

**G.C.E. (Advanced Level)**

# **Biology**

**Grade 13**

**Teachers' Guide**

**(Implemented from 2018)**

**Department of Science  
Faculty of Science and Technology  
National Institute of Education  
[www.nie.lk](http://www.nie.lk)**

**G.C.E. (A.L.)**  
**Biology**  
**Teachers' Guide**  
**Grade 13**

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Department of Science  
Faculty of Science and Technology  
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### ***Message from the Director General...***

With the primary objective of realizing the National Educational Goals recommended by the National Education Commission, the then prevalent content based curriculum was modernized, and the first phase of the new competency based curriculum was introduced to the eight year curriculum of the primary and secondary education in Sri Lanka in the year 2007.

The second phase of the curriculum cycle thus initiated was introduced to the education system in the year 2015 as a result of a curriculum rationalization process based on research findings and various proposals made by stakeholders.

Within this rationalization process, the concepts of vertical and horizontal integration have been employed in order to build up competencies of students, from foundation level to higher levels, and to avoid repetition of subject content in various subjects respectively and furthermore, to develop a curriculum that is implementable and student friendly.

The new Teacher's Guides have been introduced with the aim of providing the teachers with necessary guidance for planning lessons, engaging students effectively in the learning teaching process, and to make Teachers' Guides help teachers to be more effective within the classroom. Further, the present Teachers' Guides have given the necessary freedom for the teachers to select quality inputs and activities in order to improve student competencies. Since the Teachers' Guides do not place greater emphasis on the subject content prescribed for the relevant grades, it is very much necessary to use these guides along with the textbooks compiled by the Educational Publications Department if, Guides are to be made more effective.

The primary objective of this rationalized new curriculum, the new Teachers' Guides, and the new prescribed texts is to transform the student population into a human resource replete with the skills and competencies required for the world of work, through embarking upon a pattern of education which is more student centered and activity based.

I wish to make use of this opportunity to thank and express my appreciation to the members of the Council and the Academic Affairs Board of the NIE and the resource persons who contributed to compile of these Teachers' Guides and other parties for their dedication in this matter.

**Dr.(Mrs.) T.A.R.J. Gunasekara**  
Director General  
National Institute of Education  
Maharagama.

**Guidance** - Dr. (Mrs.) T.A.R.J. Gunasekara- Director General, National Institute of Education

**Supervision** - Mr. A.D.A. De Silva  
Director, Department of Science  
National Institute of Education

**Subject Leadership** - Miss: P.T.M.K.C. Tennakoon  
Asst. Lecturer – Dept. of Science  
National Institute of Education

**Internal Resource Contribution** –Mrs. H.M. Mapagunaratne, Senior Lecturer,  
National Institute of Education  
Miss. P.T.M.K.C.Tennakoon- Assistant lecturer  
National Institute of Education  
P.Atchuthan - Assistant Lecturer  
National Institute of Education  
Mrs. D.A.H.U.Sumanasekara- Assistant Lecturer  
National Institute of Education

**Curriculum Committee Members**

- Mr. A. D. A. De Silva - Director, Department of Science – NIE
- Mrs. H. M. Mapagunaratne- Senior Lecturer ,Dept. of Science- NIE
- Prof. M.J.S. Wijeratne - Senior Professor of Zoology and Environment Management,  
University of Kelaniya
- Dr. S.M.W. Ranwala - Senior Lecturer, Department of Plant Science  
University of Colombo
- Prof. D.S.A. Wijesundara - Research Professor, Institute of Fundamental Studies
- Prof. B.G.D.N.K. De Silva - Senior Professor, Department of Zoology,  
University of Sri Jayawardanepura
- Prof. S. Abeysinghe - Head of the Department,  
Department of Botany  
University of Ruhuna
- Mrs.M.N.F. Nasriya - Assistant Director, Science Branch,  
Ministry of Education
- Mrs. P.H.N. Kulathilake - Devi Balika Vidyalaya, Col-08
- Ms. Y.M.P.K. Yapa - Assistant Commissioner,  
Education Publications Department

**External Resource Contribution**

- Mrs. B. Ganeshadas - SLTS-I, D.S.SenanayakeCollege, Colombo 08
- Mrs. P.A.K.Perera - SLTS- (Rtd)
- Mrs. M.R.P.R.Basnayake - SLTS-I (Rtd)
- Mr. A. Illaperuma - SLTS-I(Rtd)
- Mrs. H.A.S. G. Perera - SLTS-II-I ,Sirimavo Bandaranaike College, Colombo -07
- Mrs. S.D.P.Bandara - SLTS-I-(Rtd)
- Mrs. C.V.S.Devotta - SLTS-I,Dammissara College, Natthandiya

**Cover and Typesetting** - Mrs. R. R. K. Pathirana - Technical Assistant- NIE

**Supporting Staff**

- Mrs.PadmaWeerawardana -N.I.E
- Mr.MangalaWelipitiya - N.I.E
- Mr.RanjithDayawansa - N.I.E

## **Guidelines to use the Teachers' Guide**

In the G.C.E (A/L) classes new education reforms were introduced from the year 2017 in accordance with the new education reforms implemented in the interim classes in the year 2015. According to the reforms, Teachers' Guide for Biology for grade 13 has been prepared.

The grade 13 Teacher's Guide has been organized under the titles competencies and competency levels, content, learning outcomes and number of periods. The proposed lesson sequence is given for the leaning teaching process. Further it is expected that this teachers' Guide will help to the teachers to prepare their lessons and lessons plans for the purpose of class room learning teaching process. Also it is expected that this Guide will help the teachers to take the responsibility to explain the subject matters more confidently.

Total number of periods to teach this Biology syllabus is 600. Teachers can be flexible to change the number of periods according to their necessity. Teachers can use school based assessment to assess the students.

## **Content**

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**Competency 5.6.0 : Investigates the structures and functions involved in nervous coordination**

**Competency Level 5.6.1 : Inquires into the processes and systems involved in coordination**

**Number of Periods : 03**

**Learning Outcomes:**

- describes the need for coordination
- names the systems contributing to coordination
- compares nervous system with the endocrine system in relation to coordination
- briefly describes different types of nervous organizations among animal phyla (Cnidaria, Platyhelminthes, Annelida, Arthropoda, Echinodermata, Chordata)

**Suggested Teaching- Learning Process**

- Conduct a brainstorming session on the coordination in animals.
- Guide students to explore and list down the reasons for the need of coordination systems.
- Introduce nervous system and endocrine system as systems contributing to coordination.
- Guide students to compare the nervous system and endocrine system in relation to coordination.
- Ask students to tabulate the organization of nervous systems in Cnidaria, Platyhelminthes, Annelida, Arthropoda, Echinodermata and Chordata.
- Assist students to identify the diagrams/ pictures/ photos of different organizations of nervous systems found in Cnidaria, Platyhelminthes, Annelida, Arthropoda, Echinodermata and Chordata.

**Assessment and Evaluation**

- Conduct a written test on the organization of nervous systems in Cnidaria, Platyhelminthes, Annelida, Arthropoda, Echinodermata and Chordata.



**Competency 5.6.0 : Investigates the structures and functions involved in coordination**

**Competency Level 5.6.2 : Investigates the gross structure and functions of the human nervous system**

**Number of Periods : 11**

**Learning Outcomes:**

- outlines the organization of the human nervous system
- describes the gross structure of the human brain giving specific reference to its embryonic origin, meninges, and cerebral ventricles
- states what the cerebrospinal fluid in central nervous system is
- names the main parts of the human brain and labels them on a diagram
- states the four lobes of the cerebral hemisphere
- names the three major functional areas of the cerebrum and briefly describes their importance
- states the location and function of hypothalamus and thalamus
- names the three parts of the brain stem
- states main functions of the brain stem
- states the location and function of the cerebellum
- briefly describes structure, location and function of the spinal cord
- briefly describe the peripheral nervous system
- states the basic organization pattern of autonomic nervous system
- states the differences between sympathetic and parasympathetic nervous systems according to the organizational pattern, antagonistic effects and neurotransmitter substances
- appreciates the contribution of major parts of the brain for smooth functioning of human body and maintaining a healthy life

**Suggested Teaching- Learning Process**

- Introduce the main parts of the human nervous system (cerebrum, lobes of the cerebral hemisphere, functional areas of cerebral cortex, brain stem, medulla oblongata, pons varoli, midbrain, cerebellum, thalamus, hypothalamus, spinal cord) to students and assist them to locate those parts in the given unlabelled diagram/ picture.
- Describe the gross structure of the human brain by giving specific reference to its embryonic origin, meninges and cerebro ventricles.
- Introduce cerebrospinal fluid and describe its role.
- Assist students to identify and locate the three major functional areas of the cerebrum.
- Briefly describe the functions of the above mentioned functional areas of the cerebrum.

- Introduce students, that the medulla oblongata, pons varoli and midbrain are the three major parts of the brain stem.
- Assist them to list down the major functions of the brain stem and the cerebellum.
- Briefly describe the structure and function of the spinal cord.
- Introduce cranial nerves and spinal nerves as the two major types of peripheral nervous system.
- Briefly describe the organizational pattern of autonomic nervous system and introduce sympathetic and parasympathetic nervous systems as the major two types of the autonomous nervous system.
- Guide students to tabulate the differences between sympathetic and parasympathetic nervous systems based on their organizational pattern, antagonistic effects and neurotransmitter substances.

#### **Assessment and Evaluation**

- Assess students on the labeling of the main parts of the human brain.
- Conduct an oral quiz on the peripheral and autonomous nervous systems.

**Competency 5.6.0 : Investigates the structures and functions involved in coordination**

**Competency Level 5.6.3 : Explores how nerve impulses are generated and transmitted**

**Number of Periods : 07**

**Learning Outcomes:**

- states the terms resting potential, action potential, polarization, depolarization, hyper polarization and re polarization
- briefly describes the generating of resting potential and how the nervous impulse is conducted along an axon
- states what synapses is
- states the constituents which contribute to form a synapses
- describes the mechanism of transmission of nervous impulses through synapses
- states what reflex arc is
- outlines a reflex arc with labeled parts
- names the different types of neurotransmitters

**Suggested Teaching- Learning Process**

- Show appropriate diagrams/ pictures/ video clips/ animations on the 'transmission of nerve impulses' and describe the following terms; resting potential, action potential, polarization, depolarization, hyperpolarization and repolarization.
- Show appropriate diagrams/ pictures/ video clips/ animations on the synapse, introduce the term 'synapse' in transmission of nerve impulses and assist them to develop an understanding on the role of neurotransmitters in synapses.
- Briefly describe the mechanism of transmission of nervous impulses through synapses.
- Introduce acetylcholine, some amino acids, biogenic amines, neuropeptides, some gases as different types of neurotransmitters (examples for neurotransmitters types are not required).
- Introduce what reflex arc is and assist students to draw and label the parts of reflex arc.
- Ask students to prepare presentations on transmission of nerve impulses through both axon as well as synapses in groups and let them present it .

**Assessment and Evaluation**

- Assess students' group presentations on the transmission of nerve impulses through both axon as well as synapses using following criteria.
  - Accuracy of the content
  - Relevancy of the content
  - Adequacy of the content
  - Team work

**Competency 5.6.0 : Investigates the structures and functions involved in coordination**

**Competency Level 5.6.4 : Explores the injuries and common disorders of the nervous system**

**Number of Periods : 02**

**Learning Outcomes:**

- states the reasons behind the common disorders of the nervous system

**Suggested Teaching- Learning Process**

- Guide students to extract information on reasons behind the following disorders of nervous system from the resources given and let them prepare a report ;
  - Schizophrenia
  - Depression
  - Alzheimer's disease
  - Parkinson's disease

**Assessment and Evaluation**

- Assess the student's report using the following criteria.
  - Accuracy and relevancy of information
  - Adequacy of information

**Competency 5.6.0 : Investigates the structures and functions involved in coordination**

**Competency Level 5.6.5 : Explores the functions of different sensory structures in human**

**Number of Periods : 04**

**Learning Outcomes:**

- briefly describes what a sensory receptor is
- states basic characteristics of sensory receptors
- lists the different types of receptors; chemo receptors, thermo receptors, photoreceptors, mechanoreceptors and pain receptors based on the types of stimuli
- states the location and major role of various types of receptors
- appreciates the major roles of different sensory structures for the survival of mankind

**Suggested Teaching- Learning Process**

- Guide students to construct a definition for sensory receptor and assist them to list down the basic characteristics of them.
- Introduce chemoreceptors, thermoreceptors, photoreceptors, mechanoreceptors and pain receptors as different types of sensory receptors categorized based on the type of stimuli.
- Ask students to categorize taste receptors, olfactory receptors, Cold-Krause end bulbs, Warmth-Ruffini corpuscles, free nerve endings, rods, cones, touch receptors (Meissner corpuscles, Merkel's discs, free nerve endings) and pressure receptors as chemoreceptors, thermoreceptors, photoreceptors, mechanoreceptors and pain receptors and let them tabulate their roles and locations.

**Assessment and Evaluation**

- Assess students' on the tabulation of the different types of sensory receptors using following criteria
  - Accuracy
  - Relevancy

**Competency Level 5.6.6 : Relates the structures of the eye and ear to their functions**

**Number of Periods : 08**

**Learning Outcomes:**

- names the main components of the human eye
- describes the basic structure and functioning of the human eye
- states what binocular vision and monocular vision are
- states the advantages of binocular vision over monocular vision
- briefly describes the basic structure and functions of the human ear
- describes how auditory function takes place through the human ear
- appreciates the importance of eye and ear for the survival of the mankind

**Suggested Teaching- Learning Process**

- Use models/ diagrams/ charts/ videos to introduce the parts of the human eye and ear.
- Guide students to relate parts of the human eye to their functions.
- Ask student groups to prepare wall papers on structure and functions of human ear and eye.
- Conduct a brainstorming session to introduce the terms monocular and binocular visions
- Assist students to find out the advantages of binocular vision over monocular vision.

**Assessment and Evaluation**

- Assess students' group wall papers using following criteria.
  - Accuracy and relevancy of information
  - Adequacy
  - Creativity

**Competency Level 5.6.7 : Investigates the basic structure and functions of the human skin**

**Number of Periods : 03**

**Learning Outcomes:**

- names the major components and layers of the skin
- relates the structure and function of the human skin
- states the functions of the human skin

**Suggested Teaching- Learning Process**

- Use a model/ chart/ diagram/ video clips to introduce the basic structure of the human skin.
- Introduce the basic layers of the human skin as epidermis and dermis.
- Guide students to identify components of the human skin as hairs, glands and receptors.
- Conduct a discussion relating structure of the human skin to their functions.
- Guide student groups to construct a model of human skin using clay, plaster of Paris or relevant materials.

**Assessment and Evaluation**

- Assess student's human skin model using following criteria.
  - Correct representation
  - Accurate labeling
  - Creativity

**Competency 5.7.0 : Explores endocrinal regulation and homeostasis**

**Competency Level 5.7.1 : Analyses the role of the human endocrine system**

**Number of Periods : 07**

**Learning Outcomes:**

- states what is an endocrine gland and a hormone
- states the locations of the endocrine glands and states the functions of them
- states the feedback mechanism regarding the endocrine system (limit to positive – oxytocin in parturition and lactation ; negative- regulation of blood glucose level)
- states the reasons and controlling measures for diabetes, hyperthyroidism and hypothyroidism
- appreciates the contribution of the endocrine system in coordination and homeostasis

**Suggested Teaching- Learning Process**

- Introduce and assist students to construct the definitions for the terms ‘endocrine glands’ and ‘hormones’.
- Introduce different types of endocrine glands in humans such as hypothalamus, pituitary glands, thyroid gland, parathyroid gland ,thymus gland, adrenal glands, islets of Langerhans, pineal gland, gonads.
- Guide students to use previous knowledge on endocrine glands and guide them to map their locations on a diagram of the human body.
- State the functions of each endocrine gland of human.
- Explain the feedback mechanism (limit to positive – oxytocin in parturition and lactation ; negative- regulation of blood glucose level) and its relevance to the endocrine system
- Guide students to collect information on diabetes (Type 1 and Type 2), hyperthyroidism, and hypothyroidism, causes and controlling measures and ask them to prepare a presentation on that
- Guide students to practice proper habits in day to day life to prevent those diseases and disorders.

**Assessment and Evaluation**

- Assess student presentations using following criteria.
  - Accuracy and relevancy of information
  - Presentation skills
  - Time management



**Competency Level 5.7.2: Investigates how a constant internal environment is maintained within a range in the body**

**Number of Periods : 06**

**Learning Outcomes:**

- briefly describes homeostasis with respect to the internal and external environment
- constructs a flow chart to describe a feedback mechanism in maintaining homeostasis
- describes homeostasis of man in regulation of body temperature
- describes homeostasis of man in regulating blood glucose level
- describes homeostasis of man in regulating blood osmo-regulation
- lists out the function of the liver in relation to the homeostasis
- appreciates the importance of homeostasis for the survival of human life

**Suggested Teaching- Learning Process**

- Explain the internal and external environment of man and introduce the term homeostasis with respect to the external and internal environment.
- Use charts/ diagrams to explain positive and negative feedback mechanisms of homeostasis.
- Use charts/ models/ diagrams/ videos to describe homeostasis of man in regulating body temperature, blood glucose level and osmoregulation.
- Guide students to construct charts on regulating body temperature, blood glucose level and osmoregulation of man in homeostasis.
- Explain the role of the liver in homeostasis.

**Assessment and Evaluation**

- Assess students' charts using following criteria.
  - Accuracy of information
  - Relevancy
  - Creativity

**Competency 5.8.0 : Inquires in to the reproductive process in animals**

**Competency Level 5.8.1 : Inquires into different types of reproduction in animals**

**Number of Periods : 05**

**Learning Outcomes:**

- briefly describes the reproduction and states the different types of asexual reproduction with examples
- states what is sexual reproduction, bisexuality, uni-sexuality, parthenogenesis, gametogenesis and fertilization
- compares the features of sexual reproduction with features of asexual reproduction
- accepts that reproduction is an important process to ensure the survival of species

**Suggested Teaching- Learning Process**

- Describe what reproduction is, and discuss asexual and sexual reproduction.
- Briefly describe following methods of asexual reproduction by giving relevant examples.
  - Budding
  - Fragmentation
- Explain bisexuality, unisexuality, parthenogenesis, gametogenesis, external and internal fertilization and use relevant examples whenever necessary to explain those terms.
- Guide students to compare asexual reproduction with sexual reproduction and ask them to tabulate the differences.

**Assessment and Evaluation**

- Assess students' table of comparison on asexual reproduction and sexual reproduction using following criteria.
  - Accuracy of information
  - Adequacy of information

## **Competency Level 5.8.2: Inquires into structure and functions of the male reproductive system**

**Number of Periods : 10**

### **Learning Outcomes:**

- states the main structures and their functions of the male reproductive system
- briefly describes the microscopic structures of seminiferous tubules using T.S and functions of each parts of it
- briefly describe the major steps of spermatogenesis
- states the structure and function of each part of the sperm
- states the composition of semen
- states the importance of the three accessory glands
- briefly describes the hormonal regulation of spermatogenesis using a flow chart
- identifies the main components of the male reproductive system using models/diagrams

### **Suggested Teaching- Learning Process**

- Use diagrams/ charts/ models to explain the basic parts of the male reproductive system.
- Guide students to relate the structure of the male reproductive system to their functions and ask them to prepare a chart.
- Explain the basic structure of the sperm using diagrams/ charts/ video clips etc.
- Relate the basic structure of the sperm to its function using video clips/ diagrams.
- Describe the major steps of spermatogenesis using charts/ diagrams
- Guide students to list down the composition of the semen.
- Describe the importance of the following accessory glands related to the male reproductive system.
  - Seminal vesicles
  - Prostate glands
  - Cowper's glands
- Use flow charts to explain the hormonal regulation of spermatogenesis and development and maintenance of the male reproductive system.

### **Assessment and Evaluation**

- Asses students' chart on the male reproductive system using following criteria.
  - Accuracy of information
  - Relevancy
  - Attractiveness

### **Competency Level 5.8.3: Inquires into structure and functions of the female reproductive system**

**Number of Periods : 10**

#### **Learning Outcomes:**

- briefly states the structures and functions of the female reproductive system with models/diagrams
- briefly describes the major steps of oogenesis with its hormonal regulation
- briefly describes the structures of human ovaries
- briefly describes the structure and the functions of each parts of the human ovum
- briefly describes the menstrual cycle
- illustrates the hormonal regulation and the structural changes of ovaries and endometrium that occur in menstrual cycle using appropriate graphs
- states what menopause is
- identifies the main components of the female reproductive system using models /diagrams (Practical work)
- appreciates the complexity of the human reproductive systems

#### **Suggested Teaching- Learning Process**

- Provide students with unlabeled diagram/ models/ charts of female reproductive system and guide them to label the parts of it.
- Guide students to relate the structure of the female reproductive system to its function.
- Describe the oogenesis and its hormonal regulation using charts/ video clips/ diagrams.
- Use diagrams/ models/ video clips to describe the structure of the human ovum and guide the students to relate the structure of the human ovum to its function.
- Use relevant graphs/ diagrams/ charts/ models/ video clips to describe the hormonal regulation and the structural changes that occur in menstrual cycle.
- Use relevant charts/ graphs to explain the hormonal fluctuations in blood women during menstrual cycle.
- Explain menopause.

#### **Assessment and Evaluation**

- Conduct a written test on oogenesis and its hormonal regulation

## **Competency Level 5.8.4 : Inquires into the processes involved in fertilization up to birth**

**Number of Periods : 05**

### **Learning Outcomes:**

- states fertilization
- briefly states the developmental stages of a zygote
- states what implantation is
- states the types of foetal membranes and functions of each
- briefly describes the structures of placenta and umbilical cord
- states what pregnancy is and its duration
- lists down the major foetal changes during pregnancy in each trimester
- relates the mother's immune tolerance to the embryo
- briefly describes the process and the role of positive feedback mechanism of parturition
- states what lactation is
- briefly describes the hormonal and nervous regulation of lactation
- states the composition of human milk
- states the significance of breast feeding
- appreciates the importance and complexity of fertilization and pregnancy
- appreciates the importance of breast feeding

### **Suggested Teaching- Learning Process**

- Guide students to construct a definition for “fertilization”.
- Use charts/ video clips to explain the development of zygote and implantation.
- Describe the structure and functions of the following.
  - Fetal membranes
  - Placenta
  - Umbilical cord
- Explain pregnancy and its duration.
- Discuss and relate mother's immune tolerance to the embryo.
- Use charts to explain positive feedback mechanism in the process of parturition.
- Explain the hormonal and nervous regulation of lactation.
- Guide students to list down the composition of breast milk.
- Guide students to find out the importance of breast feeding.

### **Assessment and Evaluation**

- Assess students through oral questioning method.

**Competency Level 5.8.5 : Develops an awareness on reproductive health**

**Number of Periods : 05**

**Learning Outcomes:**

- states the early signs of pregnancy
- states the basis of the pregnancy tests (hCG in urine and blood)
- briefly states the importance of birth controlling methods available for both female and male
- lists down the birth control methods and the effects of contraceptive methods on the normal physiological process
- states what is abortion
- states the harmful effects of illegal abortions
- tabulates the given sexually transmitted infections with their symptoms and pathogens
- discusses how to avoid sexually transmitted infections
- states what is infertility
- states the major two types of modern reproductive technologies; hormone therapy and surgery
- describes in vitro fertilization and intra-cytoplasmic sperm injection as assisted reproductive technology
- appreciates the significance of assisted technologies and modern reproductive technologies in resolving infertility

**Suggested Teaching- Learning Process**

- Guide students to list down the early signs of pregnancy.
- Assist students to write down the basis of the pregnancy tests.
- Assist students to list down the birth control methods available for females and males.
- Assist students to list down the effects of contraceptive methods on the normal physiological process.
- Conduct discussion on abortion and harmful effects of illegal abortions.
- Guide students to prepare a booklet on ‘sexually transmitted diseases’. (pathogens, symptoms and preventive measures should be included).
- Discuss about infertility.
- Guide students to extract information from the given sources on modern reproductive technologies (hormonal therapy and surgery) and assisted reproductive technologies (invitro fertilization and intracytoplasmic sperm injection)

**Assessment and Evaluation**

- Assess student’s booklet on ‘sexually transmitted diseases’ using following criteria.
  - Accuracy of information
  - Relevancy
  - Adequacy

**Competency 5.9.0 : Inquires into the types of supporting systems and movement in animals**

**Competency Level 5.9.1 : Inquires into the structure and functions of the skeletal systems and movement of animals**

**Number of Periods : 06**

**Learning Outcomes:**

- lists the main types of skeletons of animals
- briefly describes the organization of the hydrostatic skeleton
- names the different types of hydrostatic skeleton using phyla or classes as examples
- states the organization of different exoskeletons with examples
- states the organization of different endoskeletons with examples
- states the common functions of the skeletal system
- states the functions of the human skeletal system
- briefly describes how animals move through water and air
- appreciates the skeletal system in relation to survival of organisms in their environment

**Suggested Teaching- Learning Process.**

- Guide students to prepare a wall paper on main types of skeletons with suitable examples. Wall paper should include the following information;
  - Hydrostatic skeleton- gastrovascular cavity, pseudocoelom, interstitial fluid, coelom
  - Exoskeleton- chitinous exoskeleton, calcium carbonate exoskeleton, bony plates
  - Endoskeleton- plates of calcium carbonate, bones, cartilage
- Guide students to compare exoskeleton, endoskeleton and hydroskeleton.
- Guide students to list the common functions of the skeletal system.
- Guide students to list the functions of the human skeleton.
- Arrange a field visit to a suitable place and guide students to prepare a presentation on the movement of animals through water and air based on their observations.

**Assessment and Evaluation**

- Assess student's wall paper of main types of skeletons using following criteria.
  - Accuracy of information
  - Relevancy and adequacy
  - Presentation skills
  - Giving suitable examples

**Competency Level 5.9.2 : Investigates the structure and functions of the axial skeleton of man**

**Number of Periods : 06**

**Learning Outcomes:**

- names the two main parts of the human skeleton
- describes the organization of the human skeleton
- names the bones in the skull
- lists the main parts of the axial skeleton
- describe significant parts and functions of skull
- explains curvatures of the vertebral column and their importance
- describes the structure of a typical vertebra
- names different types of vertebrae with number
- states special features of each type of vertebrae in relation to function
- states the structure and importance of ribs and sternum
- states how the human axial skeleton contributes to maintain upright posture

**Suggested Teaching- Learning Process**

- Describe the organization of human skeleton using specimens/diagrams/ models/ video clips.
- Guide students to identify two main parts of the human skeleton.
- Guide students to identify the main parts of the axial skeleton on a unlabeled model/ diagram. This should include skull, cranium, vertebral column.
- Describe significant parts of the skull and their functions using diagrams/ specimens/models.
- Explain the curvatures of vertebral column and their importance.
- Describe the basic structure of a typical vertebra using specimen/diagram/ model/ video clip.
- Guide students to compare each type of vertebrae with respect to their number and their special features in relation to their function from the given specimens/diagrams and assist them to tabulate it.
- Explain the structure of the ribs and sternum and their importance.
- Conduct a discussion on how human axial skeleton contributes to maintain upright posture.

**Assessment and Evaluation**

- Assess student's identification of the main parts of the axial skeleton using relevant criteria.



### **Competency Level 5.9.3: Investigates the structure and functions of the appendicular skeleton of man**

**Number of Periods : 06**

#### **Learning Outcomes:**

- briefly describes the organization of human appendicular skeleton
- names the main bones of the upper limb (naming the carpal bones and meta carpal bones not required)
- describes how upper limb is adapted to move over a wide range of movements-including grasping, manipulation and weight lifting
- names the main bones of lower limb (naming the tarsal bones and meta tarsal bones not required)
- briefly describes how lower limb is adapted for erect posture, bearing of body weight and walking
- briefly describes arches of foot and their functions
- briefly describes osteoporosis, osteoarthritis and slipped discs
- lists the components of the appendicular skeleton and states the function of each of them
- identifies the importance of correct posture for healthy maintenance of the skeletal system
- identifies the bones of the appendicular skeleton using specimens /models/diagrams (Practical)

#### **Suggested Teaching- Learning Process**

- Use specimens/ models/ charts/ diagrams to describe the general structure of human appendicular skeleton.
- Relate the general structure of the human appendicular skeleton to its function.
- Describe the basic structure of the upper limb (naming the carpal bones and meta carpal bones are not required) .
- Guide students to relate how upper limb is adapted to move over a wide range including grasping, manipulation and weight lifting.
- Describe the basic structure of the lower limb (naming the tarsal and meta tarsal are not required).
- Guide students to explore and describe how lower limb is adapted for erect posture, bearing of body weight and walking.
- Describe arches of foot and their functions.
- Guide students to extract information from given resources and make a report on following disorders and abnormalities of the human skeletal system.
  - Osteoarthritis
  - Osteoporosis
  - Slipped disc

- Assign students to conduct a brief speech on the importance of correct posture for healthy maintenance of the skeletal system.

### **Assessment and Evaluation**

- Assess students speech using following criteria,
  - Accuracy and relevancy of information
  - Presentation skills
  - Time management
  - Adequacy of information

**Competency Level 5.9.4: Investigates the main types of joints and mechanism of skeletal muscle movement**

**Number of Periods : 04**

**Learning Outcomes:**

- names main types of joints and lists the functions and importance of joints
- states features of the muscle tissue
- briefly describes the structure of the sarcomere and basic mechanism of skeletal muscle movement
- briefly describes the basic concepts of the sliding filament theory
- appreciates the way of muscles performance in their functions

**Suggested Teaching- Learning Process**

- Describe functioning of main types of joints (ball and socket, hinge and pivot) and their importance.
- Conduct a brain storming session on the features of muscle tissue.
- Describe the structure of the sarcomere using video clips/ animations/ diagrams.
- Explain the basic concept of the sliding filament theory using video clips/ diagrams.

**Assessment and Evaluation**

- Assess students' performance by oral questioning method using relevant criteria.

**Competency 6.1.0 : Explores the basic principles of genetics for applications**

**Competency Level 6.1.1 : Inquires the scientific basis of Mendel's experiments**

**Number of Periods : 09**

**Learning Outcomes:**

- Explains the following terms related to genetics: F<sub>1</sub> and F<sub>2</sub> generations, contrasting characters, gene, allele, genotype, phenotype, recessive characters, dominant characters, pure breeding, pure lines, homozygous, heterozygous, monohybrid cross, dihybrid cross and test cross
- describes and analyzes the F<sub>2</sub> phenotype ratios of monohybrid cross
- states Mendel's first law
- describes and analyze the F<sub>2</sub> phenotype ratios of dihybrid cross
- states Mendel's second law
- describes the reasons for the success of Mendel's experiments
- states the reasons for selecting *Pisum sativum* for the Mendelian experiments
- predicts ratios of genotypes and phenotype of multiple factor crosses
- describes and analyzes the F<sub>2</sub> phenotype ratios of monohybrid test cross
- describes and analyzes the F<sub>2</sub> phenotype ratios of dihybrid test cross
- appreciates that patterns of inheritance could be predicted by using mathematical ratios

**Suggested Teaching- Learning Process**

- conduct a discussion to explain the given terms by highlighting the meaning of each term related to genetics (F<sub>1</sub> and F<sub>2</sub> generations, contrasting characters, gene, allele, genotype, phenotype, recessive characters, dominant characters, pure breeding, pure lines, homozygous, heterozygous, monohybrid cross, dihybrid cross and test cross)
- Describe the F<sub>1</sub> and F<sub>2</sub> generations by using relevant diagrams of crosses under monohybridization and dihybridization.
- Let the students construct diagrams for monohybridization and draw Punnett square to describe the F<sub>2</sub> progeny.
- Explain the phenotypic and genotypic ratios for Mendel's 1<sup>st</sup> and 2<sup>nd</sup> laws using examples.
- Guide students to state the crosses done by Mendel with *Pisum sativum* plant and assist students to list the reasons for selecting *Pisum sativum* plant for Mendel's experiments.
- Describe the multiple factor cross briefly.
- Construct the ratios of genotypes and phenotypes for multiple factor crosses.

**Assessment and Evaluation**

- Asses the students' performance on constructing Punnett square with relevant criteria.

## **Competency Level 6.1.2.: Examines the patterns of inheritance of Mendelian characters in humans**

**Number of Periods : 04**

### **Learning Outcomes:**

- states common Mendelian characters in humans such as attached or detached earlobe, dimples on cheek, widow's peak or without, straight or bent thumb, rolling or non-rolling tongue
- analyzes and predicts results of Mendelian inheritance in human families using pedigree charts
- appreciates the use of pedigree charts in predicting inheritance of Mendelian characters

### **Suggested Teaching- Learning Process**

- Assist students to identify some common Mendelian characters in humans such as attached or detached earlobe, dimples on cheek, widow's peak or without, straight or bent thumb, rolling or non-rolling tongue.
- Help students to carryout a project to find out the count of common Mendelian characters among the pupils in their class or section
- Describe the way of predicting results of Mendelian inheritance by using the pedigree chart of the British Royal family.
- Introduce the symbolizing system of the pedigree chart.
- Assign students to analyze a given pedigree chart (provide a pedigree chart with a disorder like haemophilia).

### **Assessment and Evaluation**

- Use the criteria given below to assess the students analysis of the given pedigree chart.
  - Correct identification
  - Accurate interpretation

**Competency Level 6.1.3 : Uses concepts and principles to explain genetic patterns that deviate from Mendel's laws**

**Number of Periods : 04**

**Learning Outcomes:**

- states patterns of non Mendelian inheritance such as incomplete dominance, codominance, poly allelism , gene interaction, poly genetic inheritance , gene linkage human sex determination and human sex linked inheritance
- describes and analyzes the  $F_2$  phenotype ratios of incomplete dominance by using flower colour of *Mirabilis*
- describes and analyzes the  $F_2$  phenotype of ratios of co-dominance using AB blood group
- describes and analyzes the  $F_2$  phenotype of ratios of poly allelism using A,B,O blood groups
- describes and analyzes the  $F_2$  phenotype of ratios of gene interaction of dominant epistasis using plumage colour of house fowl and recessive epistasis using flower colour of *Lathyrus*
- describe and analyze the  $F_2$  phenotype ratios of polygenic inheritance stating any example from list of height, IQ, skin colour in man
- describes and analyzes the  $F_2$  phenotype ratios of gene linkage using eye colour and wing type of *Drosophila*
- explains human sex determination
- states haemophilia and colour blindness as human sex linked characters
- describes and analyzes the human sex linked inheritance
- defines pleiotropy as heredity of single gene to have multiple effects (example in human cystic fibrosis and sickle cell disease)
- outlines the concept of epigenetics as the inheritance of traits transmitted by mechanism not involved in nucleotide sequence itself. (eg; in identical twins one gets schizophrenia, a genetic disease but the other does not)
- appreciates the way non Mendelian inheritance contributes to variations among population

**Suggested Teaching- Learning Process**

- Guide students to name the patterns of non Mendelian inheritance such as incomplete dominance, codominance, polyallelism, gene interaction, poly genetic inheritance, gene linkage, human sex determination and human sex linked inheritance.
- Briefly explain the nature of the given non Mendelian inheritance patterns by using relevant examples.
- Guide students to describe and analyze the  $F_2$  phenotypic ratios of the given patterns of non Mendelian inheritance.

- Guide the students to make their own diagrams to show the given non-Mendelian inheritance patterns
- Provide them with several problems in each pattern of non Mendelian inheritance to solve.
- Describe how sex is determined in man.
- Guide students to extract information on genetics of human cystic fibrosis and sickle cell anaemia and construct definition for pleiotropy.
- Lead a discussion on the concept of epigenetics using schizophrenia as an example.

### **Assessment and Evaluation**

- Evaluate the students while they solve the problems in non Mendelian inheritance according to the criteria given below.
  - Construction of a diagrammatic representation of the patterns
  - Preciseness of the inheritance patterns
  - Conclusion on inheritance patterns

**Competency Level 6.1.4 : Investigates evolution of life using changes in gene frequencies**

**Number of Periods : 04**

**Learning Outcomes:**

- explains Hardy-Weinberg equilibrium
- states conditions for Hardy-Weinberg equilibrium
- explains how changes in gene frequency leads to evolution

**Suggested Teaching- Learning Process**

- Lead a discussion on the Hardy-Weinberg equilibrium by using the equation.
- Guide the students to list down the conditions that a population should possess for this equilibrium.
- Discuss how the changes in gene frequency leads to evolution at the end.
- Guide the students to solve the problems given on Hardy-Weinberg equilibrium.

**Assessment and Evaluation**

- Evaluate the students while they solve the problems using Hardy-Weinberg equation using the criteria given below.
  - Accuracy of using Hardy-Weinberg equation
  - Calculation
  - Finding the problem



**Competency Level 6.1.5 : Explores the basic concepts in plant and animal breeding**

**Number of Periods : 04**

**Learning Outcomes:**

- briefly describes the importance of plant and animal breeding with examples
- briefly describes some breeding techniques in plants and animals
- briefly describes the genetic principles of breeding techniques
- compares advantages and disadvantages of natural and artificial breeding methods
- appreciates the plant and animal breeding techniques to obtain improved varieties

**Suggested Teaching- Learning Process**

- Conduct a discussion on the importance of plant and animal breeding, stating relevant examples
- Explain some breeding techniques used in plants and animals for human needs using appropriate pictures / videos/ literature.
- Describe the genetic principles used in breeding techniques.
- Provide students with articles or reading materials to compare natural and artificial breeding techniques and assist them to tabulate their advantages and disadvantages.
- Guide students to make a presentation on plant and animal breeding techniques used to obtain improved varieties (high milk yield in cows , high starch yield in crops etc.).

**Assessment and Evaluation**

- Evaluate students' presentations using the criteria given below.
  - Accuracy of findings
  - Relevance of information
  - Presentation skills
  - Time management

**Competency 7.1.0 : Investigates the molecular basis of genetic materials**

**Competency Level 7.1.1 : Examines the structures and functions of genetic materials**

**Number of Periods : 06**

**Learning Outcomes:**

- recalls the basic structure of DNA and RNA molecules
- describes the properties of DNA
- describes the architecture of chromosomes
- distinguishes prokaryotic chromosome from eukaryotic chromosome
- explains the importance of DNA replication
- names the enzymes involved in DNA replication and states their importance
- states that very few errors take place in DNA replication
- describes the basic characteristics of DNA replication
- distinguishes the differences between eukaryotic and prokaryotic DNA replications
- briefly describes DNA repair and states its significance
- explains the characteristics of DNA as a hereditary molecule of the cell

**Suggested Teaching- Learning Process**

- Conduct a brainstorming session on the basic structures of DNA and RNA molecules.
- Assist students to list down the properties of DNA.
- Guide students to construct a display to depict the architecture of chromosomes.
- Assist students to tabulate the differences between prokaryotic and eukaryotic chromosomes.
- Guide students to prepare a presentation using appropriate diagrams/ video clips/ models to describe the basic characteristics of DNA replication and let them present it as groups (Unwinding of double helix, Nucleotide polymerization, Role of RNA primers, Leading and lagging strands, Sealing the gaps, Role of enzymes- DNA helicase, primase, DNA polymerases and DNA ligase are expected to be focused)
- Conduct a discussion to describe how the DNA replication of prokaryotes differs from the eukaryotes.
- Let students explore and list the significance of DNA replication.
- Explain how DNA functions as the hereditary molecule of the cell.
- Assist students to prepare a poster on 'DNA repair mechanism and its significance' in groups.

**Assessment and Evaluation**

- Assess students' presentation based on the following criteria:
  - Accuracy of the subject matter
  - Relevancy and use of appropriate aids
  - Team work
  - Time management

**Competency 7.1.0 : Investigates the molecular basis of genetic materials**

**Competency Level 7.1.2 : Examines genes and how they work**

**Number of Periods : 09**

**Learning Outcomes:**

- briefly describes the basic structure and organization of prokaryotic and eukaryotic genomes and their differences
- relates gene with chromosomes
- describes the characteristics of the genetic code
- briefly describes exons and introns
- states the role of DNA, RNA and enzymes in protein synthesis
- names the major steps found in protein synthesis as transcription and translation
- States one gene/ one polypeptide hypothesis
- lists the major steps involved in transcription and translation
- appreciates the value of chromosomal theory
- appreciates the importance of molecular biology in life
- appreciates the trafficking and degradation of proteins within the cell

**Suggested Teaching- Learning Process**

- Describe the basic structures and organizations of prokaryotic and eukaryotic genomes.
- Assist students to list down the differences between prokaryotic and eukaryotic genomes.
- Conduct a brainstorming session on relationship of chromosomes with genes.
- Introduce the terms 'genetic code' and 'codon' to students.
- Assist students to prepare a poster presentation to depict exons, introns and other non coding regions of chromosomes.
- Introduce 'transcription' and 'translation' as the two major events in protein synthesis.
- Guide students to prepare presentations to describe the major steps of 'transcription' and 'translation' in protein synthesis.
- Introduce one gene-one polypeptide hypothesis.
- Briefly describe the trafficking and degradation of proteins within the cell.

### **Assessment and Evaluation**

- Assess the student's presentation on protein synthesis using the following criteria.
  - Accuracy and relevance of information
  - Active participation
  - Time management

**Competency 7.1.0 : Investigates the molecular basis of genetic materials**

**Competency Level 7.1.3 : Examines the molecular basis of mutations**

**Number of Periods : 06**

**Learning Outcomes:**

- defines the term mutation
- states the causative factors of mutations as mutagens
- states the types of mutations with examples
- describes the chromosomal conditions of given human genetic disorders (Down syndrome, Turners syndrome, Color blindness, Sickle cell anaemia).
- states the significance of genetic counseling in avoiding some human genetic problems
- explains the significance of mutation in evolution
- appreciates the contribution of mutation in evolution

**Suggested Teaching- Learning Process**

- Assist students to construct a definition for mutation and mutagens.
- Introduce gene mutations and chromosomal mutations to the students as the two major types of mutations and guide them to compare both with appropriate examples.
- Assist students to describe the chromosomal conditions of the following human genetic disorders.
  - a) Down syndrome
  - b) Turner syndrome
  - c) Klinefelter syndrome
  - d) Colour blindness
  - e) Sickle cell anaemia
- Guide students to explore the significances of mutation in evolution.
- Assist students to collect information and prepare a report on the importance of genetic counseling in avoiding some human genetic problems.

**Assessment and Evaluation**

- Assess student's report on the importance of genetic counseling in avoiding some human genetic problems using following criteria
  - Accuracy of the content
  - Relevancy of the content
  - Adequacy of the content
  - References

**Competency 7.2.0 : Gets updated on gene technology**

**Competency Level 7.2.1 : Gets updated on tools, techniques and methods of gene technology**

**Number of Periods : 08**

**Learning Outcomes:**

- briefly discusses the major steps in DNA isolation
- briefly describes the role of enzymes used in gene technology
- states the principle of agarose gel electrophoresis
- briefly describes the principle of nucleic acid hybridization
- states the use of probes
- states what recombinant DNA technology is
- names different types of vectors used in recombinant DNA technology
- briefly discusses the significance of using bacterial plasmids, bacteriophage and yeast in using them as vectors
- outlines the major steps in gene/DNA fragment cloning
- discusses the significance of marker genes and DNA libraries
- states the function of reverse transcriptase in recombinant DNA technology
- briefly describes how transformation, transduction, *Agrobacterium* and gene guns are used in transfer of desired gene fragments
- appreciates the complexity of recombinant DNA technology

**Suggested Teaching- Learning Process**

- Show video clips/ posters/ diagrams/ photographs of DNA isolation and ask students to list down the major steps of DNA isolation.
- Introduce the principle of DNA isolation, role of nucleases, ligases, polymerases, DNA probes, agarose gel electrophoresis and hybridization techniques to the students using appropriate diagrams/ photographs/ videos.
- Introduce recombinant DNA technology and conduct a discussion on cloning of genes.
- Guide students to prepare a poster on the following vector types used in recombinant DNA technology by stating their significance.
  - Bacterial plasmids
  - Bacteriophage
  - Yeast artificial
- Guide students to tabulate the roles of vectors, DNA libraries, reverse transcriptase and marker genes in the recombinant DNA technology.
- Assist students to list the major steps of gene/ DNA fragment cloning.
- Guide students to prepare a report by collecting information from available sources on the following DNA delivery systems and methods.

- Transformation
- Transduction
- *Agrobacterium* mediated transfer
- Gene guns

### **Assessment and Evaluation**

- Assess the student's report using the following criteria.
  - Accuracy and relevancy of information
  - Adequacy of information
  - Examples
  - References



**Competency 7.2.0 : Gets updated on gene technology**

**Competency Level 7.2.2 : Gets updated on DNA analysis**

**Number of Periods : 07**

**Learning Outcomes:**

- states what is meant by restriction map, DNA sequencing, DNA fingerprints and PCR
- outlines the significance of restriction map, DNA sequencing, DNA fingerprinting and PCR
- appreciate PCR as an accelerated process of DNA analysis

**Suggested Teaching- Learning Process**

- Give a brief introduction to students on the following techniques used in DNA Analysis.
  - Restriction Maps
  - DNA Sequencing
  - DNA Finger Prints
  - Polymerase Chain Reaction (PCR)
- Assist students to explore information on the significances of following DNA Analysis Techniques and let them present their findings as groups.
  - Restriction Maps
  - DNA Sequencing
  - DNA Finger Prints
  - Polymerase Chain Reaction (PCR)
- Ask students to summarize and list down the significances of Restriction Maps, DNA Sequencing, DNA Finger Prints and Polymerase Chain Reaction (PCR).

**Assessment and Evaluation**

- Assess students through a written test on the DNA Analysis Techniques.

**Competency 7.2.0 : Gets updated on gene technology**

**Competency Level 7.2.3 : Updates on the application of gene technology**

**Number of Periods : 04**

**Learning Outcomes:**

- states what a genetically modified (GM) organism is
- provides examples for the use of genetically modified organisms in medicine, agriculture and industry
- finds out possible health, environmental and socio economic concerns in using GM organisms
- briefly explains Cartagena protocol and national bio-safety framework
- appreciates the significance of international protocols and bio -safety framework in the safety of mankind
- appreciates gene technology as a field of excitements and controversies
- appreciates the applications of gene technology in different fields

**Suggested Teaching- Learning Process**

- Introduce 'Genetically modified organisms' using appropriate examples in the fields of medicine, agriculture and industry.
- Assist students to construct an appropriate definition for 'Genetically modified organisms'.
- Ask students to collect information on possible health, environmental and socio economic concerns in Genetically modified organisms and let them present it as groups in the classroom.
- Ask students to prepare a poster with examples for the use of Genetically modified organisms' in medicine, agriculture, and industry.
- Briefly describe the objectives and significance of Cartagena protocol and the National Bio-safety Framework.

**Assessment and Evaluation**

- Assess the poster prepared by students based on the following criteria.
  - Accuracy of information
  - Relevancy of information
  - Adequacy of information
  - Organization of Data

**Competency 8.1.0 : Engages in a biological analysis on relationships between organisms and their environment**

**Competency Level 8.1.1 : Investigates components of an ecosystem**

**Number of Periods : 02**

**Learning Outcomes:**

- states what Environmental Biology is
- describes the importance of learning Environmental Biology
- defines the levels of organization of the environment
- lists the major biotic and abiotic components
- appreciates the presence of various organizational levels of the environment

**Suggested Teaching- Learning Process**

- Assist students to construct a definition for environmental biology.
- Conduct a discussion on importance of studying environmental biology.
- Instruct students to construct a flow chart on organizational levels of the environment starting from individual to biosphere.
- Define each organizational levels in the environment and give relevant examples.
- Arrange a field visit and guide students to list down biotic and abiotic components in the environment and ask them to present the importance of the biotic and abiotic components in the environment.

**Assessment and evaluation**

- Assess students flow chart using following criteria.
  - Accuracy
  - Correct flow

## **Competency Level 8.1.2 : Investigates major processes of an ecosystem**

**Number of Periods : 03**

### **Learning Outcomes:**

- briefly describes the concept of niche and habitat
- identifies relationships among abiotic and biotic components
- constructs food chains and food webs in a given ecosystem
- explains the energy loss along the food chain
- draws a flow chart to show how materials and energy flow in the ecosystem
- describes the types of pyramids
- appreciates the interaction between biotic and abiotic systems

### **Suggested Teaching- Learning Process**

- Arrange a field visit to the school garden
  - guide students to find out different types of interactions found in the environment
  - guide them to identify relationship among biotic and abiotic components in the environment
  - Guide students to observe different feeding habits found among organisms in the ecosystem
  - Then instruct them to construct a food web from their observations
  - Ask them to highlight different food chains from their food webs
  - Finally conduct a discussion on how materials and energy flow in the ecosystem
  - Introduce different types of food pyramids with relevant examples
  - Introduce the concept of niche and habitat using relevant examples

### **Assessment and evaluation**

- Assess students' food webs using following criteria.
  - Accuracy
  - Relevancy
  - Adequacy

**Competency 8.2.0 : Explores the heterogeneous nature of the biotic component of global and local environment**

**Competency Level 8.2.1 : Investigates main biomes of the world**

**Number of Periods : 06**

**Learning Outcomes:**

- defines biome
- lists major terrestrial biomes in the world
- shows the distribution of major terrestrial biomes in a world map
- distinguishes different biomes using their major characteristic features (temperature, precipitation, plant features, animal features and human impact)
- appreciates the diversity of biomes

**Suggested Teaching- Learning Process**

- Guide students to construct a definition for biome
- Assist students to list down major terrestrial biomes in the world (tropical forest, savanna, desert, chaparral, temperate grassland, temperate broad leaf forest, northern coniferous forest and tundra.)
- Guide students to map their distribution on a world map.
- Guide students to extract the characteristic features of each biome from the given pictures/ articles/ video clips and assist them to differentiate those biomes based on the above extracted characteristic features.

**Assessment and Evaluation**

- Assess student's map using following criteria
  - Accuracy
  - Neatness

**Competency 8.2.0 : Explores the heterogeneous nature of the biotic component of global and local environment**

**Competency Level 8.2.2 : Investigates ecosystems of Sri Lanka**

**Number of Periods : 12**

**Learning Outcomes:**

- states different types of ecosystems in Sri Lanka
- lists characteristic features of ecosystems in Sri Lanka
- shows the distribution of major ecosystems in a map of Sri Lanka
- states dominant species in the given ecosystems
- presents a brief account about any ecosystem of Sri Lanka after a field visit
- appreciates diversity of ecosystems in Sri Lanka

**Suggested Teaching- Learning Process**

- Assist students to list down different types of ecosystems found in Sri Lanka (lowland rain forests, dry monsoon forests, montane forests, thorn forests, savanna, patana, rivers and streams, reservoirs, marshes and swamps, villus, lagoons and estuaries, mangroves, coral reefs, sea shore, sand dunes, sea grass beds and salt marshes).
- Provide students with a map of Sri Lanka and guide them to show the locations of each type of major ecosystem of Sri Lanka.
- Use diagrams/ video clips / arrange a field visit and guide students to list characteristic features of each ecosystem.
- Guide students to identify dominant species in each ecosystem.
- Guide student groups for a presentation on major ecosystems in Sri Lanka.

**Assessment and evaluation**

- Assess students' group presentation on major ecosystems in Sri Lanka using following criteria.
  - Accuracy
  - Neatness

**Competency 8.3.0 : Explore biodiversity as a component of the environment**

**Competency Level 8.3. 1: Explores biodiversity and threats due to human actions**

**Number of Periods : 07**

**Learning outcomes:**

- defines biodiversity, ecosystem diversity, species diversity and genetic diversity
- describes the values of biodiversity under the given themes
- states the main five ways that biodiversity is lost illustrating examples in Sri Lanka
- explains extinction as a natural process, but the rate has been greatly increased by human activity
- defines threatened species according to the Red Data Book
- defines the biodiversity hotspots
- expresses the meanings of the given terminologies by giving Sri Lankan examples as appropriate
- appreciates the vast biological diversity of Sri Lanka and recognizes the importance of taking necessary actions to protect it

**Suggested Teaching learning Process**

- Assist students to construct definitions for biodiversity, ecosystems diversity, species diversity and genetic diversity.
- Guide students to prepare a booklet on the values of Bio diversity under following themes
  - Commercial and non commercial goods
  - Environment
  - Recreational
  - Ethical
  - Services
- Guide students to write down the five ways for the loss of bio diversity such as habitat loss and fragmentation, over exploitation, pollution and introduction of invasive alien species and climate change with examples found in Sri Lanka.
- Lead a discussion to explain that the extinction is a natural process but rate has been greatly increased by human activities.
- Define following threatened species according to the Red Data Book and give relevant animal and plant examples.
  - Vulnerable
  - Endangered
  - Critically endangered
  - Extinct in the wild
- Guide students to construct a definition for bio diversity hotspots.

- Conduct a discussion on following terminologies highlighting the Sri Lankan examples.
  - Endemic species
  - Indigenous species
  - Exotic species
  - Migratory species
  - Relict species
  - Flagship species
  - Keystone species
  - Invasive species

### **Assessment and Evaluation**

- Assess the booklet using following criteria.
  - Accuracy
  - Relevancy
  - Adequacy
  - References



**Competency 8.4.0 :Explores global issues related to environment**

**Competency Level 8.4.1 :Gets updated on the global environmental problems**

**Number of Periods : 05**

**Learning Outcomes:**

- lists major global environmental issues
- states the meaning of global warming and climate change, depletion of the ozone layer, desertification, and acid rain
- describes the contributory factors for global warming and climate change, depletion of the ozone layer, desertification, and acid rain
- describes the impacts of global warming and climate change, depletion of the ozone layer, desertification, and acid rain
- accepts the importance of taking necessary actions to minimize the human impacts on global environmental problems

**Suggested Teaching Learning Process**

- Conduct a discussion and ask them to list down major global environmental issues
- Guide students to collect information from different sources such as newspaper articles, internet etc. on following major global environmental issues.
  - Global warming and climate change
  - Depletion of the Ozone layer
  - Desertification
  - Acid rain
- Instruct them to conduct a panel discussion on the above major global environment problems, contributory factors, their impacts and how to minimize them

**Assessment and Evaluation**

- Assess students panel discussion using following criteria
  - Accuracy and relevancy of information
  - Adequacy of information
  - Active participation
  - Time management

**Competency 8.5.0 : Explores methods of biodiversity and environmental conservation**

**Competency Level 8.5.1 : Investigates how biodiversity and environment can be conserved  
Global and national levels**

**Number of Periods : 05**

**Learning outcomes:**

- describes *In-situ* and *Ex-situ* conservation practices with examples
- demonstrates the knowledge and understanding of global agreements and key national legislations, their administration
- accepts the importance of having international agreements and national laws for the conservation of biodiversity

**Suggested Teaching Learning Process:**

- Conduct a discussion on major global issues *In-situ* and *Ex-situ* conservation practices
- Guide students to find examples for *In-situ* and *Ex-situ* conservation practices
- Instruct students to collect information from various sources and prepare a wall paper on the following international agreements
  - CITES
  - Convention of biological diversity
  - Ramsar convention
  - Marpol convention
  - Montreal protocol
  - Kyoto protocol
  - Basel convention
- Conduct a discussion highlighting following key national legislations
  - Fauna and Flora protection ordinance
  - National Environment Act

**Assessment and Evaluation**

- Assess the wall paper using following criteria.
  - Relevancy of information
  - Accuracy
  - Creativity

**Competency 9.1.0 : Investigates diversity and handling of microorganisms**

**Competency Level: 9.1.1: Explores the diversity and nature of microorganisms**

**Number of Periods : 10**

**Learning Outcomes:**

- states briefly the nature of micro-organisms
- states types of microorganisms
- briefly describes morphological, nutritional and physiological diversity of microorganisms (bacteria/ cyanobacteria/ unicellular protists / fungi/ mollicutes)
- briefly describes the characteristic features of viruses
- states different types of viruses
- states five steps in the lytic cycle of a bacteriophage
- describes virus, viroids and prions as disease causing agents
- appreciates the vast diversity of the microbial world

**Suggested Teaching Learning process:**

- Assist students to list down the nature and types of micro-organisms.
- Ask students to bring a pond water sample, a spoiled food sample, decaying materials etc. and let them to observe those samples under light microscope.
- Conduct a discussion highlighting morphological diversity of micro-organisms based on the above observations.
- Discuss the nutritional diversity of micro-organisms as photoautotrophs, photoheterotrophs, chemoautotrophs, chemoheterotrophs and give suitable examples.
- Discuss the physiological diversity of micro-organisms using relevant examples.
- Provide students with specimens/ prepared slides/ pictures of different microorganisms and discuss the taxonomic diversity of micro-organisms.
- Discuss the major structural features of viruses, viroids, and prions as disease causing agents.
- Describe the lytic cycle of a bacteriophage using picture/ diagrams/ videos.
- Assign student groups to conduct a presentation on
  - Morphological diversity of microorganisms
  - Nutritional diversity of microorganisms
  - Physiological diversity of microorganisms

**Assessment and evaluation:**

- Assess student group presentations using following criteria.
  - Presentation skills
  - Correct information
  - Time management
  - Group cooperation

## Competency Level 9.1.2: Explores some basic laboratory techniques in microbiology

Number of Periods : 06

### Learning Outcomes

- develops skills in preparing culture media (NA and PDA) applying sterilization methods and simple staining techniques
- enjoys learning about microorganisms and their applications in day to day life

### Suggested Teaching Learning Process:

- Conduct a discussion on sterilization and its importance.
- Assign students to apply different physical and chemical sterilization methods and explore the basic principles behind them.
  - Physical- moist heat, dry heat, membrane filters, UV radiation
  - Chemical- disinfectants
- Instruct students to record their findings on the following table;

Material/ equipment	Sterilization method	Relevant experimental condition
Water		
PDA		
Thermo-labile medium		
Inoculating needle		
Scalpel for minor surgeries		
Glassware		
Plastic syringes		
Vegetables/ fruits		

- Guide students to prepare culture media such as nutrient agar and potatoe dextrose agar and instruct them to apply suitable sterilization method to sterilize the above culture media.
- Assist them to inoculate the prepared culture media with relevant microbe samples (toddy/ yoghurt/ root nodule) and instruct them to apply simple staining method to stain bacteria found in yoghurt/ toddy.

## **Assessment and Evaluation**

- Assess students' simple staining method using following criteria.
  - Proper handling of equipment
  - Using correct methods
  - Correct identification

**Competency 9.2.0 : Investigates micro-organisms as human pathogens**

**Competency Level 9.2.1 : Explores the concepts, principles relevant to infectious diseases**

**Number of Periods : 05**

### **Learning Outcomes**

- describes the nature , distribution and role of normal micro biota in the human body
- describes the terms in relation to infectious diseases
- states the important characteristics of pathogenic micro-organisms
- describes the importance of virulence factors in pathogenicity
- states the relationship of virulence to the invasiveness and toxigenicity
- describes differences between endotoxins and exotoxins
- states suitable examples for endotoxins and exotoxins producing organisms
- states the portals of entry of pathogens into the human body
- recognizes the nature of pathogenic micro-organisms in causing infectious diseases
- states the major infectious diseases in human skin, eye, nervous system, cardiovascular system, respiratory system, digestive system, reproductive system, urinary system and immune system with causal agents
- describes the ways of prevention of infectious diseases in human skin , eye, nervous system, cardiovascular system, respiratory system, digestive system, reproductive system, urinary system and immune system
- understands the role of micro - organisms in causing diseases

### **Suggested Teaching Learning Process**

- Conduct a discussion to explain the nature, distribution and role of normal micro biota in the human body
- Conduct a discussion to explain the following terms in relation to infectious diseases
  - Pathogen
  - Pathogenicity
  - Host
  - Parasite
  - Relationship between the host and the parasite/ pathogen
  - Virulence
  - Toxins
  - Portals

- Assign students to construct a table on the following information.

<b>Name of the toxin</b>	<b>Endotoxin/ exotoxin</b>	<b>Example</b>
<b>Cytotoxin</b>		
<b>Enterotoxin</b>		
<b>Neurotoxin</b>		

- Guide students to tabulate the major infectious diseases found in following parts of human body and assist them to state their causative agents.
  - Skin
  - Eye
  - Nervous system
  - Cardiovascular system
  - Respiratory system
  - Digestive system
  - Reproductive system
  - Urinary system
  - Immune system

### **Assessment and Evaluation**

- Assess the students' table using following criteria.
  - Accuracy of the subject matter



## **Competency Level 9.2.2 : Explores the methods of controlling microbial population**

**Number of Periods : 03**

### **Learning Outcomes**

- describes the role of disinfectants and antiseptics in controlling microbial diseases
- states differences between disinfectants and antiseptics
- states the role of antibiotics in controlling microbial diseases
- states types of vaccines
- appreciates the importance of hygienic practices in day to day life in controlling infectious diseases
- appreciates the artificial methods of immunization in controlling infectious diseases

### **Suggested Teaching Learning Process**

- Distribute the labels and instructions of disinfectants and antiseptics among the students.
- Assist them to differentiate disinfectant and antiseptics.
- Conduct an open discussion about antiseptics, disinfectants and antibiotics focusing on their roles in controlling microbial diseases.
- Introduce immunization by providing names of common vaccines and chemotherapeutics and conduct a discussion with the students focusing on the following.
  - Types of immunization (natural and artificial)
- Assign students to construct a table on types of immunization and relevant examples.

### **Assessment and Evaluation**

- Assess the students' table by the accuracy of information

**Competency 9.3.0 : Investigates the use of micro-organisms in industry, agriculture , environment and contribution of soil microorganisms for agriculture**

**Competency Level 9.3.1 :Investigates and explores the use of microorganisms in industry, agriculture and environment**

**Number of Periods : 06**

### **Learning Outcomes**

- explains the advantages of employing microbes in commercial products
- describes the basic principles of metabolic processes of microorganisms important for production
- states different industrial applications of micro-organisms
- distinguishes industries based on microbes, microbial products and processes
- states the applications of micro-organisms in environmental management
- states the applications of micro-organisms in agriculture
- appreciates the advantages of microbial processes over chemical processes in industry

### **Suggested Teaching Learning Process**

- Instruct the students to gather information about the industries which are based on micro-organisms.
- Assist them to distinguish industries based on microbes, microbial products and microbial processes.
- Instruct students to list down the basic principles of metabolic processes of micro-organisms.
- Assign students to list down advantages of employing microbes in manufacturing commercial products
- Assign students to list down other applications of micro-organisms and conduct a discussion focusing on following.
  - Environmental management
  - Agriculture
- Assign students to compare the advantages and disadvantages of microbial processes over chemical processes.
- Construct a concept map regarding the usage of microorganisms by man to make him comfortable (industries, agriculture, remedial measures for pollution).

### **Assessment and Evaluation**

- Assess students' concept map using following criteria.
  - Accuracy of subject matter
  - Correct interrelationships
  - Time management
  - Complexity of the concept map

## **Competency Level 9.3.2 : Explores the functions of soil micro-organisms to maintain soil health**

**Number of Periods : 06**

### **Learning Outcomes**

- describes how the chemical and physical environment of soil act as a healthy media for the growth of micro-organisms
- describes the nature , distribution and roles of soil microbes
- describes the natural role of micro-organisms as decomposers in recycling of minerals
- elaborates the specific role of micro-organisms in nitrogen cycle and carbon cycle, mineralization
- describes the interactions of soil micro-organisms relevant to plant growth
- describes the role of micro-organisms in improving soil quality
- appreciates the decomposition role in micro-organisms

### **Suggested Teaching Learning Process**

- Inoculate a soil sample which was selected randomly into NA or PDA and use it as the initial step to explain that soil provides a very suitable medium for growth of micro-organisms
- Discuss that the chemical and physical environment of soil provides a natural medium for micro-organisms
- Use the charts of Nitrogen cycle, Carbon cycle and mineralization to represent the cyclic processes
- Guide students to gather information on role of soil micro-organisms for a presentation.

### **Assessment and Evaluation**

- Assess the students' presentations using the following criteria.
  - Accuracy of information
  - Relevance
  - Appropriate examples

**Competency 9.4.0 : Utilizes the microbiological concepts and principles to maintain the quality of water and for solid waste management**

**Competency Level 9.4.1 : Uses the microbiological concepts and principles in potable water supply and waste water management**

**Number of Periods : 06**

**Learning Outcomes :**

- describes the possible contamination routes of drinking water
- states the importance of coliforms as an indicator of fecal contamination
- lists the diseases transmitted through water
- states the steps in water treatment in an urban water treatment plant
- explains the effects of discharging waste water into natural water resources
- appreciates the importance of waste water treatment methods to avoid water pollution and their impact

### **Suggested Teaching Learning Process**

- Introduce the microbiological concepts and principles to maintain the quality of water.
- Lead a discussion on the possible ways of contamination of drinking water.
- Conduct a brainstorming session on water borne diseases.
- Introduce the importance of coliforms as an indicator of fecal contamination and its characteristic features.
- With the help of a chart which represents the process of water treatment plant and explain the steps followed.
- Assign students to draw a flow chart for the water treatment process
- Assign students to construct a definition for waste water.
- Conduct a discussion on the effects of discharging waste water into natural water bodies.
- Assign them to list down the impact of water pollution which happens by waste water discharge.
- Make them understand the importance of waste water management
- With the help of pictures/ videos/ diagrams or by a field visit to a waste water treatment plant, explain the main steps along with the underlying principles.
- Assign students to prepare a flow chart regarding main steps of industrial waste water treatment.

### **Assessment and Evaluation**

- Assess one of the flow charts using following criteria.
  - Accuracy of information
  - Correct interrelationships

## **Competency Level 9.4.2 Explores the environmental and sanitary importance of recycling of solid wastes**

**Number of Periods : 02**

### **Learning Outcomes:**

- describes the nature of solid waste
- describes the environmental and hygienic importance of recycling solid waste
- describes the techniques used in managing solid waste
- appreciates the value of solid waste management

### **Suggested Teaching Learning Process**

- Guide students to construct a definition on solid wastes.
- Guide students to collect information on different disastrous situations which happened recently in our country and ask them to prepare a report on it.
- Conduct a discussion on the remedial measures of solid waste management.
- Make them understand the value of solid waste management
- Introduce the following.
  - Recycling and solid waste management
  - Environmental and hygienic importance of this method
  - Techniques used in solid waste management

### **Assessment and Evaluation**

- Assess students' report using following criteria.
  - Accuracy of information
  - Relevance
  - On time submission
  - New suggestions

**Competency 9.5.0 : Explores the impact of microbes on food deterioration**

**Competency Level 9.5.1 : Contributes to the prevention of diseases that are caused by spoiled food**

**Number of Periods : 06**

**Learning Outcomes:**

- states why food is easily spoiled by microorganisms
- describes the physical and chemical changes in food spoilage by the action of microorganisms
- explains the effect of external and internal factors effecting food spoilage
- states food borne pathogens of humans
- describes the effects of food spoilage on human health
- appreciates the influence of microorganisms in food security

**Suggested Teaching learning Process**

- Ask students to bring different types of food and leave them to get spoiled.
- Instruct students to observe those spoiled foods and conduct a discussion on the food spoilage and its reasons.
- Conduct a discussion on the physical, chemical and biological changes in food due to spoilage of food based on their experience.
- Assist students to identify the effect of external and internal factors on food spoilage.
- Guide students to fill the following table.

Types of food	Causative microbes	Changes found in the spoiled condition		
		Physical	Chemical	Biological
Rice/bread (any carbohydrate food)				
Meat				
Butter				
Fruits				
Milk				
Vegetables				

### Assessment and Evaluation

- Assess the above table using the relevant criteria.

**Competency 10.1.0 : Uses biological concepts and principles to promote the living standards**

**Competency Level 10.1.1 : Investigates ornamental fish culture systems**

**Number of Periods : 05**

**Learning Outcomes:**

- identifies the importance of aquaculture
- states general characteristics of species that could be cultured
- lists the species that are used in ornamental fish culture
- explains how to maintain an aquarium
- lists common diseases found among ornamental fish
- describes environmental impact of ornamental fish culture
- appreciates the diversity of ornamental fish and develop an interest in preparing an aquarium

**Suggested Teaching Learning Process**

- Conduct discussion on the importance of aquaculture.
- Assist students to list down the general characteristics of species that could be cultured.
- List general characters and gather the pictures of species that are used in ornamental fish culture.
- Guide students' to conduct a speech on the following topics
  - Maintain an aquarium
  - Diseases which are commonly found in aquarium.
  - Diversity of ornamental fish and benefits obtained from an aquarium
  - Environmental impacts of ornamental fish culture

**Assessment and Evaluation**

- Assess students speeches using following criteria.
  - Accuracy of subject matter
  - Presentation skills
  - Time management
  - New concepts



## **Competency Level 10.1.2 Investigates into opportunities related to horticultural practices**

**Number of Periods : 05**

### **Learning outcomes:**

- explains and discusses issues in nursery management
- describes methods and rationale of protected agriculture
- states examples for plants grown in green house and poly tunnels in Sri Lanka
- explains principles of tissue culture and its importance
- explains grafting and propagation methods used in floriculture
- states the floricultural practices found in Sri Lanka with examples
- appreciates the importance of horticultural practices in agriculture

### **Suggested Teaching Learning Process**

- Introduce the horticultural practices.
- Guide students to construct a definition for nursery management.
- Conduct a discussion on the issues in nursery management.
- Discuss the concept of protected agriculture.
- Guide students' groups to prepare presentations on the following.
  - Protected agriculture
  - Tissue culture
  - Floriculture in relation to examples which are grown in Sri Lankan context
- Describe methods and rationale of protected agriculture.
- Arrange a field visit to an agriculture research station on a botanical garden which practice above

### **Assessment and Evaluation**

- Assess students' presentation using following criteria.
  - Accuracy of subject matter
  - Relevance of subject matter
  - Completion of the work

**Competency Level 10.1.3 :Uses biological knowledge for understanding and minimizing damage caused by vector -borne diseases**

**Number of Periods : 05**

**Learning outcomes:**

- describes the methods of transmission of filaria and dengue
- states the symptoms of infection
- describes the controlling measures of vectors and discusses the issues
- appreciates the importance of keeping the environment clean to prevent vector borne infections

**Suggested Teaching Learning Process**

- Introduce vector borne disease.
- Assign students to gather articles/ leaflets/ posters on dengue and filaria published by medical centres .
- Guide students to complete the following table with the help of collected materials.

	<b>Dengue</b>	<b>Filaria</b>
<b>Name of the vector</b>		
<b>General characteristics of the vector</b>		
<b>Causal agent</b>		
<b>Breeding sites</b>		
<b>General symptoms of the disease</b>		
<b>How to control</b>		

- Conduct a discussion on the above table.

**Assessment and Evaluation**

- Assess the students table using relevant criteria.

**Competency Level 10.1.4 :Utilizes the knowledge on food preservation and postharvest losses for successful applications in day to day life**

**Number of Periods : 05**

**Learning outcomes:**

- explains the importance of food preservation
- state the basis of three principles of food preservation
- states various types of food preservative methods and examples - drying, salting, salting and drying , addition of sugar, pasteurization, smoking, addition of chemicals, radiation and temperature, preservation
- states causes for postharvest loss
- describes how post harvest loss could be minimized at harvesting, transporting , storing and domestic processing
- appreciates the importance of food preservation methods

**Suggested Teaching Learning Process:**

- Lead a discussion on need and importance of food preservation .
- Discuss the principles underlying food preservation.
- Ask students to bring different types of food, packaging and labels of foods to the classroom.
- Assign students to fill the following table with the aid of materials brought.

Types of food preservation	Principles underlying the method	Examples

- Guide students to list down causes for postharvest loss.
- Guide students to find out places where postharvest loss happens.
- Conduct a discussion on how to minimize postharvest losses during transporting, storing and domestic processing.

**Assessment and Evaluation**

- Assess the completed students' table using relevant criteria.

## **Competency Level 10.1.5 Gets updated in applications of emerging technologies related to biology**

**Number of Periods : 05**

### **Learning outcomes:**

- states what nano technology is
- states the applications of nanotechnology in biology
- states what stem cells are and list their sources
- states the applications of stem cells in the field of medicine and discusses the issues associated with it
- elaborates the outcomes and applications of human genome project
- appreciates the significance of stem cell therapy in many untreatable human disorders

### **Suggested Teaching Learning Process**

- Ask students to find out the advancement of technology and focus on application of modern technology in biology.
- Introduce nano technology and guide them to find about the applications of nano technology in biology.
- Give a brief introduction on stem cell therapy.
- Guide student groups to find out applications of stem cell therapy, issues associated with it and ask them to conduct a presentation on that.
- Discuss human genome project and genomes of other organisms.

### **Assessment and Evaluation**

- Assess students presentations using following criteria.
  - Accuracy of information
  - Relevance of information
  - Presentation skills