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: • define science as a way of knowledge • list the steps involved in scientific methods • demonstrate scientific methods in solving problems • plan and conduct scientific experiment to test a given problem	**1. *The science of biology*** **1.1 Methods of science** *(10 periods)* • What is science? • Steps of the scientific method • Scientific experiment	• Start the lesson by asking students to tell how they perceive the term science. Then give them the appropriate definition. • 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. • 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. • 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 • classify tools used in biology as laboratory and field equipments • explain the functions	**1.2 Basic tools of a biologist** *(7 periods)* • 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. • 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. • 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 • demonstrate the use of some tools used in biology	centrifuge, balance, etc.) • Field tools (insect net, plant press, altimeter, GPS, meter, traps, etc.)	
• explain the relevance and promise of biological science • conduct a simple library research on relevance and promises of biology • gather information or data through interviews	**1.3 Relevance and promises of biological science** *(5 periods)* • 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. • Let them write a report of their findings and present it to the class • 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 • express willingness to participate in community undertakings against HIV and AIDS • demonstrate life skills that lead to responsible sexual behaviour	**1.4 Biology and HIV/AIDS** *(7 periods)* • Contribution of biology to the fight against AIDS • Students' contribution to the fight against AIDS (community participation; love, care and protection of PLWHA; The fight against stigma and discrimination; etc.) • Responsible sexual behaviour • 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.

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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: • group biochemical molecules as organic and inorganic • explain the property of water for life • state the importance of water for life	***2. Biochemical molecules*** **2.1 Inorganic molecules** *(8 periods)* • Elements in life (H, C, N, O, P, S) • Properties of water • 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. • 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. • 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 • state the functions of organic molecules in living things • show the structures of biological molecules using chemical formulae • identify biologically important compounds by conducting simple tests	**2.2 Organic molecules** *(16 periods)* • Carbohydrates (structure, functional groups, isomers) • Lipids, proteins and nucleic acids (structure and functional groups) • 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. • The importance of C – H bond for energy should be underlined when dealing with organic molecules. • Students conduct simple experiments to identify carbohydrates, fats and proteins in food. • 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. • Students list the food of their daily diet and make statements on the presence of carbohydrates, fats and proteins. • 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 • 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.

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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: • define enzymes as proteins that catalyze chemical changes • explain the properties of enzymes • name and classify enzymes according to their structure • appreciate the importance of enzymes in industries and local products life	***3. Enzymes*** **3.1 Nature of enzymes** *(7 periods)* • Properties of enzymes • Classification of enzymes • Naming enzymes	• Use text with general properties of enzymes including the nomenclature (-ase) and provide tasks and questions for students. • Let students list the four criteria of naming enzymes and produce a schematic representation of enzyme classification • 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 • explain the mechanism of enzyme action • discuss the action of apo- and co-enzymes • give examples of vitamins and minerals in food that act as co-factors	**3.2 Functions of enzymes** *(9 periods)* • Enzymes and activation energy • Mechanism of enzyme action • Apoenzymes and coenzymes • 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. • 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 • Make a list of vitamins that serve as cofactors • 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 • demonstrate how temperature, pH, substrate conc. and enzyme conc. affect enzymatic activity • explain allosteric regulation and feedback control mechanism of enzyme activity • appreciate the role of enzymes in controlling our metabolic activities	**3.3 Factors affecting the functions of enzymes** *(11 periods)* • Temperature, pH, substrate concentration, and enzyme concentration • 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. • Conduct experiments on the effects of factors on enzyme activity: • Enzymes and temperature • Enzymes and pH • Enzymes and substrate concentration • Enzyme concentration • 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.

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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: • tell the history of cell biology • describe the cell theory • investigate the size of cells • sate the basic functions of cells • appreciate that all life on earth originates from life	***4. Cell biology*** **4.1 Cell theory** *(8 periods)* • Development of the cell theory • Modern cell theory • 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. • 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. • Draw four cubes with sides of 1, 2, 4 and 8 cms and let students compare: • Surface area (the surface through which materials enter the cell) • Volume (cellular materials and functions that require input from outside) • Surface area/Volume • 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)* • 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 • 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 • describe the composition and the arrangement of lipids and proteins in the membrane • compare the Daveson-Daniel and the fluid mosaic models • show the arrangement of the phospholipids and proteins in the fluid mosaic model • explain the role of glycoprotein and other components in the membrane	**4.3 Parts of the cell and their functions** *(17 periods)* • 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. • 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. • 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 • 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: | Cell organelle | Functions | | | |
• explain the mechanisms of substance transport across a cell membrane • conduct an experiment to show movement of solvent through semi-permeable membrane • demonstrate osmosis at a semi-permeable membrane • explain that the size of a cell changes by osmosis because of in and outflow of water • 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). • Demonstrate the processes of osmosis and diffusion by simple activities. • Cautiously bring egg yolk (membrane must not be damaged!) into a beaker glass with a) concentrated Sodium chloride solution and b) distilled water. With this experiment you can discuss and explain Movement of water through semi-permeable membrane and osmosis (including change of size of the cell) • 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. • 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

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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 • explain the role of electron donors and acceptors	**5.1 Cellular respiration** *(14 periods)* • 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 – Glycolysis and Kreb's cycle – 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. • 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 • explain the process of lactate production • appreciate the importance of lactate production	• Fermentation • Conversion of sugars to fatty acids • 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. • Use a chart to show how proteins and lipids are metabolized through the central pathway

Competencies	*Contents*	*Suggested activities*
during running and other sports • summarize the metabolism of proteins, polysaccharides and lipids		
• draw and label a chloroplast • locate where light dependent and independent processes occur in the chloroplast • name the products of the light independent and dependent processes	**5.2 Photosynthesis** *(13 periods)* • Structure of chloroplast • Photosynthetic pigments • 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. • 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. • 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. • 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 • give at least three examples of C_3 and C_4 plants • appreciate the importance of C_4 plants in Ethiopia • 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 • Let students list C_4-plants in Ethiopia and other countries by using literature like the schoolbook and other sources from the library. • 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.

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