STANDARDS FOR Secondary Education

BIOLOGY

Quality Assurance and Development Services Ministry of Education, Youth and Sports 2004



BIOLOGY

Content Standard No. 1 Discuss the science 'biology'.

Learning Outcomes

Third Form

- 1.1 Identify the branches of biology and their application to the real world, as in health, agricultural industries and environmental conservation.
- 1.2 Explain the scientific method and its relevance to Biology.
- 1.3 Identify and apply the use of instruments and/or apparatus and skills (drawing, manipulation, measurement, observation, recording, reporting, analysis, interpretation, planning, designing) that are needed in the study of Biology.
- 1.4 Recognize the scope and the implications of biotechnology.

Content Standard No. 2

Analyze cells and investigate the relationship between the functions of the main cell structures with cell specialization, and the processes of transporting substances in and out of cells.

Learning Outcomes

Third Form

- 2.1 Show the structure of unspecialized plant and animal cells (e.g. onion skin cell and cheek/blood cells).
- 2.2 State the functions and explain the importance of different cell structures: cell wall, cell membrane, nucleus, chromosomes, cytoplasm, mitochondria, vacuoles, and chloroplast.
- 2.3 Differentiate between plant and animal cells.
- 2.4 Explain the importance of cell specialization in multicellular organisms.
- 2.5 Illustrate the movement of particles (diffusion, osmosis and active transport) in living organisms.

Content Standard No. 3

Explain that nutrition occurs in different ways and is the means by which living organisms obtain their energy and material requirements and recognize the necessity for storage in living organisms.

Learning Outcomes

Third Form

- 3.1 Distinguish between different types of nutrition: autotrophic, heterotrophic, saprotrophic, chemotrophic.
- 3.2 Describe photosynthesis as the process by which green plants make organic substances from inorganic substances i.e. carbon dioxide + water + (light + chlorophyll) \rightarrow oxygen + carbohydrate (glucose/starch).
- 3.3 Relate the external and internal structure of a leaf to its function in photosynthesis.
- 3.4 Demonstrate that light and chlorophyll are necessary conditions for photosynthesis.
- 3.5 Describe the role of minerals in the metabolism and development of plants.
- 3.6 Discuss the role of food storage in living organisms
- 3.7 Identify the sites of food storage through labeled diagrams of storage organs (e.g. stem tuber, root tuber, rhizomes, onion bulbs) and list the products stored in each.
- 3.8 Identify the six food groups and examples of foods that belong to each group: breads/cereals, meats, milk products, fruits/vegetables, fats/oils, legumes/nuts.
- 3.9 Identify the classes of food substances: carbohydrates, fats/oils, proteins, minerals, and vitamins.
- 3.10 Distinguish among food substances by performing food tests.
- 3.11 Describe specific regions of the human alimentary canal in relation to the intake of food, its breakdown into small molecules, its absorption and egestion.
- 3.12 Explain the role and importance of enzymes in digestion and explain what happens to the products of digestion after their absorption.
- 3.13 Demonstrate the action of enzymes and the effects of temperature and pH on enzyme activity through investigations and making deductions from tables and graphs.
- 3.14 Discuss the importance of a balanced diet in humans.

Explain that respiration is the means by which energy is made available for carrying out life processes and demonstrate knowledge of the products of respiration and diseases that may affect respiratory systems.

Learning Outcomes

- Third Form
 - 4.1 State that respiration takes place at the level of the cell and state the function of ATP (adenosine triphosphate) in energy transfer.
 - 4.2 Distinguish between the processes of aerobic and anaerobic respiration.
 - 4.3 Demonstrate the products of respiration through carrying out and interpreting results from simple controlled investigations.
 - 4.4 Describe and explain the importance of breathing in humans and gaseous exchange in other living organisms (e.g. plants, invertebrates).
 - 4.5 Identify characteristics common to and compare gaseous exchange surfaces e.g. lungs, fish gills, frog skin, leaf surface, unicellular organisms.
 - 4.6 Discuss the effects of cigarette smoking and other disease causing factors on the respiratory system.

Content Standard No. 5

Recognize the necessity for and explain the structure and function of transport mechanisms and the types of materials transported in living organisms.

Learning Outcomes

Third Form

- 5.1 Explain the need for transport systems in multicellular organisms.
- 5.2 Identify the types of materials that need to be transported in living organisms.
- 5.3 Describe the structure and function of the circulatory system in living organisms, especially humans.
- 5.4 Describe the composition and functions of blood in transport.
- 5.5 Explain the different blood types (A, B, O, AB), which are donors and recipients and explain the Rhesus factor.
- 5.6 Describe the structure of xylem vessels and explain how their structures are suited to their function.
- 5.7 Describe the processes (e.g. capillarity, cohesion, adhesion) involved in transpiration.
- 5.8 Describe the effect of external factors on transpiration.
- 5.9 Describe the structure and state the function of phloem in the transport system of plants.

Content Standard No. 6

Describe the structures involved and the processes by which living organisms get rid of metabolic waste and regulate body fluid concentration.

Learning Outcomes

Third Form

- 6.1 Discuss the importance of excretion in living organisms and differentiate between excretion and egestion.
- 6.2 Give examples of substances excreted by living organisms.
- 6.3 State the means by which excretory products are eliminated from living organisms.
- 6.4 Relate the structure of a kidney to its osmoregulatory and excretory functions.
- 6.5 Explain the role of the hormone ADH (anti-diuretic hormone) in osmoregulation and the importance of homeostasis in maintaining a balanced internal environment of an organism.
- 6.6 Recognize the importance of minor excretory organs such as the skin and lungs.
- 6.7 Discuss adaptations in plants to conserve water.

Describe the mechanisms and the role of movement in living organisms.

Learning Outcomes

Fourth Form

- 7.1 Distinguish between different types of movement in living organisms e.g. phototropism, geotropism, nastics, turgor in plants, and whole movement (locomotion) in animals, and give examples to demonstrate this.
- 7.2 Show how external factors such as light and gravity affect plant movement.
- 7.3 Relate the structure of the skeleton to its functions in living organisms.
- 7.4 Describe the mechanism of movement in the limb of a living organism e.g. how muscles, joints and bones work together to move a human limb.
- 7.5 Identify the long bones of a fore or hind limb.
- 7.6 Distinguish between cervical, thoracic and lumbar vertebrae.
- 7.7 Discuss the importance of locomotion in animals.

Content Standard No. 8

Explain that organisms detect and respond to changes (stimuli) in their external and internal environment, the structures and processes involved in response and its importance for the survival of a living organism

Learning Outcomes

Fourth Form

- 8.1 Define the terms 'stimulus' and 'response'.
- 8.2 Describe the response of stems and roots of seedlings of green plants to unilateral stimuli of light and gravity.
- 8.3 Describe the response of invertebrates to variations in light intensities, temperature and moisture.
- 8.4 Exlain the importance and the relationship between the central, peripheral and autonomic nervous systems.
- 8.5 Explain why the response to stimuli is important for the survival of organisms.
- 8.6 Distinguish between a cranial and a spinal reflex, for e.g. the pupil and knee-jerk reflex.
- 8.7 Describe the structure and functions of the main regions of the brain: cerebrum, cerebellum, medulla.
- 8.8 Identify the main sense organs and the stimuli to which they respond.
- 8.9 Relate the structure of a mammalian eye to its functions as a sense organ.
- 8.10 Explain sight defects such as long and near sightedness and their corrections using special lenses.
- 8.11 Relate the structure of the ear in living organisms, to its function as a main sense organ.
- 8.12 Relate the structure of the nose and tongue to their functions as sense organs.
- 8.13 Describe the function of the skin, especially in humans as a sense organ and in temperature regulation and explain temperature control as an example of homeostasis.
- 8.14 Identify the location of endocrine glands such as the thyroid, pancreas, adrenals, gonads and pituitary in humans.
- 8.15 Describe the role of the hormones of selected endocrine glands.

Content Standard No. 9

Describe the importance of the structures involved and the processes by which life is perpetuated and that organisms increase in mass, size and complexity during their lives.

Learning Outcomes Third Form

- 9.1 Compare sexual and asexual reproduction in living organisms.
- 9.2 Describe the structure and function of the reproductive systems in living organisms, especially humans.
- 9.3 Compare the structure of an animal (insect, bats) pollinated and a wind pollinated flower and relate these to their functions in pollination.

- 9.4 Compare the structure of a monocot and dicot seed and relate the structure of the fruit and seed to the structure of a dicot flower.
- 9.5 Describe fruit and seed structures and the adaptations and importance for dispersal.

Fourth Form

- 9.6 Describe different types of asexual reproduction and explain that it is conservative (gives rise to genetically identical offspring).
- 9.7 Compare sexual reproduction in different organisms and explain that it leads to variation in the offspring.
- 9.8 Describe and state the roles of hormones and the effect of pregnancy on the oestrus cycle of living organisms particularly humans.
- 9.9 Describe the mechanism for bringing gametes together, their fusion and the development of the embryo in animals particularly in humans.
- 9.10 Discuss the advantages and disadvantages of various methods of birth control.
- 9.11 Explain the importance of maternity and paternity.
- 9.12 Describe the means by which gametes are brought together and their fusion to form the zygote and the development of the embryo in a flowering plant.
- 9.13 Describe the processes taking place within a seed during germination.
- 9.14 Demonstrate growth and state the functions of hormones in controlling growth and development in living organisms.

Content Standard No. 10

Analyze the concepts, principal processes and basic terminology of genetics and heredity.

Learning Outcomes Fourth Form

- 10.1 Describe the differences between plant and animal cells and the function cell structures such as nucleus, chromosomes, centrioles, centromeres.
- 10.2 Describe a chromosome as a length of DNA, sections of which are genes.
- 10.3 Describe the process of mitosis and explain its importance for maintaining species chromosome number.
- 10.4 Describe the role of mitosis in growth.
- 10.5 Explain the role of mitosis in asexual reproduction.
- 10.6 Describe the process of meiosis.
- 10.7 State the importance of halving of chromosome number in the formation of gametes and explain that production of gametes in meiosis leads to variation.

Content Standard No. 11

Explain the concepts and importance of genetic variation in species, the process of evolution and discuss the implications of genetic engineering.

Learning Outcomes Fourth Form

- 11.1 Explain the role of gametes in the transmission of inheritable genetic characteristics.
- 11.2 Distinguish between continuous and discontinuous variation.
- 11.3 Explain the meaning of terms gene, allele, dominant, recessive, incomplete dominance, genotype, phenotype, DNA, RNA, replication, cloning.
- 11.4 Explain the inheritance of a single pair of characteristics such as blood groups.
- 11.5 Predict the results of crosses involving one pair of alleles and including pedigree charts dominant, recessive and co-dominant.
- 11.6 Describe the mechanism of sex determinations in humans.
- 11.7 Explain the impact of environmental factors on genetically identical organisms.
- 11.8 Explain why genetic variation is important and that it is inheritable unlike environmental variation.

- 11.9 Define natural selection as a process by which a population remains well adapted to its habitat.
- 11.10 Distinguish between natural and artificial selection and state that humans select traits to suit their needs.
- 11.11 Define and explain the theory of evolution.
- 11.12 Explain that genetic engineering can be used to change the traits of an organism and discuss the advantages and disadvantages of this.

Explain that there is diversity and similarity of form in living organisms and interdependence between them and their environment, and that there is a flow of energy through living organisms within an ecosystem.

Learning Outcomes

Third Form

- 12.1 Group living organisms according to visible characteristics (similarities and differences) and record observations in tables.
- 12.2 Identify the relative positions of producers and consumers in a food chain and relate the positions to their modes of feeding.
- 12.3 Identify, from selected habitats, a food chain containing at least four organisms and construct single pyramids or food chains.
- 12.4 Identify, from selected habitats, a herbivore, carnivore, omnivore and predator-prey relationships.
- 12.5 Describe different trophic levels by constructing food webs.
- 12.6 Explain the role of decomposers (fungi and bacteria) in converting complex compounds to simple substances.
- 12.7 Discuss the advantages and disadvantages of feeding and other special relationships (symbiosis: parasitism, mutualism, commensalism) to the organisms involved.
- 12.8 Discuss the interdependence of organisms within a food web.
- 12.9 Recognize and explain energy flow within a food chain or web.
- 12.10 Explain, with examples, the continual re-use of materials in nature.
- 12.11 Explain the principles and concepts involved in interrelationships between organisms through illustrations of the water, carbon and nitrogen cycles.

Content Standard No. 13

Explain the importance of the physical environment and the soil to living organisms, describe the factors that affect the growth of populations, the importance of managing the world's resources and describe the effects of human activities on the environment.

Learning Outcomes Fourth Form

- 13.1 Distinguish between and use in the correct context the following terms: (i) physical and biotic factors (ii) environment, niche and habitat (iii) population and community.
- 13.2 List the components of soil and demonstrate soil characteristics by carrying out simple experiments.
- 13.3 Discuss the importance of different types of soil in providing water, mineral nutrients and oxygen to plants, animals and microorganisms.
- 13.4 Discuss the advantages and disadvantages of the use of natural and chemical fertilizers in the soil.
- 13.5 Discuss the importance of air in providing raw materials such as oxygen, carbon dioxide and nitrogen to living organisms.
- 13.6 Discuss the role of microorganisms to living organisms.
- 13.7 Describe the relationship between living organisms and their environment by conducting simple ecological studies in a local ecosystem.

- 13.8 Describe the most appropriate sampling methods (quadrats, transects, bottles, jars, nets) to be used when conducting ecological studies.
- 13.9 Estimate the population density of species using quadrats.
- 13.10 Relate the distribution of species to physical factors such as light, water, and temperature.
- 13.11 Discuss the factors such as competition for food and space on the survival and growth of a natural population.
- 13.12 Discuss the effects of disease pests and natural disasters on the growth of a natural population.
- 13.13 Describe various energy and mineral resources and their limits.
- 13.14 Discuss the importance of and difficulties encountered in Solid Waste Management (recycling, collecting, transporting and storing biodegradable and non-biodegradable materials).
- 13.15 Discuss the negative and positive impacts of human activity on the environment e.g. agricultural (chemical fertilizers), industrial and improper garbage disposal, deforestation and reforestation.
- 13.16 Discuss the implications of pollution of aquatic and terrestrial environments.
- 13.17 Discuss means by which natural habitats could be conserved and restored in sustainable ways.

Describe the major groups of diseases that occur in living organisms and explain the principles and importance of disease control.

Learning Outcomes Fourth Form

- 14.1 Distinguish among and give examples of diseases that affect living organisms e.g. pathogenic, deficiency, hereditary and physiological.
- 14.2 Discuss the treatment and control to the differences among the major groups of diseases.
- 14.3 Discuss the role of diet and exercise in controlling diseases such as hypertension and diabetes.
- 14.4 Explain the role of vectors in the transmission of diseases and identify the stages in the life history of a vector such as a mosquito or housefly.
- 14.5 State appropriate methods of control of each stage of the life history of a named vector/pest.
- 14.6 Identify the advantages and disadvantages of biological control.
- 14.7 Discuss the causative agents, transmission, implications and control of AIDS and other sexually transmitted diseases.
- 14.8 Describe the role of blood, clotting and the role of phagocytes and natural immunity in defending the body against disease.
- 14.9 Explain how the principles of immunization, that is artificial immunity by vaccines, are used in the control of communicable diseases.
- 14.10 Identify different types of drugs (alcohol, illegal, prescription, caffeine, tranquilizers, steroids etc) and discuss the physiological, social and economic effects of their abuse.
- 14.11 Discuss the social and economic implications of disease in plants and animals placing emphasis on the loss of productivity, loss of human life, livestock and agricultural crops.