upper left abdominal cavity, just below the diaphragm and posterior to the stomach. Its shape and structure are similar to that of a lymph node, but it is much larger.

5.2.2. Diseases of the circulatory and lymphatic systems

Specific learning objectives

By the end of this sub – topic, the student should be able to:

- Discuss the diseases of the circulatory and lymphatic systems (leukemia, varicose vein, elephantiasis, cardiovascular diseases)

Learning strategies

Discuss briefly the diseases of the circulatory and lymphatic systems and mention commonly known diseases. Then ask students to do a library search about the diseases of the circulatory and lymphatic system and present in the class. Finally, the teacher summarizes the main points of the subsection focussing on the deadly disease of the two systems.

Suggested Active Learning Methods:

- Brainstorming, Gapped/enhanced lecture, questioning/answering, pictures

Suggested Formative Continuous Assessment:

- Written/verbal test, assignment, homework, observation, presentation, and reflections
- Assess students' prior knowledge, their misconception, and misunderstanding about the Circulatory and lymphatic system diseases.
- Ask students to mention the major circulatory and lymphatic system diseases in Ethiopia.

Feedback to Activity 5.19 THINK-PAIR-SHARE

Ask the students to form groups of 2-3 students on the same desk, and let them write down the types of circulatory and lymphatic system diseases and discuss the causes and symptoms of such diseases. Finally, report their findings to their classmates. Some of them are given in the student textbook.

Feedback to Individual Activity 5.20

Susceptibility to infections is dependent on an individual's immunity. Individuals with strong immune systems withstand some bacterial, viral, or fungal infections, while the week is once and susceptible.

Here, help your students to get sufficient information about the human immune system. Let the students present their work.

What are cardiovascular diseases?

Cardiovascular diseases are classified into several types. A detailed list of cardiovascular diseases is given in the student textbook.

Have you heard about any type of heart disease? If yes mention and share your classmates.

There are several types of heart diseases: heart attack, stroke, and heart failure are some of them. The teacher can search for more heart diseases.

What is the reason for stroke?

A stroke occurs when a blood vessel that supplies the brain becomes blocked and causing a blood clot or when a blood vessel in the brain bursts; blood flows in the brain causing haemorrhage.

Feedback to Activity 5.21

In the textbook are mentioned some cardiovascular and lymphatic system diseases. Yet there are others to mention. Therefore, ask the students to form groups of 3-4 students and reading books, and browsing internet resources list cardiovascular and lymphatic system diseases as much as they can, and discuss them in the classroom.

5.3. The respiratory system

Specific learning objectives

By the end of this sub – topic, the student should be able to:

- draw and label the human breathing systems
- show the link between the human breathing system and the circulatory system
- demonstrate the mechanism of breathing using locally available materials

Learning strategies

Ask your students to briefly describe what the breathing system is. The breathing system is **the network of organs and tissues that help us breathe**. It includes our respiratory tract, lungs, and blood vessels. The muscles that power our lungs are also part of the respiratory system. These parts work together to move oxygen throughout the body and clean out waste gases like carbon dioxide. To further, consolidate your teaching:

- Provide students with prepared diagrams or models of the human breathing and excretory

systems and then ask them to draw, label, and study the two systems. Let them support this activity using virtual lab (simulation software, animation, and video)

- Let students in groups discuss and identify the interplay between the circulatory and the breathing systems
- Ask your students to produce the respiratory system model using balloons and bell jars and demonstrate the mechanisms of breathing in the class. Furthermore, they practically will show the movements of the chest while breathing in and out.
- Ask the students to conduct internet searches /consult health professionals/ users about the effects of smoking and cannabis on the normal functioning of the breathing system and present their findings to the class. Let them support this activity using a virtual lab (simulation software, animation, and video).
- Let students in groups discuss and identify the interplay between the circulatory and the breathing systems

Suggested Active Learning Methods:

- Brainstorming, Gapped/enhanced lecture, questioning/answering, Drawing and labelling

Suggested Formative Continuous Assessment:

- Written/verbal test, assignment, homework, observation, presentation, and reflections, model/chart preparation
- Assess students' prior knowledge, their misconception, and misunderstanding about the the respiratory system
- Ask students how we can divide the respiratory system based on their functions and their roles in the process of gas exchange and blood circulation.
- Ask about mechanism of respiration during activities like inhalation and exhalation.

Now, have you understood why you felt uncomfortable?

Feedback to Activity 5.22

Ask the students to prepare diagrams/ models of the respiratory system (as shown in activity 5.23). And provide them with a prepared diagram/model of the human breathing systems. Using the diagram/model let the students study the breathing system. During their activity, uses advise them to use virtual lab (simulation software, animation, and video). Then, let them answer the following question.

What is the primary function of the respiratory system in human body?

The respiratory system organs' primary functions are to:

- provide oxygen to body tissues for cellular respiration,

- remove the waste product, carbon dioxide,
- help to maintain acid-base balance, and
- portions of the respiratory system are also used for non-vital functions such as sensing odors, producing speech and coughing.

Feedback to Activity 5.23

When we are sick of the common cold or influenza, we may lose our smelling ability for some time and regain it back when we get better of the common cold. This is simply because the epithelial lining of the nasal cavity is filled with a thick layer of mucus secreted as a response to the infection. This is an immune response of the organism.

Why nasal cavity is considered as a good air conditioner?

The moist epithelium warms and humidifies the incoming air. The incoming air is warmed by capillaries just beneath the nasal epithelium before it enters to the lower breathing systems.

Do you know how sound is formed in the voice box?

Sound is formed as a result of the vibration of the vocal cords of the larynx during the movement of air in and out of the lungs.

What happens if pieces of food or fluid you swallow-in miss-leaded into your trachea? Which structure of your laryngeal area prevents you from such drop-ins?

If pieces of food or fluid we swallow-in miss-leaded into our trachea, we tend to cough and expel it out. This is because the cilia cells of the oesophageal epithelium are sensitive to foreign substances except for air. At the laryngeal tip, there is a muscular structure called the epiglottis that prevents the entrance of food or water when we swallow.

Feedback to Activity 5.24

Before continuing to the next topic ask the students to form groups of 2-3 students and discuss and identify the interplay between the circulatory and the breathing systems. Finally, let them explain how the breathing system is interrelated with the circulatory system. The teacher should help the students during their group activities.

Where in the breathing system does the actual gas exchange takes place?

Actual gas exchange takes place in the alveoli.

What is the composition of atmospheric and exhaled air?

In order to answer to this question go to table 5.5 in the text book.

Feedback to Activity 5.25

Dear teacher, please help your students during this activity. You can call two of your students and demonstrate how they can do it. Finally, let all students in the classroom practice the activity.

i. Let them put their pointing Figure in between two of their ribs
ii. Inhale air to the maximum. Ask what happens with their ribs.
iii. Now, let them exhale the volume of air they inhaled. Ask what happens to their ribs. And ask what happens with their chest cavity as they inhale and exhale air from their lungs?

Feedback to Activity 5.26 Observing the mechanism of breathing

Let the students prepare a lung model and use a Bell jar experiment to demonstrate the mechanism of breathing as shown in the student textbook.

How a blood circulatory system does interact with the respiratory system?

The circulatory and respiratory systems work together to **circulate blood** and oxygen throughout the body. Air moves in and out of the lungs through the trachea, bronchi, and bronchioles, and finally alveoli where the gas exchange takes place; oxygen diffuse in while carbon dioxide diffuses out. Blood moves in and out of the lungs through the pulmonary arteries and veins that connect to the heart.

Feedback to Activity 5.27

Ask the students to conduct internet searches /consult health professionals/ users about the effects of smoking and cannabis on the normal functioning of the breathing system and present their findings to their classmates. During their presentation, consult them to use virtual lab (simulation software, animation, and video) as available. Help the students during their practical activities.

5.4. The human urinary system

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- discuss the structure and function of the kidney
- identify the process of urine formation
- tell the role of the excretory system in the homeostatic process
- Discuss the relationship of the excretory system with

Learning strategies

Start your lesson with a brief description of the excretory system. Ask questions to find out what they know about the system. Questions such as what is urine? How urine is formed? What is homeostasis?

And how the homeostasis of the human is maintained? Besides, you can also ask the students if they have any idea about other types of the excretory system. What is the role of the liver, lungs, and the skin in excretion can also be asked as a question.

- As one of the good strategies let the students, use models/diagrams and discuss the structure and function of the kidneys.

Suggested Active Learning Methods:

- Brainstorming, Gapped/enhanced lecture, questioning/answering, Drawing and labelling/ model preparation

Suggested Formative Continuous Assessment:

- Written/verbal test, assignment, homework, observation, presentation, and reflections, model/chart preparation
- Assess students' prior knowledge, their misconception, and misunderstanding about the excretory system
- Ask students how we can divide the parts of kidney as an excretory organ and based on the functions of each structure of the kidney.

What do you know about the excretory system of human beings?

The excretory system is a system by which metabolic waste products are removed from the body of a human being. Here, the kidney is discussed as one of the excretory systems of our body. We can also mention others; the skin, and lungs as organs that help the body to remove metabolic waste out of the body.

What do you know about regulating the concentration of solutes in the blood? Did you know that the kidney is important in determining the concentration of red blood cells?

The kidneys produce 85% of the erythropoietin needed to drive red blood cell formation. The kidneys also undertake the final synthesis step in the creation of vitamin D. When the kidneys fail, these functions are weakened or removed entirely, causing homeostasis to be disrupted. Weakness, fatigue, shortness of breath, anemia, generalized edema (swelling), metabolic acidosis, increased potassium levels, heart arrhythmias, and other symptoms may occur in the affected person. Each of these functions is critical to your survival and well-being.

Feedback to Activity 5.28

In your school laboratory, you will get a model/diagram of the kidney. Ask your students these models/diagrams discuss the structure and function of the kidney.

What do we call the filtrate that leaves the kidney?

We call it Urine.

Do you know the three parts of the renal tubule? What are they?

The three parts of the renal tubules are:

i. the proximal convoluted tubule (PCT),
ii. the loop of Henle, which forms a loop (with descending and ascending limbs), and
iii. the distal convoluted tubule (DCT). The DCT, or distal collecting duct, joins and discharges the nephron's contents into collecting ducts. Urine will eventually pass via the renal pelvis and into the ureters.

What are the functions of the kidney?

Kidney functions and physiology are given in the student text in detail. No need of repeating them here. The teacher can use the detail in the textbook.

Feedback to Activity 5.29

1. Do you find any relationship between the circulatory system and the excretory system? What are they?

The excretory system is **a close partnership with both the circulatory and endocrine systems**. The circulatory system connection is obvious. Blood that circulates through the body passes through one of the two kidneys. Urea, uric acid, and water are removed from the blood and most of the water is put back into the system.

2. Nowadays our society is affected by kidney diseases. What could be the reason? Forward your possible solution (mechanisms) to solve the problem

Who is at risk for chronic kidney disease?

Millions of peoples in the world are living with kidney disease. Anyone can get kidney disease. You are more at risk for kidney disease if you:

- Have diabetes
- Have high blood pressure
- Have heart disease
- Have a family history of kidney disease
- Have abnormal kidney structure
- Are over 60 years of age
- Have a long history of taking painkillers, including over-the-counter products such as aspirin and ibuprofen
- malformations at birth that occur as a fetus develops
- immune diseases
- obstructions such as kidney stones or an enlarged prostate; and
- repeated urinary tract infections, which can also lead to kidney infections and can cause long-term damage to the kidneys.

How Do You Prevent Kidney Disease?

1. Early Detection

Early detection is the most effective way to combat kidney disease. Early detection helps the patients to properly treat the disease. There are two tests to detect kidney disease:

I. A **kidney damage urine albumin-creatinine ratio (uACR) test** measures the amount of protein called albumin in your urine. Damaged kidneys leak protein into your urine; it should be in your bloodstream.

II. **A kidney function blood test, creatinine,** is used to measure your glomerular filtration rate (GFR), which tells how well your kidneys are working to remove wastes from your blood. It is the best way to check kidney function.

2. Keep your kidney healthy

People with kidney disease should:

- Lower high blood pressure
- Manage blood sugar levels
- Reduce salt intake
- Avoid usage of painkillers frequently
- Moderate protein consumption

Everyone should:

- Exercise regularly
- Control weight
- Follow a balanced diet
- Quit smoking
- Drink alcohol only in moderation
- Stay hydrated
- Monitor cholesterol levels

- Get an annual physical check up
- Know your family medical history

5.5. The immune system

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- define the immune system
- discuss the types of immunity (innate and acquired).
- relate the lymphatic system with the immune system

Learning strategies

Describe the immune system as the system that protects our body from outside invaders, such as bacteria, viruses, fungi, and toxins (chemicals produced by microbes). It is made up of different organs, cells, and proteins that work together. There are two main parts of the immune system: The innate immune system, which we are born with, and the acquired immune system that we acquired through vaccination.

As a strategy to teach this section:

- Form groups and let the students discuss on the immune system and types of immunity and present to the class with the guidance of the teacher.
- Let the students study the relationship between the lymphatic system and the immune system and present it in the classroom

Suggested Active Learning Methods:

- Brainstorming, Gapped/enhanced lecture, questioning/answering

Suggested Formative Continuous Assessment:

- Written/verbal test, assignment, homework, observation, presentation, and reflections
- Assess students' prior knowledge, their misconception, and misunderstanding about the immune system
- Ask students how we can divide the immune system
- Ask about the importance of the different types of immunity to human beings

Mothers are recommended to breast feed their kids immediately after delivery. Do you know why?

From the very beginning, mothers' breast milk is filled with immunity-boosting antibodies, **Colostrum**, the first milk that a mother produces for her baby, is full of antibodies. By offering her newborn some breast milk early on, she is offering her child a great gift for life.

What do you know about the vaccines against certain diseases e.g. vaccine against COVID-19?

After an initial reaction to a new pathogen, adaptive (or acquired) immunity is formed, resulting in an increased response to future exposure to the same disease. Vaccination isbased on this acquired immunity process.

Do you have any idea about the cells of the immune system? What types of cells of the immune system do you know?

The immune system is made up of numerous different cell types and subtypes: Lymphocytes, Neutrophils, Macrophages, and Dendritic cells. Detailed information for each of these is given in the student textbook.

5.6 Renowned physicians in Ethiopia

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- mention renowned Ethiopian physicians
- discuss contributions of renowned Ethiopian physicians
- appreciate the contributions of Ethiopian physicians
- Discuss the relationship of the excretory system with

Learning strategies

Start your lesson with a think-pair-share activity in which the studnts will get a chance to think and share their knowledge of discoveries done by Ethiopian scientists. And then ask them to mention some of them and present their work to the whole class.

Suggested Active Learning Methods:

- Brainstorming, Gapped/enhanced lecture, questioning/answering

Suggested Formative Continuous Assessment:

- Written/verbal test, assignment, homework, presentation, and reflections
- Assess students' prior knowledge, about the reknowned Ethiopian scientists
- Ask students to think-pair-share what they know with their classmates

Feedback to Activity 5.30 THINK-PAIR-SHARE

As in all countries of the world, in Ethiopia, the history of medicine begins much earlier and the number of physicians that contributed to their country increased from time to time. Here are

mentioned two of the most renowned pioneer Ethiopian physicians. Ask the students to form groups of 3-4 students and using books, the internet, and interviewing as a source of information:

i) List down names of the renowned Ethiopian physicians

ii) Write a report on their contributions to Ethiopian society and the world

Finally, share their findings with the whole classroom.

ANSWERS TO REVIEW QUESTIONS

I. True-False items

1. F
2. T
3. F
4. F
5. F
6. F
7. T
8. T

II. Multiple Choice items

1. A	6. D	11. A	16. C	21. D	26. D
2. B	7. C	12. A	17. D	22. D	
3. C	8. E	13. C	18. C	23. B	
4. E	9. A	14. C	19. E	24. D	
5. A	10. C	15. C	20. A	25. D	

III. Fill-in the blank space

1. Hypertension
2. Plasma
3. Antigen
4. Alveoli
5. Asthma
6. Perytalysis
7. Mechanical
8. Villi
9. Bowl
10. Minerals

Answers for the short answer/essay items and the diagrams to be labelled are left for the teachers. Let the students try by themselves and the teacher fills the gap.

Unit 6: Ecological Interactions 17 periods

Content	Learning Competency
6.1 Trophic levels 6.1.1 Food chains & Food webs 6.1.2 Flow of energy and matter through ecosystems 6.2 Cycling of materials in the ecosystem 6.2.1 Water cycle 6.2.2 Carbon cycle 6.2.3 Nitrogen cycle 6.2.4 Phosphorus cycle	At the end of this unit, the student will be able to: ▪ outline with examples the trophic levels in an ecosystem ▪ elaborate food chain and food web with examples ▪ show the flow of energy and matter in an ecosystem ▪ discuss ecological pyramid ▪ draw and label the water, carbon, nitrogen and phosphorus cycles ▪ relate the carbon cycle with global warming ▪ associate nitrogen cycle with soil fertility and agriculture ▪ appreciate the role of soil organisms in soil fertility ▪ investigate why farmers in their locality use crop rotation in cultivation

6.1 Trophic level

Specific learning objectives

By the end of this sub – topic, the student will be able to:

- define trophic level, food chain, and food web
- construct food chain and food web-based on observed feeding relationship among common organisms in their locality
- outline the flow of energy from the sun to plants than to a higher trophic level

Learning strategies

The teacher can start the lesson with common feeding relationship, who eats who or what? Example Dog and hyena, Cat and rat? Why do organisms eat one another?

Then the teacher can introduce the concept of trophic level and start discussing about plants in relation to photosynthesis, which they have learned in unit 2. It is known that plants are self – feeders or use solar energy trapped during food synthesis (photosynthesis). There are animals that eat or feed on plants. These animals in turn are eaten by other animals. This results in an order of receiving solar energy, and this is what we call Trophic level. Plants are the first to receive solar energy; hence, they stand at the first trophic level (front position). Herbivores that feed on plants are at second trophic level (Second position) and the number of links usually goes on up to 3 to 4 trophic level. In terms of feeding level, the herbivores are the first feeders (First feeding level) and carnivores that eat herbivores will be at the second feeding level.

The teacher can arrange on site observation, where students will shortly be out of class and observe real feeding relationship in their school compound. For example, grasshopper is common in a grass field or garden. Let student identify what grasshopper eats and who eats grasshopper. In school garden, students may also see other feeding relationship that starts from plant (Eg. Fruit/seed eating birds, grazing animals such goats and cows). Coming back to class students in small group can discuss and arrange organisms they observed in trophic level (in an order of receiving solar energy). The teacher can tell students that it is such arrangement that we call **food chain.** All the food chains in the community form **food web.**

The teacher can encourage students to construct as many food chains as possible. Students can use diagrams included in the text or follow model lesson plan at the beginning of this guideline. The model lesson plan deals with food chain and has an illustration of food web. Students can make different food chains from the given food web, thereby creating a hierarchy of trophic level as illustrated in Figure. 6.2 in the student's text.

The teacher should also initiate and guide class discussion on food chain or food web. The following remarks could be given after the class discussion

- Food chain starts with green plants that trap and store solar energy in the food they make.
- Food chain is a means for energy transfer and shows the position of an organism in an order of receiving solar energy, which is known as trophic level
- Energy flows from plants (producers) to the different level feeders
- Organisms are eating one another to get energy stored in food.
- Not all energy in one level can be transferred to the next level. Some energy is lost in respiration, by heat, incomplete digestion, etc.
- Since much energy is lost at each trophic level, it is only fewer organisms are supported at succeeding levels. This is the reason why trophic level is usually restricted to 3 or 4 levels

Students can be directed to construct ecological pyramid to show the amount of energy, number of organisms or their biomass. Based on a given food chain, let the teacher first show them how the pyramid is constructed and ask them to do the same individually or in group.

Suggested Active Learning Methods:

Brainstorming, Think – Pair - Share, Group discussion, Questioning, Cooperative learning

Suggested Formative Continuous Assessment

- Giving students chance to share and reflect their idea
- Asking oral questions to reinforce students' understanding
- Identifying learning difficulties and giving timely support.

Feedback to activity 6.1

The teacher should allow students to present the food chains they constructed to their classmates and give final comment (feedback) after the presentations.

Feedback to activity 6.2

The teacher should allow students to discuss about feeding relationship they observed in their school compound and ask them to present the group report to their classmates. The teacher should give final comment (feedback) after the presentations.

Feedback to activity 6.3

- Trophic level is usually limited to 3 or 4, because energy is successively decreasing as it is transferred from one level to other level and sufficient energy for life will not reach for organisms above 4 trophic level.
- Human beings are omnivore; they eat either plants or other animals that feed on plants. Thus, they can be herbivore at one time and carnivore at another type, which correspond to Second of Third trophic level respectively.

Feedback to activity 6.4

- The pyramid of energy is always upright. However, pyramid of number and biomass can be upright or inverted and this depends on the given food chain and the particularly ecosystem.

6.2 Cycling of materials in the ecosystem

Specific learning objectives

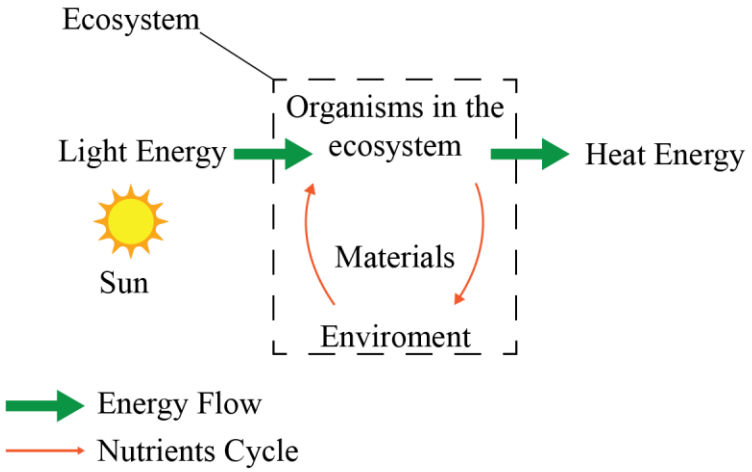
By the end of this sub – topic, the student will be able to:

- draw and label the water, carbon, nitrogen, and phosphorous cycle
- relate the carbon cycle with global warming
- associate nitrogen with soil fertility and agriculture
- appreciate the role of soil organisms in soil fertility
- identify why crop rotation is important to farmers

Learning strategies

The teacher should start this lesson with the need for recycling. To do this, he/she should inform students that different materials in the ecosystem including, minerals, gases, water, etc, are found in limited amount. Let the teacher ask students the following brainstorming questions: "what will happen if these materials are continuously used or taken up ?", " What should occur to keep their balance in an ecosystem?"

Students can be informed that if life is to continue there must be continuous flow of energy and cycling of materials in an ecosystem is the order of nature. This is illustrated in the next diagram.

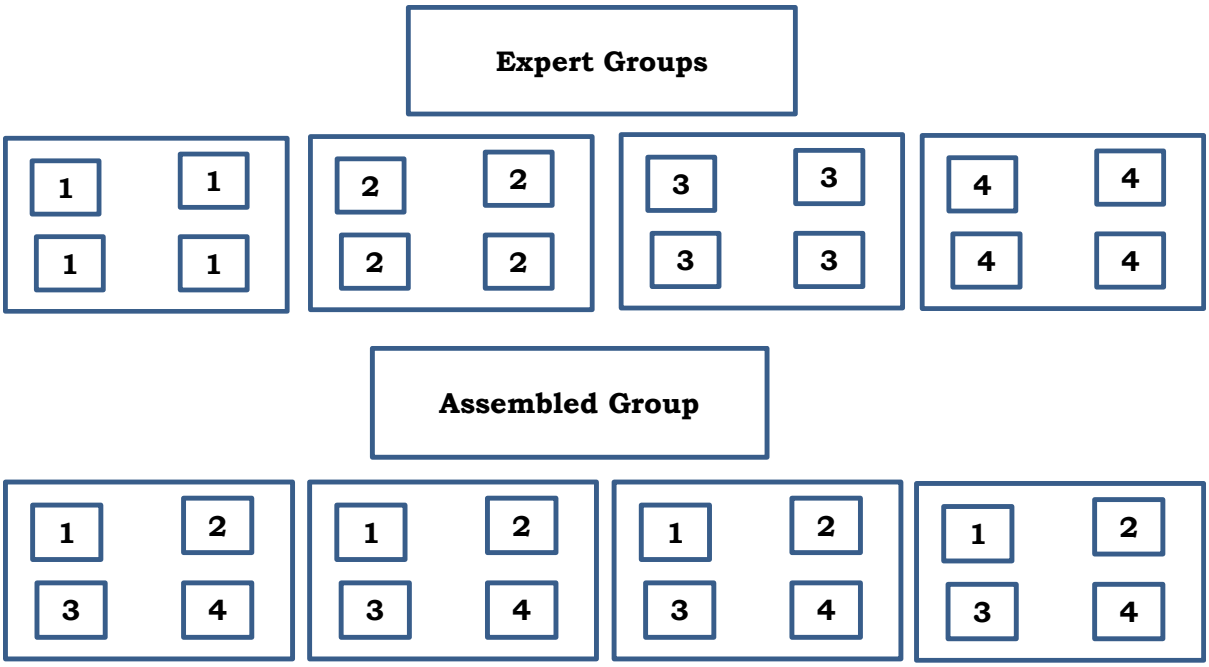


As shown by the diagram, the energy that originated from the sun flows or transferred from organisms to organisms and lost as heat energy. It does not go back to the sun, i.e. energy cannot be recycled. However, nutrients or materials recycle in the ecosystem. Essential materials used by living things are replenished (regenerated) by physical, chemical and biological processes. For instance, aerobic organisms can regenerate carbon taken from the atmosphere by green plants during cellular respiration. Following the example, that teacher may ask students to give more examples that show how materials are continuously used and replenished.

The section that deals with how certain substances like water, carbon, nitrogen and phosphorus are recycled can be best studied through group discussion. After giving brief descriptions on cycling each substance, Jigsaw method can be applied to engage students to discuss each cycle intensively and share it with the rest of the group.

At the beginning when neither the teacher nor the students are familiar with the procedure, organization Jigsaw as learning method will require a great amount of time. However, the time will be given back after students become experienced in this method. Jigsaw method allows one to cover different topic exhaustively with in one or two periods. The following steps can be used

1. Formation of the groups for discussion
    - The number of groups and number of team members depend on the number of key issues for discussion.
    - In the case of recycling four groups for the four cycling materials – Water cycle, Carbon–oxygen cycle, nitrogen cycle and Phosphorous cycle are needed
    - Example of group information can be designed as follows



2. Distributing the key issues to be discussed
   The four substances to be recycled can be randomly distributed among the four groups – one for each expert group. The teacher has to allocate enough time and assist each group to discuss extensively on the specific topic given to them. Be sure that each member should understand the topic very well. Inform the group that each team member is going to act as an expert and present key points discussed in the expert group while presenting for the assembled group
3. The teacher has to follow the performance of each group and provide the necessary assistance if the group encounter learning difficulties.
4. The teacher has to allow at least one group to present key points and initiate whole class discussion
5. Then he /she have to give feedback to group discussion and presentation.
6. Finally, the teacher has to Wrap – up or consolidate key points with final remark on recycling of materials in the ecosystem.

A lesson on nutrient cycle should not be limited to describing the different cycles. It is very essential to show their importance to life and link them to climate change and/or agricultural activity. Emphasis should be given to soil organisms (both microorganisms like bacteria and larger soil organisms like earth worm) in improving soil property and fertility thereby increasing agricultural productivity. Students should realize the role of nitrogen fixing bacteria and the importance of crop rotation to farmers.

Suggested Active Learning Methods:

Brainstorming, Jigsae method, Group discussion, Questioning, Cooperative learning

Suggested Formative Continuous Assessment

- Giving students chance to share and reflect their idea
- Asking oral questions to reinforce students' understanding
- Identifying learning difficulties and giving timely support.

Students can be asked to tell what will happen to organisms or life if decomposers are absent from the ecosystem. The following can be possible answers

- Nutrients/materials such as nitrogen, carbon, oxygen are found in limited amount in nature. If we are continuously using them they will be depleted, hence there must be a means of cycling or regenerating them. Thus cycling of materials in an ecosystem is so important for sustainable use of resource and existence of organisms
- Decomposers such as bacteria and fungi are important to break down complex compounds such as organic matter. By so doing they release nutrients essential for life. They are also important in the transformation of substances as it isseen in nitrogen cycle. Therefore, life will cease and the ecosystem collapses in the absence of decomposers. For example, proteins that are essential to build our bodies cannot by synthesized in the absence of bacteria involved in the nitrogen cycle. For example, nitrogen fixing bacteria convert atmospheric nitrogen (N_2) to ammonium and nitrate to be used by green plants in the synthesis of proteins**.**

Feedback to activity 6.6

- Water droplets formed by condensation will be observed under the plastic cover.
- It is evaporation of water that enabled water particles to move as vapour towards the plastic bags
- Precipitation (rainfall) is demonstrated as liquid water falls back to the small beaker

Feedback to activity 6.7

- Illegal logging (cutting trees) and forest burning interferes in the carbon-oxygen cycle, because they will contribute to an increase in carbon dioxide and decrease in oxygen concentration
- An increase in carbon dioxide is the cause for climate change , because it causes global warming
- The water cycle is a sun driven process, because solar heating is the cause for evaporation. The water cycle is a change in state of water due to a change in temperature. This in turn affected by heating and cooling.
- Let students prepare group report and this can be a point of whole class discussion.

Feedback to activity 6.8

We cannot think life without nitrogen .Nitrogen is key to life because it is compulsory for protein synthesis. Protein in turn helps repair and build our body's tissue. Protein plays structural and functional role in living things. DNA synthesis require protein. More information is available in the "Tips" box under the sub- section 6.2.3 (Nitrogen cycle) of the student text.

The major processes of nitrogen cycle (nitrogen fixation, nitrification, ammonification and denitrification) require the involvement of soil bacteria. Decomposition of organic matter and release of carbon is the result of bacterial action. Bacteria are useful in the production of biofuel, biofertilizer and during food processing such as milk. As there are harmful bacteria, which are pathogenic, there are huge numbers of bacterial with beneficial role. Thus, bacteria are mostly taken a misconception as harmful and dangerous to human beings

Feedback to activity 6.9

The teacher has to give comment on information collected by students on crop rotation and how farmers practice.it.

Feedback to activity 6.10

Agrochemicals (fertilizers and pesticides) released from farmlands to the nearby water body, such as lakes or reservoirs cause pollution and deterioration of water quality. Fertilizers reaching water body causes excessive and unwanted growth of algae and aquatic plants (macrophytes). Pesticides can accumulate in fish and cause health problems on human that eat fish.

ANSWER TO REVIEW QUESTIONS

I. True – False Items

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

II. Multiple Choice Items

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

III. Matching Items

1. A 2. H 3. I 4. F 5. E 6. D

IV. Short Answers

1. It is unusual for a large number of organisms to be present at the top of ecological pyramid, because energy successively declines as it is transferred to higher trophic level and supports small number of organisms.
2. Plants cannot use atmospheric nitrogen directly, it should be transformed to ammonium and nitrate by nitrogen fixing bacteria and nitrifying bacteria.
3. As compared to chemical (inorganic) fertilizers, organic fertilizers such as compost and bio – slurry slowly releases nutrients to be taken by plants. They cannot be easily leached (washed away). They also improve soil physic – chemical properties such as soil moisture and pH
4. Forest clearing (cutting trees) is removing plants that could have taken carbon dioxide from the atmosphere for photosynthesis. This indirectly helps accumulation of carbon, thereby increasing chance of global warming. On the other hand, forest burning directly releases carbon dioxide to the atmosphere, thereby increasing global warming.