Federal Democratic Republic of Ethiopia
Ministry of Education

Biology Syllabus, Grades 11 and 12

2009

Table of Contents

Introduction iii

Allotment of Periods ix

Biology Grade 11

General Objectives of Grade 11 Biology 2

Unit 1: The Science of Biology 3

Unit 2: Biochemical Molecules 6

Unit 3: Enzymes 8

Unit 4: Cell Biology 10

Unit 5: Energy Transformation 13

Biology Grade 12

General Objectives of Grade 12 Biology 17

Unit 1: Micro-organisms 18

Unit 2: Ecology 22

Unit 3: Genetics 26

Unit 4: Evolution 30

Unit 5: Behaviour 33

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 The learner will know and be able to interpret and apply biological, technological and environmental knowledge.
Skills	2. Biological investigation 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 The learner will be able to demonstrate interest and appreciation on the relationships between biology, technology, society and environment.

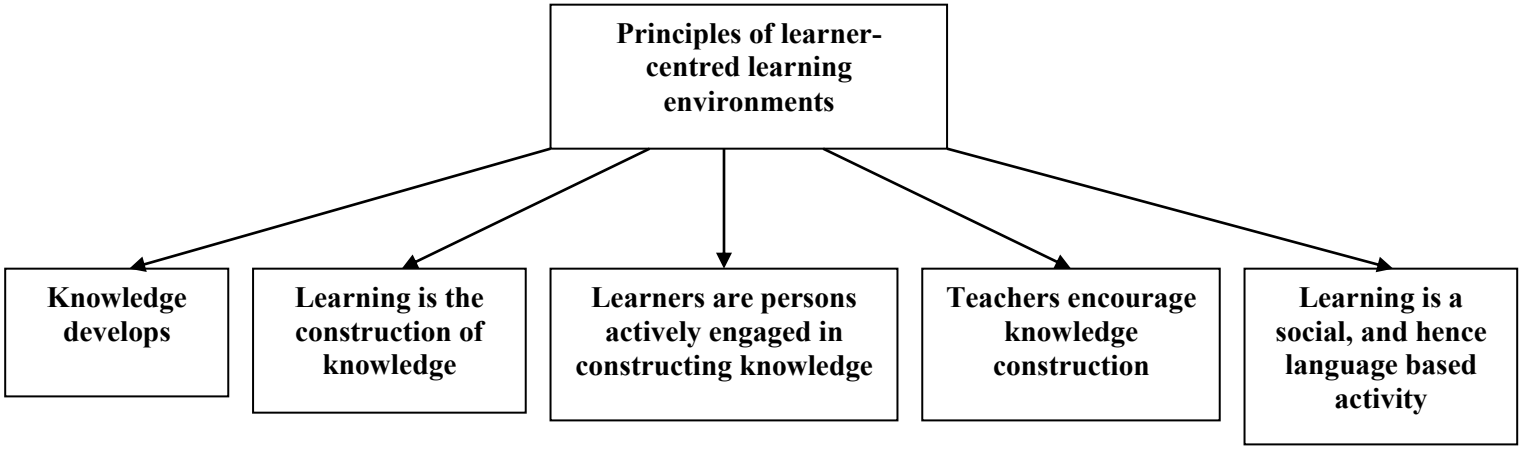
The developed competencies relate directly to these broad outcomes. The approach is based on the constructivist theory of teaching and learning. Constructivism underpins the concept of Competency Based Education. This education strategy supports teaching and learning in different environments.

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:

1. International consultant on biology education
   Heinrichs Heinrich

2. Local consultant on biology education
   Professor Mogessie Ashenafi (Addis Ababa University)

3. Curriculum experts from the Ministry Of Education
   Bekele Geleta, Getachew Tadesse, and Solomon Belayneh,

4. Teachers from Regions

Getachew Bogale	(Addis Ababa)
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 12

General Objectives of Grade 12 Biology

1. To develop understanding and acquire knowledge of:

- the structure, shape and group of bacteria and their role in every ecosystem
- infectious diseases, the germ theory, how bacteria produce diseases and the role of reservoir hosts in disease transmission
- industrial processes that use bacteria and how bacteria are used in these processes
- the structure, forms, types and reproduction of viruses and their differences from free living cells
- the structure of HIV, how it affects the immune system, its life cycle, ARVs and its social and economic impacts
- importance of recycling in nature, and the water, carbon, nitrogen, sulphur and phosphorus cycles
- primary and secondary successions and the major terrestrial and aquatic biomes with their characteristics and major fauna and flora
- biodiversity, its significance, status in Ethiopia, threats, and principles of conservation
- Intra-specific and inter-specific competitions and exponential and arithmetic growth curves and the influence of natality and mortality on population size
- the impacts of rapid population growth on development and the measures that should be taken to control it
- mono- and di-hybrid crosses, genotypes and phenotypes and types of dominance
- the stages of meiosis and its significance in bringing variation, why fruit flies are considered ideal for genetic experiments and sex determination, sex linkage, sex limited and sex influenced traits
- the molecular structure of a chromosome, the four nucleotides of DNA and DNA replication, the processes and sites of transcription and translation, mutation and its causes, types and impacts
- the theories of origin of life, and evolution and the evidences of evolution
- the mechanisms of speciation, adaptive radiation and convergent evolution and examples of types of natural selection
- the biological evolution of humans, and the importance of Lucy *(A. afarensis)* and the controversies regarding human races
- the importance of studying behaviour, the characteristics, types and examples of innate and learned behaviour
- examples of courtship, territorial, and social patterns of behaviours in animals

2. To develop skills and abilities of:

- growing trees in a given area
- interpreting a population growth rate curve
- working out gamates for mono- and di-hybrid crosses using Punnet square and determining genotypes and phenotypes
- constructing a DNA model
- scientific enquiry: observing, classifying, comparing, making models, communicating, measuring, asking questions, drawing conclusions, applying concepts, interpreting photos, illustrations and data and relating cause and effect

3. To develop the habit and attitude of:

- demonstrate life skills that lead to responsible sexual behaviour
- love and respect to fauna and flora and their biomes
- a concern towards and appreciating the importance of biodiversity and the need for its conservation
- willingness to participate in tree growing activities in their locality
- curiosity, love, freedom, honesty, respect, co-operation, tolerance, humility, reasoning, and openness as values of learning biology as a science

Unit 1: Micro-organisms *(30 periods)*

Unit Outcomes: Students will be able to:

- describe the structure, show the shape of and classify bacteria and explain their role in every ecosystem
- compare infectious disease with functional disease and state the germ theory
- explain how bacteria produce diseases and the role of reservoir hosts in disease transmission
- give examples of industrial processes that use bacteria and indicate how bacteria are used in these processes
- describe the structure of a virus, draw and label it, diagram its different forms, give examples of RNA and DNA viruses and compare viruses with free living cells
- compare the lytic and lysogenic cycles of viral reproduction
- draw and label the structure of HIV, explain how it affects the immune system, explain its life cycle, and state its social and economic impacts
- explain how antiretroviral drugs inhibit enzymes of the life cycle of HIV
- demonstrate life skills that lead to responsible sexual behaviour.

Competencies	***Contents***	***Suggested activities***
Students will be able to • describe bacterial cell structure • show different shapes of bacteria using diagrams • classify bacteria based on Gram stain and cell shape	***1. Micro-organisms*** **1.1 Bacteria** *(5 Periods)* • Prokaryotic cell structure • Bacterial shapes • Classifying bacteria	• Make sure that students understand the key concepts that: prokaryotic cells have no true nucleus and are usually very small; bacteria may be spheres, rods, spirals, or long filaments; and that bacteria are classified by cell shape, metabolism and reactions to the Gram stain • Student should know that bacteria and viruses are not the only micro-organisms. Let them name some other micro-organisms before they start learning about bacteria and viruses • Provide diagrams to show organelles in eukaryotic cells and their absence in prokaryotic cells • Show that prokaryotic cells also contain DNA and the cell functions occur in the cytoplasm and the plasma membrane • Provide diagrams to show the different shapes of bacteria • Students write how Gram stain is done to classify bacteria into Gram positive and Gram negative cells • Let the students observe bacteria through the microscope. You can provide them with fermented milk such as irgo and yoghurt. A drop of irgo contains hundreds of millions of bacteria. Therefore, wet mounting a drop of diluted irgo could enable students look at bacteria through the microscope.
• explain the roles that bacteria play in every ecosystem	**1.2 Ecology and uses of bacteria** *(10 periods)* • Roles of bacteria in the	• Make sure that students understand the key concepts that: bacteria have critical roles in every ecosystem; many bacteria cause infectious diseases; pathogens produce disease through invasion and toxin production; infectious agents are transmitted to new hosts from

Competencies	*Contents*	*Suggested activities*
	ecosystem	reservoirs of infection; many bacteria are used in industrial processes; and that foreign genes can be cloned in bacterial plasmids for research and practical applications. • Students discuss the role of bacteria in the ecosystem by considering the Nitrogen and Sulphur cycles and appreciate what will happen in the absence of bacteria • Students identify that the different body parts of animals contain bacteria normally
• compare infectious disease with functional disease • state the germ theory • explain how bacteria produce disease • explain the role of reservoir hosts in disease transmission • list different reservoirs of infection	• Bacteria, disease and disease transmission	• Define the term "infectious diseases' and explain to students why they are different from functional diseases such as heart disease • Discuss the germ theory of disease and its importance in understanding and controlling diseases transmission • Elaborate by giving examples how some bacteria cause disease by invading and growing in host tissues and how others cause disease by producing toxins • Define what a reservoir of infection is and let students list the different reservoirs of infection • Students identify the various ways by which disease causing bacteria are transmitted to human beings
• give examples of industrial processes that use bacteria • indicate how bacteria are used in these industrial processes	• Bacteria in industrial processes	• Students write and present in class the different ways bacteria are used in industrial process - Food and beverage fermentations - Vinegar production - Production of antibiotics - Sewage treatment
• state the role of bacteria in recombinant DNA work	• Bacteria in recombinant DNA work	• Give a general description on how foreign genes are inserted in bacterial plasmids and how bacteria are used as vectors. Example: transgenic maize
• describe the structure of a virus • draw and label a bacteriophage	**1.3 Viruses** *(15 periods)* • Nature of viruses – Structure of viruses – Types of viruses	• Make sure that students understand the key concepts that: viruses are not organisms; virions have simple regular structures; viruses multiply in a common pattern; and that viruses have DNA or RNA genomes • Use picture of a virus (bacteriophage; HIV) and different other viruses with specific surface structures
• diagram the different forms of viruses • give examples of RNA and DNA viruses	– Virus multiplication – Modes of transmission of viruses	• Let students debate in groups why viruses may be or may not be considered as living • Students could prepare a chart showing a diagram of a virus and

Competencies	***Contents***	***Suggested activities***
• compare the reproductive cycle of lytic and lysogenic viruses • compare viruses with free living cells		a plant/animal cell to see how simple a viral structure is • Draw a diagram to show how a bacteriophage and an animal virus attach and enter a host cell
• draw and label the structure of HIV • explain the life cycle of HIV • explain how antiretroviral drugs inhibit enzymes of the life cycle of HIV • state the social and economic impacts of AIDS • express interest and desire for voluntary HIV testing • demonstrate life skills that lead to responsible sexual behaviour	• HIV & AIDS – Structure of HIV – Life cycle of HIV – Antiretroviral drugs – Impacts of AIDS – responsible sexual behaviour – life skills	• Draw a diagram to show gp120 of HIV, CD4 of human T-cell, and how viral multiplication in T-cell occurs • Use video films, publications like booklets and leaflets, and posters prepared on HIV and AIDS by various organizations (governmental or NGO) as supplementary materials and as teaching aids • 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 VCT centre or NGO which is working on AIDS. 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: describe the structure, show the shape of and classify bacteria and explain their role in every ecosystem; compare infectious disease with functional disease and state the germ theory; explain how bacteria produce diseases and the role of reservoir hosts in disease transmission; give examples of industrial processes that use bacteria and indicate how bacteria are used in these processes; define cloning and illustrate its processes; describe the structure of a virus, draw and label it, diagram its different forms, give examples of RNA and DNA viruses and compare viruses with free living cells; compare the lytic and lysogenic cycles of viral reproduction; draw and label the structure of HIV, explain its life cycle and state its social and economic impacts; explain how antiretroviral drugs inhibit enzymes of the life cycle of HIV; demonstrate life skills that lead to responsible sexual behaviour.

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 2: Ecology *(30 periods)*

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

- explain why recycling is important, describe and diagram the water, carbon, nitrogen, sulphur and phosphorus cycles
- define succession and describe, give examples, and compare primary and secondary successions
- define biome, state the major terrestrial and aquatic biomes with their characteristics and major fauna and flora
- express love and respect to fauna and flora and their biomes
- define biodiversity, explain its significance, status in Ethiopia, threats, and principles of conservation
- reflect a concern towards and appreciate the importance of biodiversity and the need for its conservation
- grow trees in a given area and express willingness to participate in tree growing activities in their locality
- compare Intra-specific and inter-specific competitions and exponential and arithmetic growth curves
- demonstrate the influence of natality and mortality on population size and interpret a population growth rate curve
- explain the impacts of rapid population growth on development and state the measures that should be taken to control it.

Competencies	***Contents***	***Suggested activities***
Students will be able to: • explain the need for recycling in nature • illustrate the nutrient cycle • describe the water, carbon, nitrogen phosphorus and sulphur cycles • diagram the water, carbon, nitrogen, sulphur and phosphorus cycles	***2. Ecology*** **2.1 The Cycling of matter through ecosystems** *(8 Periods)* • The need for recycling • Transfer of nutrients in the ecosystem • The hydrological cycle • The carbon cycle • The nitrogen cycle • The phosphorus cycle • The sulphur cycle	• Make sure that students understand the key concepts that: plants use only a small percentage of the available light energy for growth; higher trophic levels also have low conversion efficiencies; components of an ecosystem are always turning over; water continuously cycles through the biosphere; organisms create cycles of elements through the biosphere; the detritus food web is a major part of every ecosystem; a terrestrial ecosystem continuously loses nutrients to its surrounding; and that pollutants can accumulate in communities with potential disastrous results • Let the students prepare in groups charts showing the different cycles and present their charts in the class. Their presentations include the role of detrivores, decomposers, primary producers and consumers in these cycles. • Students make classroom presentation on what happens when the balance of these cycles is disturbed • Project: Importance of recycling of resources • Students provide exhibition in school, community centre or other suitable venue using posters, wall paper etc.

Competencies	***Contents***	***Suggested activities***
• define succession as establishment of plant communities in a habitat over a period of time • describe primary and secondary successions • give examples of primary and secondary successions • compare primary and secondary successions	**2.2 Ecological succession** *(3 periods)* • What is succession? • Primary succession • Secondary succession	• Make sure that students understand the key concepts that: communities tend to replace one another in successions; seral stages show definite trends in structure and productivity; communities tend to become more diverse in successions; more diverse communities appear to be more stable; and that primary and secondary successions begin from different conditions. • If possible, it is recommended that students watch video films that illustrate actual examples of succession and report what they learned from the show. • Let students present in groups what kind of animals follow when a new seral stage is established in primary succession and secondary succession • Students could debate the advantages and disadvantages of clearing forests to create new farmlands
• define biome as a climatically and geographically limited area of ecologically similar organisms • state the major terrestrial and aquatic biomes • indicate the characteristics of each biome • mention the fauna and flora of each biome • express love and respect to fauna and flora and their biomes	**2.3 Biomes** *(5 periods)* • Terrestrial biomes (tropical rain forest, savannah, desert, temperate grass land, temperate deciduous forest, taiga, tundra) • Aquatic biomes (Fresh water and ocean:- littoral zone, sub littoral zone, pelagic zone) - Phytoplanktons and zooplanktons	• Make sure that students understand the key concepts that: several major terrestrial biomes cover the earth; terrestrial ecosystems are determined by the relationship among climate, vegetation and soil; fresh water habitats are among the richest and most varied on earth; and that oceans support several kinds of communities. • Use diagrams or picture of different biomes/ ecosystems • Students develop a concept map of different biomes with their characteristics including fauna and flora. The concept map could be done on wallpaper and exhibited in the classroom/ biology room • Students develop a 'cause – effect' chart on "cutting the trees of Ethiopia" or a similar problem

Competencies	***Contents***	***Suggested activities***
• define biodiversity as the variability among living organisms within species, between species and of ecosystems • explain the threats to biodiversity • explain the significance of biodiversity • explain the status of biodiversity in Ethiopia • describe the principles of conservation • reflect a concern towards biodiversity and the need for its conservation • appreciate the importance of plant diversity for animal diversity and vice versa	**2.4 Biodiversity** *(7 periods)* • What is biological diversity? • The threats to biodiversity • The significance of biological diversity • Biodiversity in Ethiopia • The principles of conservation	• Students collect information material from relevant conservation and wildlife organisations and institute of biodiversity conservation and do research on the Internet if possible • Students develop on a wallpaper in groups a 'cause – effect' chart on "decreasing biodiversity in Ethiopia" • Students raise awareness on the problems caused by rubbish carelessly thrown away • Students start initiative to collect plastic bags, tins and other rubbish and clean their environment • Students discuss in groups the interdependence of animals and plants
• grow trees in a given area • express willingness to participate in tree growing activities in their locality	•Tree growing project	• Students plan a tree growing project including - informing the local newspaper, radio and other media about the project - raising awareness in their school - buying seedlings from a nursery or other source - getting informed on how trees have to be cared for to ensure that they don't die - getting the community involved
• compare Intra-specific and inter-specific competitions • compare exponential and arithmetic growth curves	**2.5 Population structure and dynamics** *(7 periods)* • Intra-specific and inter-specific competition	• Make sure that students understand the key concepts that: competition in communities occurs both within and between species; populations tend to grow exponentially; all populations are limited to a maximum size by various factors; and that the human population is growing far beyond its ecological limits.

Competencies	***Contents***	***Suggested activities***
• demonstrate the influence of natality and mortality on population size • define carrying capacity as the maximum population size a habitat can support • interpret a population growth rate curve • explain the impacts of rapid population growth on development • state the measures that should be taken to control rapid population growth	• Geographic range and habitat • Population size and density • Natality and mortality • Carrying capacity • Population explosion (trends, impacts and control measures)	• Students elaborate the fact that the driving force of competition is resource limitation • Define geographic range and habitat • Explain how exponential growth is different from arithmetic growth and let students give reasons why this exponential growth should be stabilized at one point • Let students present in class in groups: – When was population explosion seen in human history – What are the reasons of population explosion/ – What are the consequences? – What control measures do they recommend?

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: explain why recycling is important, describe and diagram the water, carbon, nitrogen, sulphur and phosphorus cycles; define succession and describe, give examples, and compare primary and secondary successions; define biome, state the major terrestrial and aquatic biomes with their characteristics and major fauna and flora; express love and respect to fauna and flora and their biomes; define biodiversity, explain its significance, status in Ethiopia, threats, and principles of conservation; reflect a concern towards and appreciate the importance of biodiversity and the need for its conservation; grow trees in a given area and express willingness to participate in tree growing activities in their locality; compare Intra-specific and inter-specific competitions and exponential and arithmetic growth curves; demonstrate the influence of natality and mortality on population size and interpret a population growth rate curve; explain the impacts of rapid population growth on development and state the measures that should be taken to control it.

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: Genetics *(26 periods)*

Unit Outcomes: Students will be able to:

- work out gamates for mono- and di-hybrid crosses, use Punnet square, determine genotypes and phenotypes and explain types of dominance
- describe the stages of meiosis and its significance in bringing variation
- explain why fruit flies are considered ideal for genetic experiments
- explain sex determination, sex linkage, sex limited and sex influenced traits
- describe the molecular structure of a chromosome, name the four nucleotides of DNA, construct a DNA model and explain DNA replication
- explain the processes and sites of transcription and translation
- define mutation and explain its causes, types and impacts.

Competencies	***Contents***	***Suggested activities***
Students will be able to: • work out different types of gametes for given monohybrid and dihybrid organisms • use the Punnet square to determine genetic crosses • determine genotypes and phenotypes formed in a genetic cross • explain the different types of dominance	***3. Genetics*** **3.1 Crossing principles** *(10 periods)* • Monohybrid cross • Dihybrid cross – using punnett square – gamates – genotype and phenotype • Types of dominance	• Make sure that students understand the key concepts that: not all genes exhibit dominance; two genes may be inherited quite independently of each other; genes are linked to one another; any gene can have more than two alleles; and that special chromosomes often determine an individual sex. • Students identify the various genetic characters on a head of maize, count seeds with one contrasting character and calculate the ratio. • Students count seeds with more than one contrasting characters and calculate the ratio. • Provide examples for dihybrid cross and show the genotypes and phenotypes formed using Punnett square.
• appreciate the significance of artificial crossbreeding and inbreeding to obtain required varieties • describe the different stages of meiotic division • describe the significance of meiosis in bringing	• Cross breeding and inbreeding • Meiosis and crossing over	• Field visit to an agricultural institution, university faculty etc. to find out about artificial crossbreeding to obtain required varieties • Use diagrams and photos (if possible) on stages on meiosis • Use diagrams with examples explaining crossing over

Competencies	*Contents*	*Suggested activities*
• variation through crossing over and independent assortment • explain why fruit flies are considered ideal for genetic experiments • explain sex determination, sex linkage, sex limited and sex influenced traits	• Sex determination • Sex linkage • Sex linked and sex influenced traits • Multiple alleles	
• describe the molecular structure of a chromosome • name the four nucleotides that build up the DNA molecule • construct a model of DNA showing the base pair between complementary nucleotides • explain DNA replication • appreciate the way molecular biology is applied in forensic medicine	**3.2 Molecular genetics** *(6 periods)* • Structure of chromosome • Structure of DNA • DNA replication	• Make sure that students understand the key concepts that: genes are located on chromosomes; chromosomes are DNA-protein complexes; DNA replicates semi-conservatively; two strands of DNA typically make a double helix; and that DNA can replicate through specific base pairing. • Let the students produce a model of DNA molecule from locally available low cost materials. They can also prepare in groups a chart showing a DNA strand forming a chromosome. • Use a chart on DNA replication mechanism • Present the use of on genetic fingerprinting in forensic medicine using diagrams and actual photographs. - A simple case of a crime with different suspects could be used to illustrate the DNA patterns; students will have to match the pattern of the suspects with that of the criminal. - Another case in which genetic fingerprinting is used to confirm maternity or paternity could also be used. • Explain simple principle of separation of proteins and DNA by electrophoresis
• define cloning • illustrate the process of	• Recombinant DNA (cloning)	• Discuss genetic engineering and its advantages. Discuss also the ethical issues that should be considered in this area of biology. Use recent articles from journals and/or internet sources on this issue. Case studies such as "Dolly the sheep" could be presented to illustrate

<table>
<tr><th>Competencies</th><th>Contents</th><th>Suggested activities</th></tr>
<tr><td>cloning with example
• explain the advantages of genetic engineering</td><td></td><td>cloning. If available, a film show is also recommended.</td></tr>
<tr><td>• explain the process and site of transcription
• explain the process and site of translation
• appreciate that the proteins synthesized in our body requires a continuous supply of amino acids from food
• appreciate that proteins determine the variation of traits</td><td>3.3 Protein synthesis
(5 periods)
• Transcription
• Translation
• Gene expression</td><td>• Make sure that students understand the key concepts that: DNA specifies RNA, and RNA specifies protein; unstable messenger RNA carries genetic information; transfer RNA adaptors carry amino acids to the m-RNA templates; the genetic code is systematic and redundant; and that transcription and translation are coupled in prokaryotes and separated in eukaryotes
• Use diagrams to show processes and sites of transcription and translation
• Students, in groups, draw charts showing:
- m-RNA segment carrying codons and attached to a ribosome
- t-RNA with anti-codon and accompanying amino acid
- arrangements of amino acids according to information on m-RNA
• Students develop table, as follows, on proteins and give examples
<table><tr><td rowspan="2">Structural proteins</td><td colspan="3">Functional proteins</td></tr><tr><td>Enzymes</td><td>Transport</td><td>Peptide hormones</td></tr><tr><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>• define mutation as a sudden hereditary change in the genotype of an organism
• describe the different types of mutations
• explain the causes of induced mutations
• state the spontaneity of a mutation
• explain the impact of mutations
• give examples of inheritable mutations</td><td>3.4 Mutations (5 periods)
• Causes of mutation
• Gene and chromosomal mutation
• Impacts of mutations
• Inheritable mutations</td><td>• Make sure that students understand the key concepts that mutations are changes in nucleic acid sequences
• Given a sequence of nucleotides on DNA, students trace what the sequence of amino acids would be if nucleotides at three different locations are replaced by other nucleotides
• Let students discuss causes of mutations
• Case study: Resistance to penicillin; importance to take the whole course</td></tr>
</table>

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: work out gamates for mono- and di-hybrid crosses, use Punnet square, determine genotypes and phenotypes and explain types of dominance; describe the stages of meiosis and its significance in bringing variation; explain why fruit flies are considered ideal for genetic experiments; explain sex determination, sex linkage, sex limited and sex influenced traits; describe the molecular structure of a chromosome, name the four nucleotides of DNA, construct a DNA model and explain DNA replication; explain the processes and sites of transcription and translation; define mutation and explain its causes, types and impacts.

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: Evolution *(25 periods)*

Unit Outcomes: Students will be able to:

- define evolution, describe and compare the theories of origin of life, and explain the experiments of Oparin and Stanley Miller
- explain and compare the theories of evolution of Lamarck and Darwin and state the neo-Darwinian ideas of evolution
- describe and give examples of the evidences of evolution
- define and explain the mechanisms of speciation and compare adaptive radiation with convergent evolution
- define natural selection, list, describe and give examples of types of natural selection
- explain the biological evolution of humans, construct an evolutionary tree, explain the importance of Lucy *(A. afarensis)* in this regard, and discuss the controversies regarding human races.

Competencies	***Contents***	***Suggested activities***
Students will be able to: • define evolution as a process of gradual changes over a long period of geological time • describe the different theories of the origin of life • compare the different theories of the origin of life	***4. Evolution*** **4.1 The origin of life** *(5 periods)* • Theories on the origin of life – Special creation – Spontaneous generation – Eternity of life – Cosmozoan theory – Biochemical theory	• Make sure that students understand the key concepts that: organic molecules form in the reducing atmosphere of primitive planets; the earliest organisms must have been heterotrophs that fed on preformed compound; photosynthesis evolved with the ability to make chlorophyll; and that the production of oxygen opened the door to aerobic respiration. • Provide historic sources that show how modern theories have evolved. If possible students could do Internet research on well defined questions and tasks on the origin of life. Also other sources can be used for this research. Then students prepare and summarise in groups the outcomes of the research and display them on wallpaper
• explain the experiments of Oparin and Stanley Miller • appreciate the quest by humans for knowledge of their origins	• Oparin's theory of biochemical evolution (heterotrophic hypothesis) • Origin of autotrophs	• Use charts on the experiment of Stanley Miller. Let students discuss the value of this experiment based on Oparin's hypothesis. • Let students discuss in group why spontaneous generation is impossible today. • If possible use video materials to demonstrate the evolution of heterotrophic and autotrophic organisms, including information of anaerobic organisms and those that do chemosynthesis that still live today
• explain the theories of evolution of Lamarck and Darwin	**4.2 Theories of evolution** *(5 periods)* • Pre-Darwinian (Lamarck and acquired	• Make sure that students understand the key concepts that: evolution fundamentally depends on selection; speciation and extinction are major features of evolution; and that different organisms may evolve in quite different pattern.

Competencies	***Contents***	***Suggested activities***
• compare the theories of evolution of Lamarck and Darwin • state the neo-Darwinian ideas of evolution	characteristics) • Charles Darwin and natural selection • Comparing Darwin and Lamarck • Neo-Darwinism (Mendelian genetics, molecular biology and ethology)	• Let the students discuss the theories of Lamarck and Darwin in small groups and prepare charts on the main points of Darwin's theory, and let them elaborate the differences and similarities in the explanations of Lamarck and Darwin. • Use charts on different behavioural patterns of Darwin's finches. Let students discuss on the variations (e.g., beak shape) of these finches
• describe the evidences of evolution • give examples for each of the evidences of evolution	**4.3 Evidences of evolution** *(5 periods)* • Palaeontology (fossil record) • Comparative anatomy • Embryology • Biochemistry • Plant and animal breeding	• Use charts that show examples of fossils; the bone anatomy of different mammals; different stages of embryos of mammals, birds, reptiles, and fish; and vestigial/rudimentary structures. • Let students compare different species (bones, proteins, embryonic stages) and see the basic relationships and phylogenetic trees • Discuss the difference between natural selection and breeding
• define natural selection as a process in which individuals with a particular heritable trait survive than others • list the types of natural selection • describe the types of natural selection • give examples for each type of natural selection	**4.4 The process of evolution** *(5 periods)* • Speciation (isolating mechanisms) • Adaptive radiation (divergent evolution) • Convergent evolution • Types of natural selection	• Make sure that students understand the key concepts that: speciation occurs primarily through geographic isolation; species diverge by taking advantage of new opportunities; bnoth gene flow and selection influence speciation; and that plant evolution frequently involves hybridization and polyploidy. • Use charts with pictures that illustrate speciation, adaptive radiation, convergent evolution and types of natural selection • If possible, field visits to relevant museums are recommended • Students gather information about Darwin's finches in the Galapagos islands and present in class the effects of geographical isolation and adaptation in forming new species

Competencies	*Contents*	*Suggested activities*
• explain the biological evolution of humans • construct an evolutionary tree of human evolution • explain the importance of Lucy *(A. afarensis)* in the study of human evolution • discuss the controversies regarding human races	**4.5 The evolution of humans** *(5 periods)* • Biological evolution of humans – Hominid evolution – Races of humans – Problems and controversies regarding human races	• Use pictures, diagrams and video material on human evolution • Field visit (if possible) to the national museum to get information on *A. afarensis* (Lucy). Let students prepare beforehand a list of queries for experts at the museum. Let them take notes on the answers for these questions during the visit. • Let students cinduct further research on the Internet if possible • Students discuss the causes of differences between human races

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 evolution, describe and compare the theories of origin of life, and explain the experiments of Oparin and Stanley Miller; explain and compare the theories of evolution of Lamarck and Darwin and state the neo-Darwinian ideas of evolution; describe and give examples of the evidences of evolution; define and explain the mechanisms of speciation and compare adaptive radiation with convergent evolution; define natural selection, list, describe and give examples of types of natural selection; explain the biological evolution of humans, construct an evolutionary tree, explain the importance of Lucy *(A. afarensis)* in this regard, and discuss the controversies on human races.

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: Behaviour *(25 periods)*

Unit Outcomes: Students will be able to:

- define and explain the importance of studying behaviour
- explain the characteristics, list the types and give examples of innate behaviour
- list types of learned behaviour, explain how animals learn and give examples of each type of learned behaviour
- compare innate behaviour with learned behaviour
- describe and give examples of courtship, territorial, and social patterns of behaviours in animals.

Competencies	***Contents***	***Suggested activities***
Students will be able to: • define behaviour as a coordinated response to changes in external and internal conditions • explain the importance of studying behaviour `	***5. Behaviour*** **5.1 Introduction** *(3 periods)* • What is behaviour • Why study behaviour	• Introduce learners to the discipline of behaviour giving an overview on basic techniques and areas of interest
• explain the characteristics of innate behaviour • list types of innate behaviour • give examples of innate behaviour • describe reflexes in humans and instincts and biological clocks in animals	**5.2 Innate behaviour** *(5 periods)* • Reflexes • Instinct behaviour	• Use pictures and video material on reflexes and instinctive behaviour. Let students read watch video material and write reports on their observations
• list types of learned behaviour • explain how animals learn through each type of learned behaviour	**5.3 Learned behaviour** *(10 periods)*	• Use pictures, diagrams, video material on various learning types • Use pictures and video material to illustrate experiments

Competencies	***Contents***	***Suggested activities***
• give examples of each type of learned behaviour • compare innate behaviour with learned behaviour	• Types of learning (habituation, sensitization, associative learning, latent learning, insight learning, imprinting)	• Skinner box • Pavlov experiments • Students perform simple experiment on habituation and write report on it
• describe courtship, territorial, and social patterns of behaviours in animals • give examples of each of the three patterns of behaviours in animals	**5.4 Patterns of behaviour** *(7 periods)* • Courtship behaviour • Territorial behaviour • Social behaviour	• Use pictures, diagrams and video material that illustrate behaviour patterns and let students write reports on different behaviour patterns observed. • Project: Develop an exhibition on social insects and let students discuss what humans can learn from social insects

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 and explain the importance of studying behaviour; explain the characteristics, list the types and give examples of innate behaviour; list types of learned behaviour, explain how animals learn and give examples of each type of learned behaviour; compare innate behaviour with learned behaviour; describe and give examples of courtship, territorial, and social patterns of behaviours in animals.

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.