# Federal Democratic Republic of Ethiopia
# Ministry of Education

# Biology Syllabus, Grades 11 and 12

# 2009

## Table of Contents

## Introduction

Biology is a life science that allows students to acquire knowledge and understanding about themselves and the organisms in their environment. It allows students to appreciate the harmony, contrast, and beauty of nature around them. Biology as an experimental science involves critical thinking, reasoning and problem solving in everyday contexts. Biology has special relevance to students as individuals, to the society and to the growth and development of Ethiopia at large. It is true that many of the contemporary issues and problems in the society are essentially biological in nature. Nutrition, health, drug abuse, agriculture, pollution, rapid population growth, environmental depletion and conservation are some examples. If these problems are to be dealt with realistically, an understanding of biological knowledge is required. The recent advances in biotechnology and genetic engineering that have significant influences on people's life also indicate the role of biology as everybody's science everyday.

The Biology syllabus for grades 11 and 12 is built upon the new curriculum framework for Ethiopian schools and on the needs assessment conducted prior to revision work. The syllabus has also considered international content standards for a similar age and grade level of learners. The specific objectives and contents are derived from the minimum learning competencies designed for the two grade levels. Agriculture, technology and AIDS are integrated in a much broader manner in response to the recommendations of the needs assessment. The needs assessment has indicated areas in the curriculum where contents are too difficult for children and grade levels where contents are overloaded. This syllabus has removed some difficult contents and retained others by simplifying them. The content overload has also been addressed by limiting details of contents and reducing the highly prescriptive methodology. Large content details and highly prescriptive methodology were proved to result in big volumes of textbooks which teachers found difficult to complete in an academic year.

In general, the main changes that are made during the revision of the biology curriculum revolved around:

- Addressing content overload
- Addressing content difficulty
- Strengthening active learning
- Integrating technology
- Integrating agriculture
- Considering international standards
- Strengthening horizontal and vertical relationships
- Strengthening relationships with TVET and further education
- Ensuring relevance of contents to the life and need of students and
- Organizing teaching around learning competencies

The learning competencies developed are based on 3 broad outcomes that were developed and defined for the areas knowledge, skills and values and attitudes. They read as follows:

| **Competency Area** | **Broad competencies** |
|---|---|
| **Knowledge** | 1. Constructing biological knowledge<br>The learner will know and be able to interpret and apply biological, technological and environmental knowledge. |
| **Skills** | 2. Biological investigation<br>The learner will be able to use confidently scientific methods to conduct biological experiments and to investigate biological phenomena and solve problems in biological, technological and environmental context. |
| **Values & attitudes** | 3. Biology, Society and Environment<br>The learner will be able to demonstrate interest and appreciation on the relationships between biology, technology, society and environment. |

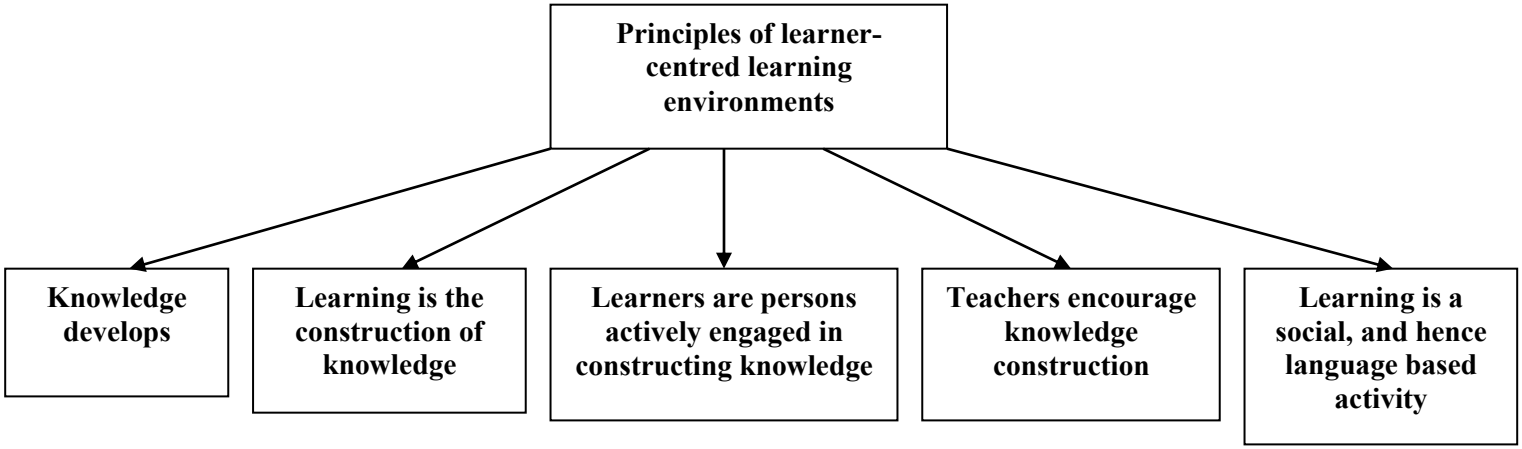
The developed competencies relate directly to these broad outcomes. The approach is based on the constructivist theory of teaching and learning. Constructivism underpins the concept of Competency Based Education. This education strategy supports teaching and learning in different environments.

Constructivism emphasizes on two important dimensions:

- Learners actively acquire existing human knowledge (language, cultural wisdom, technical skills, school disciplines etc.) as their own system of knowing.
- Learners actively construct their own novel ways of knowing in the face of unfamiliar problems.

Therefore: Learners construct and re-construct knowledge. This is an active process of the learner and, thus gaining knowledge must be a learner-centred process. The learner-centred approach challenges both learners and teachers. The constructivist learning theory is very obvious since the knowledge of human kind was developed in this way: People engaged in understanding, explaining and working in the real world. The construction of knowledge is individual. Every learner, in particular the child as a learner, undergoes a process of acquiring knowledge. Knowledge is invented and re-invented. Therefore, knowledge cannot be transmitted from the teacher to the learner; it is re-constructed by the learner engaged in a culture of learning in school.

The main principle of constructivism in the classroom is to create an environment that gets learners engaged in the processes and development of thinking (cognition). To learn means to think about life, culture and work in increasingly complex ways in order to act more and more competently. A school (especially the classroom) is a particular important learning environment, because it makes systematic learning possible. The principles of learner-centred learning are summarized in the following diagram.




The above diagram shows that ONE; Knowledge is a body of information, ideas and practices that change and develop over time; TWO: the construction of knowledge is closely related to the activities in the classroom which include reasoning and critical thinking, problem-solving, retrieval, understanding and use of information, relating learning to one's existing knowledge, belief and attitudes, and thoughtful reflection on experience. THREE: Only a person that is enabled to engage actively in learning can be considered as a learner. This happens individually and collectively. FOUR: Teachers have to emphasize on authentic and meaningful tasks in real-world settings. This will enable the learners to construct context- and content-dependent knowledge. And FIVE: Constructivist learning environments support collaborative construction of knowledge through social negotiation and dialog between learner and teacher and among learners. Therefore language plays an important role and should be given particular attention.

The new curriculum framework for Ethiopian schools has clearly indicated that continuous assessment should be part of the teaching learning process and be done using oral, written and practical work. Therefore, this syllabus expects teachers to conduct continuous assessment throughout each term in the form of classroom exercises (written or oral), tests, homework/assignments, assessment of practical and field works, reports of project activities and personal inventories. In this syllabus, at the end of each unit, are given assessment descriptions, based on competencies, in order to help teachers focus their continuous assessments around them and make sure whether the ones set as standard competencies are achieved or not. In the assessment, the statement "minimum requirement level" should not be misleading and should be understood as the "standard level". Students working at the standard level are expected to achieve the competencies set for the grade level successfully. Teachers should give special considerations for those who are working above and below the standard levels by encouraging the ones that work above the standard and by giving extra attention for those who work below the standard.

The curriculum framework has allotted four periods per week for grades 11 and 12 biology. Even though the academic calendar is made up of 40 weeks, the syllabus is prepared for 34 weeks (136 periods) creating a wider chance for teachers to use about six extra weeks for tasks of helping students that need further assistance and even for revision and student projects . In addition to getting more relaxed time for activities this also ensures that the curriculum be covered rightly in the academic year. The distribution of periods for each unit and sub-unit of each grade level is indicated in the table at the end of this introduction. It should be noted that

periods allocated for the sub-units of each unit, throughout the syllabus, are proposed leaving a room for teachers' freedom of using them flexibly.

This syllabus is not the only curricular material for biology. It is preceded by the flow chart and the minimum learning competencies (MLCs) and is expected to be succeeded by students textbook, students' workbook, teachers guide, and practical activities manual. **The flowchart** is a document that presents the contents listed in a sequence that gives a guideline on the topics to be taught and arranging them in such a way that they build on each other in a spiral progression. The flow chart begets the MLC. **The MLC** is a document that indicates the minimum that a student must learn in each grade level in terms of content and skills and it builds on the themes or competency areas identified for the subject. The MLC begets the syllabus. **The syllabus** is a document that is pre-planned, preordained, pre-sequenced, inventory of specifications that serves as a road map to teachers, students and textbook writers. It is made up of unit outcomes, competencies, contents, and hints for teaching and assessment. The syllabus begets the students' textbook and workbook and to the teachers guide and practical activities manual. **The textbook** is a standard book used in schools for a given subject and grade level and which serves as a primary learning instrument for students. **The workbook** is a booklet used by a student in which answers and workings may be entered besides questions and exercises. The booklet is designed in such a way that it has enough spaces for solving problems or recording activities. **The teacher's guide** is a book for the teacher that consists of written instructions for the teacher giving specific directions for teaching the various parts of a lesson. **The practical activities manual** is a manual for the teacher giving instructions on the 'how to' of conducting experiments and simple activities inside and outside the classroom, preparing equipments and chemicals, arranging and performing field trips and visits, making teaching aids and constructing models.

Finally, it should be underlined that the key players in the proper implementation of the biology curriculum are not only students and teachers. Parents, school management, community and government (both central and regional) have important roles. Parents should provide opportunities for their children to practice at home the knowledge and skills they have learnt at school. They should give necessary advice and supervision of their activities. The school management should provide moral and material support for biology activities in the school and establishing linkages between the community, relevant institutions and activities initiated by the subject such as tree planting. The community should avail community resources for the teaching of biology especially when students are required to demonstrate active participation in community undertakings.

This document of grades 11 and 12 biology syllabuses was developed by a workshop (January 8- May 8, 2008) held at the premises of the Curriculum Framework Development Department of the MOE and at which 12 teachers from nine regions of the country participated. Following is a list of team of experts and teachers who developed this document:

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   Heinrichs Heinrich

2. Local consultant on biology education
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3. Curriculum experts from the Ministry Of Education
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4. Teachers from Regions

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| Girma Mengistu | (Addis Ababa) |
| Kalkidan Isayas | (Gambela) |
| Kebede Faris | (Benshangul-gumuz) |
| Samuel Solomon | (Somali) |
| Solomon Wedeyes | (Harar) |
| Tagel Gashaw | (Afar) |
| Terefe Leta | (Oromia) |
| Teshome Habte | (SNNPR) |
| Tessema Tofu | (Addis Ababa) |

**Allotment of Periods**
**For Units and Sub-units of Biology**
**Grades 11 and 12**

| ***Grade*** | ***Unit*** | ***Sub-unit*** | ***Number of Periods*** | |
|---|---|---|---|---|
| | | | ***Sub-unit*** | ***Total*** |
| 11 | Unit 1: The Science of Biology | 1.1 Methods of science | 10 | 29 |
| | | 1.2 Basic tools of a biologist | 7 | |
| | | 1.3 Relevance and promises of biology | 5 | |
| | | 1.4 Biology and HIV/AIDS | 7 | |
| | Unit 2: Biochemical Molecules | 2.1 Inorganic molecules | 8 | 24 |
| | | 2.2 Organic molecules | 16 | |
| | Unit 3: Enzymes | 3.1 Nature of enzymes | 7 | 27 |
| | | 3.2 Functions of enzymes | 9 | |
| | | 3.3 Factors affecting the functions of enzymes | 11 | |
| | Unit 4: Cell Biology | 4.1 Cell theory | 8 | 29 |
| | | 4.2 Types of cells | 4 | |
| | | 4.3 Parts of the cell and their functions | 17 | |
| | Unit 5: Energy Transformation | 5.1 Cellular respiration | 14 | 27 |
| | | 5.2 Photosynthesis | 13 | |
| 12 | Unit 1: Micro-organisms | 1.1 Bacteria | 5 | 30 |
| | | 1.2 Ecology and uses of bacteria | 10 | |
| | | 1.3 Viruses | 15 | |
| | Unit 2: Ecology | 2.1 Cycling of matter through ecosystems | 8 | 30 |
| | | 2.2 Ecological succession | 3 | |
| | | 2.3 Biomes | 5 | |
| | | 2.4 Biodiversity | 7 | |
| | | 2.5 Population structure and dynamics | 7 | |
| | Unit 3: Genetics | 3.1 Crossing principles | 10 | 26 |
| | | 3.2 Molecular genetics | 6 | |

| ***Grade*** | ***Unit*** | ***Sub-unit*** | ***Number of Periods*** | |
|---|---|---|---|---|
| | | | ***Sub-unit*** | ***Total*** |
| | | 3.3 Protein synthesis | 5 | |
| | | 3.4 Mutations | 5 | |
| | Unit 4: Evolution | 4.1 The origin of life | 5 | 25 |
| | | 4.2 Theories of evolution | 5 | |
| | | 4.3 Evidences of evolution | 5 | |
| | | 4.4 The process of evolution | 5 | |
| | | 4.5 The evolution of humans | 5 | |
| | Unit 5: Behaviour | 5.1 Introduction | 3 | 25 |
| | | 5.2 Innate behaviour | 5 | |
| | | 5.3 Learned behaviour | 10 | |
| | | 5.4 Patterns of behaviour | 7 | |

# Biology Syllabus, Grade 11

## General Objectives of Grade 11 Biology

**1**. **To develop understanding and acquire knowledge of:**

- meaning of science and the steps of the scientific method
- tools used in biology and their functions
- the relevance and promise of biological science and the role of biology as a science in the fight against HIV and AIDS
- organic molecules, their structures and functions and the property and importance of water for life
- meaning, names, properties, and importance of enzymes and how they lower activation energy
- the mechanism of action of enzymes, the actions of apo- and co- enzymes, co-factors and allosteric regulation and feedback control mechanism of enzyme activity
- the cell theory, the size and functions of cells, prokaryotic and eukaryotic cells and the functions of the different parts of the cell
- the importance and composition of a cell membrane, the models of cell membrane and the mechanisms of substance transport across a cell membrane
- the structure of ATP and its role in cellular metabolism and the role of electron donors and acceptors
- the structure of a mitochondrion and where the different processes of cellular respiration occur
- the process of alcoholic fermentation and lactate production
- the chloroplast, light dependent and independent processes of photosynthesis the products of the two processes
- photorespiration and $C_3$ and $C_4$ plants

**2. To develop skills and abilities of:**

- applying the scientific method in solving problems
- planning and conducting scientific experiment and writing a report for scientific experiments
- using laboratory and field tools in biology activities
- conducting a library research and gathering information on biology topics
- identifying biologically important compounds by conducting simple tests
- demonstrating factors that affect enzyme activity with simple experiments
- demonstrating osmosis and diffusion with simple experiments
- separating photosynthetic pigments by paper chromatography
- scientific enquiry: observing, classifying, comparing, making models, communicating, measuring, asking questions, drawing conclusions, applying concepts, interpreting photos and illustrations and relating cause and effect

**3. To develop the habit and attitude of:**

- willingness to participate in community undertakings against HIV and AIDS
- demonstrating life skills that lead to responsible sexual behaviour
- curiosity, love, freedom, honesty, respect, co-operation, tolerance, humility, reasoning, and openness as values of learning biology as a science

## Unit 1: The science of biology *(29 periods)*

***Unit Outcomes:*** Students will be able to:

- define science, name and demonstrate the scientific methods
- plan and conduct scientific experiment and write a report for scientific experiments
- name and classify the tools used in biology, explain their functions and demonstrate how to use some tools
- conduct a library research and gather information to explain the relevance and promise of biological science
- explain the role of biology as a science in the fight against HIV and AIDS
- express willingness to participate in community undertakings against HIV and AIDS
- demonstrate life skills that lead to responsible sexual behaviour.

| ***Competencies*** | ***Contents*** | ***Suggested activities*** |
|---|---|---|
| *Students will be able to:*<br>• define science as a way of knowledge<br>• list the steps involved in scientific methods<br>• demonstrate scientific methods in solving problems<br>• plan and conduct scientific experiment to test a given problem | **1. *The science of biology***<br>**1.1 Methods of science** *(10 periods)*<br>• What is science?<br>• Steps of the scientific method<br>• Scientific experiment | • Start the lesson by asking students to tell how they perceive the term science. Then give them the appropriate definition.<br>• A concrete example, from scientific publications, should be shown to demonstrate scientific methods to solve problems. Students should be allowed to make simple practices of each step of the scientific method.<br>• You can also use case studies from experiences of some scientists. By narrating how a given scientist discovered his findings, students can discern the Scientific Methods followed up to the discovery. For example, the scientific Methods that Alexander Fleming followed to discover penicillin could be related as a very interesting case study.<br>• Let the students conduct a group work to identify problems from what they observe in their surroundings and show the steps they follow to solve the problem |
| • write a report for scientific experiment | • Writing reports | • Present a format for writing a report for experiments. Let the students discuss on the outlined format. Let them understand that report writing skill is essential not only for experiments but also for any scientific activity conducted inside and outside the classroom. Let them practice report writing. |
| • name some common tools used in biology<br>• classify tools used in biology as laboratory and field equipments<br>• explain the functions | **1.2 Basic tools of a biologist** *(7 periods)*<br>• Laboratory tools (light and electron microscopes, dissecting kit, pipette, Petri-dish, | • Display some of the tools available in the school laboratory. Let the students identify each tool and explain its function. Let them practice the use of some of the tools.<br>• If samples of some relevant tools and instruments for biological research are not available in the school laboratory pictures and charts could be used to teach about them.<br>• Whenever there is access to the higher education institutions students may visit biology laboratories and observe the laboratory and field tools available there. |

| *Competencies* | *Contents* | *Suggested activities* |
|---|---|---|
| of some tools used in biology<br>• demonstrate the use of some tools used in biology | centrifuge, balance, etc.)<br>• Field tools (insect net, plant press, altimeter, GPS, meter, traps, etc.) | |
| • explain the relevance and promise of biological science<br>• conduct a simple library research on relevance and promises of biology<br>• gather information or data through interviews | **1.3 Relevance and promises of biological science** *(5 periods)*<br>• Mainly a student project | • Let students conduct a simple library research on relevance and promises of biology. This could also be extended to interviewing some professionals of relevant or concerned institutions.<br>• Let them write a report of their findings and present it to the class<br>• Their findings should indicate a) the relevance of biology in agriculture, medicine, nutrition and food shortage, environmental protection, control of RPG; and b) the promises of biology in the area of biotechnology and its role in the development of the country |
| • explain the role of biology as a science in the fight against HIV and AIDS<br>• express willingness to participate in community undertakings against HIV and AIDS<br>• demonstrate life skills that lead to responsible sexual behaviour | **1.4 Biology and HIV/AIDS** *(7 periods)*<br>• Contribution of biology to the fight against AIDS<br>• Students' contribution to the fight against AIDS (community participation; love, care and protection of PLWHA; The fight against stigma and discrimination; etc.)<br>• Responsible sexual behaviour<br>• Life skills (decision making; problem solving; assertiveness; self-esteem; communication; etc.) | • Use various participatory approaches when dealing with this content. You can plan to have guest speakers from health institutions or from among PLWHA. You can also arrange a visit to a nearby centre or NGO which is working with PLWHA. Let the students practice certain life skills through role plays, and methods like case studies, devil's advocate, values clarification, debate and other similar methods. You can also allow members of the AIDS club to have a discussion session with your students. The AIDS club could demonstrate variety of activities that help in the development of life skills. |

## Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the Competencies, to determine whether the student has achieved the minimum required level.

A student working at the minimum requirement level will be able to: define science, name and demonstrate the scientific methods; plan and conduct scientific experiment and write a report for scientific experiments; name and classify the tools used in biology, explain their functions and demonstrate how to use some tools; conduct a library research and gather information to explain the relevance and promise of biological science
Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students working below the minimum requirement level will require extra help if they are to catch up with the rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.

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## Unit 2: Biochemical molecules *(24 periods)*

***Unit Outcomes:*** Students will be able to

- group biochemical molecules as organic and inorganic
- explain the property and state the importance of water for life
- describe and show the structures and state the functions of organic molecules in living things
- identify biologically important compounds by conducting simple tests.

| ***Competencies*** | ***Contents*** | ***Suggested activities*** |
|---|---|---|
| *Students will be able to:*<br>• group biochemical molecules as organic and inorganic<br>• explain the property of water for life<br>• state the importance of water for life | ***2. Biochemical molecules***<br>**2.1 Inorganic molecules** *(8 periods)*<br>• Elements in life (H, C, N, O, P, S)<br>• Properties of water<br>• Importance of water | • Give students a list of chemical compounds containing C and N. Let the students group the compounds as inorganic and organic. Students could also discuss in small groups on what organic and inorganic compounds are and prepare more lists of organic and inorganic compounds.<br>• Students brainstorm in groups and develop a concept map on all properties of water. They may use reference material like chemistry books, biology books, physics books etc.<br>• Let students discuss in groups on some properties of water. For example they can discuss on why a bottle filled with water and plugged properly breaks when the water is completely changed into ice |
| • describe the structures of organic molecules in living things<br>• state the functions of organic molecules in living things<br>• show the structures of biological molecules using chemical formulae<br>• identify biologically important compounds by conducting simple tests | **2.2 Organic molecules** *(16 periods)*<br>• Carbohydrates (structure, functional groups, isomers)<br>• Lipids, proteins and nucleic acids (structure and functional groups)<br>• Identification of biologically important compounds, i.e., starch, sugars, cellulose, lipids, protein | • Students brainstorm in groups and develop a list of organic compounds. They may use reference material like chemistry books, biology books etc.<br>• The importance of C – H bond for energy should be underlined when dealing with organic molecules.<br>• Students conduct simple experiments to identify carbohydrates, fats and proteins in food.<br>• Students develop a table where they list resources of fats, carbohydrates and proteins. This could be documented on posters (e.g. on wallpaper) and exhibited on the classroom walls.<br>• Students list the food of their daily diet and make statements on the presence of carbohydrates, fats and proteins.<br>• Use diagrams and text on the chemical structures and properties of: Amino acids, peptides and proteins (including primary, secondary and tertiary structure); Lipids; and Carbohydrates<br>• Let the students appreciate that these organic molecules serve not only as foods but also as structural and functional molecules (e.g., protein as hair). |

## Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the Competencies, to determine whether the student has achieved the minimum required level.

A student working at the minimum requirement level will be able to: group biochemical molecules as organic and inorganic; explain the property and state the importance of water for life; describe and show the structures and state the functions of organic molecules in living things; identify biologically important compounds by conducting simple tests.

Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students working below the minimum requirement level will require extra help if they are to catch up with the rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.

## Unit 3: Enzymes *(27 periods)*

***Unit Outcomes:*** Students will be able to

- define, name, classify and explain the properties of enzymes and appreciate their importance
- explain how enzymes lower activation energy, their mechanism of action and the actions of apo- and co- enzymes
- give examples of vitamins and minerals in food that act as co-factors
- explain factors that affect enzyme activity and demonstrate that with simple experiments
- explain allosteric regulation and feedback control mechanism of enzyme activity.

| ***Competencies*** | ***Contents*** | ***Suggested activities*** |
|---|---|---|
| *Students will be able to:*<br>• define enzymes as proteins that catalyze chemical changes<br>• explain the properties of enzymes<br>• name and classify enzymes according to their structure<br>• appreciate the importance of enzymes in industries and local products life | ***3. Enzymes***<br>**3.1 Nature of enzymes** *(7 periods)*<br>• Properties of enzymes<br>• Classification of enzymes<br>• Naming enzymes | • Use text with general properties of enzymes including the nomenclature (-ase) and provide tasks and questions for students.<br>• Let students list the four criteria of naming enzymes and produce a schematic representation of enzyme classification<br>• Students could discuss in groups on the role of enzymes in the making of any local food (like injera) or drink (like tella) and present a report to the class. |
| • explain how enzymes lower activation energy<br>• explain the mechanism of enzyme action<br>• discuss the action of apo- and co-enzymes<br>• give examples of vitamins and minerals in food that act as co-factors | **3.2 Functions of enzymes** *(9 periods)*<br>• Enzymes and activation energy<br>• Mechanism of enzyme action<br>• Apoenzymes and coenzymes<br>• Application of enzymes | • Make sure that students understand the key concepts that enzymes work by lowering energy barriers; an enzyme's structure enables it to catalyze a specific reaction; an enzyme has a limited number of active sites; and that some enzymes require co-factors and co-enzymes to function.<br>• When learning the reduction of the activation energy of a chemical reaction students could draw the energy profile of a reaction with and without a catalyst<br>• Make a list of vitamins that serve as cofactors<br>• Let students visit a nearby factory or industry that uses enzymes (if available) and write a report on practical applications of enzymes |

| *Competencies* | *Contents* | *Suggested activities* |
|---|---|---|
| • explain factors that affect enzyme activity<br>• demonstrate how temperature, pH, substrate conc. and enzyme conc. affect enzymatic activity<br>• explain allosteric regulation and feedback control mechanism of enzyme activity<br>• appreciate the role of enzymes in controlling our metabolic activities | **3.3 Factors affecting the functions of enzymes**<br>*(11 periods)*<br>• Temperature, pH, substrate concentration, and enzyme concentration<br>• Allosteric regulation and feedback control mechanism | • Make sure that students understand the key concepts that temperature affects the rate of enzyme catalyzed reaction; and that each enzyme has an optimal pH.<br>• Conduct experiments on the effects of factors on enzyme activity:<br>• Enzymes and temperature<br>• Enzymes and pH<br>• Enzymes and substrate concentration<br>• Enzyme concentration<br>• Use a diagram showing allosteric regulation and feedback control mechanisms. Students could write a summary of both regulation mechanisms using sentences containing "if… then…" |

## Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the Competencies, to determine whether the student has achieved the minimum required level.

A student working at the minimum requirement level will be able to: define, name, classify and explain the properties of enzymes and appreciate their importance; explain how enzymes lower activation energy, their mechanism of action and the actions of apo- and co- enzymes; give examples of vitamins and minerals in food that act as co-factors; explain factors that affect enzyme activity and demonstrate that with simple experiments; explain allosteric regulation and feedback control mechanism of enzyme activity.

Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students working below the minimum requirement level will require extra help if they are to catch up with the rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.

## Unit 4: Cell biology *(29 periods)*

***Unit Outcomes:*** Students will be able to

- tell the history of cell biology and describe the cell theory
- investigate the size and sate the functions of cells
- state the importance and describe the composition of a cell membrane
- compare the models of cell membrane and show the arrangement of the phospholipids and proteins in the fluid mosaic model
- name and explain the function of the different parts of the cell
- explain the mechanisms of substance transport across a cell membrane and demonstrate osmosis and diffusion
- explain the difference between prokaryotic and eukaryotic cells.

| ***Competencies*** | ***Contents*** | ***Suggested activities*** |
|---|---|---|
| *Students will be able to:*<br>• tell the history of cell biology<br>• describe the cell theory<br>• investigate the size of cells<br>• sate the basic functions of cells<br>• appreciate that all life on earth originates from life | ***4. Cell biology***<br>**4.1 Cell theory** *(8 periods)*<br>• Development of the cell theory<br>• Modern cell theory<br>• Cell size and function | • Make sure that students understand the key concepts that the cell theory has had a long history; most cells are very small; and that microscopy reveals cell structure.<br>• Let the students work in groups and present to the class about the contributions of the following scientists to the cell theory (stating the time they made their observations): Robert Hook, Antoine van Leeuwenhoek, Rene Dutrochet, Mathias Schleiden, Theodore Schwann, and Rudolf Wirchow.<br>• Draw four cubes with sides of 1, 2, 4 and 8 cms and let students compare:<br>• Surface area (the surface through which materials enter the cell)<br>• Volume (cellular materials and functions that require input from outside)<br>• Surface area/Volume<br>• Then let the students debate in group which is advantageous to the cell: high surface area to volume ratio or low. |
| • explain the difference between prokaryotic and eukaryotic cells | **4.2 Types of cells** *(4 periods)*<br>• Prokaryotic and eukaryotic cells | • Make sure that students understand the key concepts that: the two major types of cell are prokaryotic and eukaryotic; and that a eukaryotic cell is compartmentalized by its nucleus and membranous organelles<br>• Use text and diagrams of prokaryotic and eukaryotic organisms. (If possible, use film material or other media) and let students list all features of prokaryotic and eukaryotic cells and let them draw prokaryotic and eukaryotic organisms |

| *Competencies* | *Contents* | *Suggested activities* |
|---|---|---|
| • state the importance of a cell membrane<br>• describe the composition and the arrangement of lipids and proteins in the membrane<br>• compare the Daveson-Daniel and the fluid mosaic models<br>• show the arrangement of the phospholipids and proteins in the fluid mosaic model<br>• explain the role of glycoprotein and other components in the membrane | **4.3 Parts of the cell and their functions**<br>*(17 periods)*<br>• Cell membrane | • Make sure that students understand the key concepts that: cells are surrounded by plasma membrane; cells contain structures called organelles that have specialized functions; organelles themselves are membrane bound; molecules move by diffusion; membranes allow some molecules to diffuse freely while they inhibit the passage of others; proteins transport some substances across the cell membrane through facilitated diffusion; and that some molecules are actively transported against concentration gradient.<br>• Use diagrams and text on the Daveson-Daniel and the fluid mosaic model including time of discovery. Let the students draw the model in their exercise books. Let them compare the models and write a short paragraph on the differences.<br>• Demonstrate the importance of models in science; Students could discuss the question of a model and a reality and finally answer "Which is the correct model, the Daniel-Daveson or the fluid mosaic model?" (A model reflects always the evidence available on a given phenomenon) |
| • name the different parts of the cell<br>• explain the functions of each part | • Cell organelles | • Use text on cell structures and functions and let students develop table on cell structures and their functions as follows:<br><br>\| Cell organelle \| Functions \|<br>\| \| \| |
| • explain the mechanisms of substance transport across a cell membrane<br>• conduct an experiment to show movement of solvent through semi-permeable membrane<br>• demonstrate osmosis at a semi-permeable membrane<br>• explain that the size of a cell changes by osmosis because of in and outflow of water<br>• appreciate the fact that | • Transport of materials in cells | • Let students prepare charts showing the passage of small molecules (oxygen, water, and carbon dioxide), and macromolecules required by the cell (amino acids, glucose, fatty acids).<br>• Demonstrate the processes of osmosis and diffusion by simple activities.<br>• Cautiously bring egg yolk (membrane must not be damaged!) into a beaker glass with a) concentrated Sodium chloride solution and b) distilled water.<br>With this experiment you can discuss and explain Movement of water through semi-permeable membrane and osmosis (including change of size of the cell)<br>• Bore three potato tubers to form a U shape and add concentrated salt solution in one and distilled water in the second and physiological solution (isotonic) in the third (control). |

| *Competencies* | *Contents* | *Suggested activities* |
|---|---|---|
| osmosis is responsible for every day life phenomena | | Then check whether the potatoes shrink or get turgid.<br>• Let students discuss on every day life phenomena that are related to osmosis, e.g. danger of drinking sea water, turgor of plants, bursting of fruits during rain, eating food with too much salt in it, etc. |

## Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the Competencies, to determine whether the student has achieved the minimum required level.

A student working at the minimum requirement level will be able to: tell the history of cell biology and describe the cell theory; investigate the size and sate the functions of cells; state the importance and describe the composition of a cell membrane; compare the models of cell membrane and show the arrangement of the phospholipids and proteins in the fluid mosaic model; name and explain the function of the different parts of the cell; explain the mechanisms of substance transport across a cell membrane and demonstrate osmosis and diffusion; explain the difference between prokaryotic and eukaryotic cells

Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students working below the minimum requirement level will require extra help if they are to catch up with the rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.

## Unit 5: Energy transformation *(27 periods)*

***Unit Outcomes:*** Students will be able to

- describe the structure of ATP and its role in cellular metabolism and the role of electron donors and acceptors
- draw and label the structure of a mitochondrion and locate where the different processes of cellular respiration occur
- explain and demonstrate the process of alcoholic fermentation and lactate production
- draw and label a chloroplast, locate where light dependent and independent processes occur and name the products of the two processes
- explain photorespiration
- distinguish between $C_3$ and $C_4$ plants and give at least three examples for each
- separate photosynthetic pigments by paper chromatography.

| ***Competencies*** | ***Contents*** | ***Suggested activities*** |
|---|---|---|
| *Students will be able to:* | ***5. Energy transformation*** | |
| • describe the structure of ATP and its role in cellular metabolism<br>• explain the role of electron donors and acceptors | **5.1 Cellular respiration** *(14 periods)*<br>• ATP and NADH | • Make sure that students understand the key concepts that: respiration produces NADH and ATP; mitochondria are the principal sites of respiration in eukaryotic cells; the Kreb's cycle is the core of metabolism; the electron transport system synthesizes ATP; many organisms obtain energy through fermentation; excess sugar can be made into fatty acids; and that many compounds are catabolized into the central pathway. |
| • draw and label the structure of a mitochondrion | • Structure of mitochondria | • Students draw and label a mitochondrion and describe the importance of the membranes |
| • locate where the different processes of cellular respiration occur in the cell | • Phases of respiration<br>– Glycolysis and Kreb's cycle<br>– Electron transport system | • In a diagram/ picture of a mitochondrion are the stages of cellular respiration depicted. Students write a list of the steps included and allocated to the different locations. Let them prepare a chart that shows the respiratory process. They should not be expected to memorize the steps.<br>• Prepare a generalized schematic drawing of the respiratory process to show which steps constitute glycolysis, Kreb's cycle and ETS. Show also at which step fermentation starts and give example of fermentation reactions. |
| • explain the process of alcoholic fermentation<br>• explain the process of lactate production<br>• appreciate the importance of lactate production | • Fermentation<br>• Conversion of sugars to fatty acids<br>• Metabolism of proteins, polysaccharides and lipids | • Let students conduct a fermentation activity to produce an alcoholic beverage or bread/injera. They describe all steps of the process and note it in their exercise books.<br>• Use a chart to show how proteins and lipids are metabolized through the central pathway |

| ***Competencies*** | ***Contents*** | ***Suggested activities*** |
|---|---|---|
| during running and other sports<br>• summarize the metabolism of proteins, polysaccharides and lipids | | |
| • draw and label a chloroplast<br>• locate where light dependent and independent processes occur in the chloroplast<br>• name the products of the light independent and dependent processes | **5.2 Photosynthesis**<br>*(13 periods)*<br>• Structure of chloroplast<br>• Photosynthetic pigments<br>• Light–dependent and light–independent reactions | • Make sure that students understand the key concepts that: photosynthesis in eukaryotes occurs in chloroplasts; molecules absorb light through activation of their electrons; chlorophylls are the major pigments used in photosynthesis; two phtosystems cooperate in plant photosynthesis; cyclic photophosphorylation creates only ATP; non-cyclic photophosphorylation creates NADH; $CO_2$ is reduced to organic compounds in the Calvin cycle; and that some plants use an alternative pathway for $CO_2$ fixation.<br>• Let students draw the structure of a chloroplast and label them. Let them indicate light-dependent reactions in the thylakoids and light-independent reactions in the stroma.<br>• Let students discuss in groups and illustrate the function of the light harvesting complex and let them identify products of both light-dependent and light-independent processes and develop a summary of both processes. Let them give a group presentation on: light-dependent and light-independent reactions; photorespiration; and on $C_3$ and $C_4$ plants.<br>• Prepare a chart showing the fate of an electron during PS1 and PS2 and show non-cyclic and cyclic photophosphoryllation. |
| • explain photorespiration and how it is related to higher temperatures | • Photorespiration | |
| • distinguish between $C_3$ and $C_4$ plants<br>• give at least three examples of $C_3$ and $C_4$ plants<br>• appreciate the importance of $C_4$ plants in Ethiopia<br>• separate photosynthetic pigments by paper chromatography | • $C_3$ and $C_4$ plants | • Draw a chart to show the calvin cycle and indicate where it occurs in $C_3$ and $C_4$ plants<br>• Let students list $C_4$-plants in Ethiopia and other countries by using literature like the schoolbook and other sources from the library.<br>• Let the students conduct an activity to separate photosynthetic pigments by paper chromatography. |

## Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the Competencies, to determine whether the student has achieved the minimum required level.

A student working at the minimum requirement level will be able to: describe the structure of ATP and its role in cellular metabolism and the role of electron donors and acceptors; draw and label the structure of a mitochondrion and locate where the different processes of cellular respiration occur; explain and demonstrate the process of alcoholic fermentation and lactate production; draw and label a chloroplast, locate where light dependent and independent processes occur and name the products of the two processes; explain photorespiration; distinguish between $C_3$ and $C_4$ plants and give at least three examples for each; separate photosynthetic pigments by paper chromatography.

Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

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