# Combined Science Curriculum (Biology Part) (Secondary 4-6)

## Supplementary Document

Jointly prepared by the Curriculum Development Council and the Hong Kong Examinations and Assessment Authority

Recommended to be used with the Combined Science Curriculum and Assessment Guide (Secondary 4-6)

Science Education Section, Education Bureau

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## Introduction

The purpose of the revision is to provide space for enhancing the effectiveness of learning and teaching of the Biology Part of Combined Science. This document is the result of a number of discussion sessions of the following committees.

- Working Group on the Review of Biology (S4-6) and Combined Science (Biology part) (S4-6) Curricula
- CDC-HKEAA Committee on Biology (Senior Secondary)

It is applicable for the Combined Science (Biology Part) Hong Kong Diploma of Secondary Education (HKDSE) Examination in year 2016 and onwards. The explanatory notes in this document are by no means exhaustive nor intended to dictate the scope of learning and teaching at the classrooms. It is recommended to be used together with the *Combined Science Curriculum and Assessment Guide (Secondary 4-6)* jointly prepared by the Curriculum Development Council and the Hong Kong Examinations and Assessment Authority.

## General Notes

In each topic, there is a table with the following parts:

(1) Students should learn

This part lists the intentions of learning in the content domain of the curriculum. It outlines the major content areas of each topic and also indicates the knowledge and concepts that students should learn. This provides a basic framework upon which the learning and teaching activities can be developed.

(2) Student should be able to

This part lists a range of learning outcomes to be achieved by students, with different levels of ability in the content domain of the curriculum. Whenever learning outcomes which draw on higher cognitive ability (e.g. evaluate, relate) are applicable, other learning outcomes drawing on lower cognitive ability (e.g. state, describe) are not listed. Students are expected to demonstrate the whole range of cognitive abilities and use these learning outcomes as the basis for self-evaluation. Teachers can also use these learning outcomes to set assessment tasks for monitoring the progress of learning.

(3) Suggested Learning and Teaching Activities

This part suggests activities that can be provided for students to enable them to achieve the learning outcomes. The list includes a wide range of activities, such as discussion, debate, practical work, investigations, information searching and projects. It should be seen as a guide for teachers rather than as an exhaustive or mandatory list. Teachers should exercise their professional judgment in selecting activities to meet the interests and abilities of their students. Where possible, the activities should be framed in the context of students' own experience, to enable them to make connections with scientific knowledge, society and the environment around them. Students will then be well equipped to apply scientific concepts, theories, processes, and values to situations in which they have to investigate and solve everyday problems.

(4) Curriculum Emphases

This part comprises Scientific Inquiry, Science–Technology–Society–Environment Connections, and the Nature and History of Biology. It outlines the generic skills, scientific process skills, values and attitudes that are highlighted in the topic. It also helps enhance students' understanding of the nature of scientific inquiry in biology, the interconnections between science, technology, society and the environment, and biology as a dynamic body of knowledge.

(5) Footnotes

This part is to clarify the learning and assessment focuses of certain curriculum contents.

# I. Cells and Molecules of Life

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
|---|---|---|---|
| **a. Molecules of life**<br>Water and inorganic ions (e.g. nitrogen, magnesium, calcium and iron)<br><br>Biomolecules[1]: carbohydrates, lipids, proteins and nucleic acids<br>• Building blocks<br>• Functions | • Relate the significance of water, inorganic ions and biomolecules to life. | • Discuss whether life can exist without water, and the possible benefits of drinking mineral water or isotonic drinks.<br>• Perform common biochemical tests (e.g. Benedict's test, iodine test, grease spot test, and different types of test papers) to identify the presence of biomolecules in living tissues. | ① Ask relevant questions, identify problems and formulate hypotheses for investigations related to cells and molecules of life.<br>① Use appropriate instruments and proper techniques for carrying out practical work (e.g. food tests).<br>② Be aware of the applications of biological knowledge of molecules of life in society.<br>② Appreciate the role of science and technology in understanding the molecular basis of life. |
| **b. Cellular organisation**<br>Discovery of cells | • Appreciate the contribution of the technological development of the microscope to the discovery of cells. | • Read articles about the discovery of cells.<br>• Conduct a project to explore the contribution of the development of the microscope to the understanding of cells. | ② Recognise that the development of microscopic technology, computing technology and image analysing technology may lead to the advancement of biological knowledge.<br><br>② Recognise the contributions of various people (e.g. Robert Hooke and Theodor Schwann) to developments in biology. |

[1] The following contents are not the learning and assessment focus: optical isomers, linear form of sugar molecules, structural differences of starch, glycogen and cellulose.

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| Cell membrane<br>• Properties and functions | • Use the fluid mosaic model to explain the properties and functions of cell membrane.<br>• Appreciate the uses and limitations of scientific models. | • Construct a model to represent the structure of cell membrane (e.g. using tank and ping-pong balls). | ① Plan and conduct scientific investigations in the area of cellular structures and functions.<br>① Use appropriate instruments and proper techniques for carrying out practical work (e.g. preparation of temporary mounts and microscopic examination). |
| Sub-cellular structures and their functions<br>• Nucleus and chromosomes, endoplasmic reticulum, mitochondrion, chloroplast, cell wall and vacuole | • Prepare temporary mounts of specimens for examination, and make observations and drawings under a light microscope.<br>• Identify cell organelles as seen under light and electron microscopes.<br>• Compare the cellular organisation of animal and plant cells. | • Prepare temporary mounts of animal and plant tissues for examination under a light microscope.<br>• Discuss the variations of the number of mitochondria in different tissues and cell types. | ① Make careful observations and accurate records (e.g. examine prepared slides or temporary mounts of tissues and make biological drawings).<br>② Be aware of the applications of biological knowledge of cells in society. |
| Prokaryotic cells (e.g. bacterial cells) and eukaryotic cells | • Compare the sub-cellular organisation of prokaryotic and eukaryotic cells. | • Examine electron micrographs or live cell images of prokaryotic, eukaryotic cells and sub-cellular structures. | ③ Be aware of the dynamic nature of biological knowledge (e.g. the understanding of cell membrane and sub-cellular organelles).<br>③ Be aware that biological knowledge and theories are developed through observations, hypotheses, experimentations and analyses (e.g. fluid mosaic model of cell membrane structure). |

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| **c. Movement of substances across membrane**<br>Diffusion[2], osmosis and active transport[3]<br><br><br><br><br><br>Occurrence of phagocytosis in cells | • Account for the movement of substances across membrane using the concepts of diffusion, osmosis and active transport.<br>• Apply the concept of osmosis to explain plasmolysis and haemolysis. | • Perform practical work to study osmosis at cellular, tissue or organ levels.<br>• Examine live cell images of the processes involved in the movement of substances across membrane. | ① Make careful observations and accurate records (e.g. examine prepared slides or temporary mounts of tissues and make biological drawings).<br>① Identify and explain the importance of control variables in scientific investigations (e.g. the study of osmosis). |
| **d. Cell cycle and division**<br>Stages of cell cycle[4]<br>• Cell growth, nuclear division and cytoplasmic division<br><br><br>Nuclear division<br>• Mitosis<br>• Meiosis[5] | • Recognise the various stages of cell cycle.<br>• Understand the importance of cell division in growth and reproduction.<br><br>• Outline and compare the processes of mitosis and meiosis. | • Observe and identify the different stages of mitosis and meiosis, using prepared slides, photomicrographs or live cell images. | ① Make careful observations and accurate records (e.g. examine prepared slides and make biological drawings).<br>② Recognise that the development of microscopic technology and imaging technology may lead to the advancement of biological knowledge. |

[2] The learning and assessment focus is confined to simple diffusion.
[3] Detailed mechanism of active transport is not the learning and assessment focus.
[4] Details of cell cycle are not the learning and assessment focus.
[5] Crossing over is a feature of meiosis.

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
|---|---|---|---|
| **e. Cellular energetics**<br>Metabolism: catabolism and anabolism<br>• Occurrence of catabolic and anabolic processes in cells | • Distinguish between catabolic and anabolic processes. | | |
| Enzymes and enzymatic reactions<br>• Properties and roles of enzyme<br>• Active site and specificity<br>• Factors (temperature, pH and inhibitors) affecting the rate of enzymatic reactions[6]<br>• Application of enzyme in everyday life | • Recognise the properties of enzyme and its roles in metabolism.<br>• Explain enzyme specificity in terms of active site.<br>• Explain the effects of factors on the rate of enzymatic reactions. | • Perform practical work to demonstrate the breaking down or building up action of enzymes.<br>• Design and perform investigations to study the effects of temperature, pH or inhibitors on the activities of enzymes, and to find out some commercial applications of enzymes (e.g. bioactive washing powder, meat tenderiser). | ① Identify and explain the importance of control variables in scientific investigations (e.g. the study of enzymatic activities).<br>② Be aware of the applications of biological knowledge of enzymes in society. |

[6] Modes and mechanism of enzyme inhibition are not the learning and assessment focus.

## II. Genetics and Evolution

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
|---|---|---|---|
| **a. Basic genetics**<br>Mendel's laws of inheritance<br><br><br><br><br>Inheritance in humans[1]<br>• Multiple alleles: ABO blood groups<br>• Sex linkage<br>• Sex determination | • Understand the law of segregation and law of independent assortment.<br>• Apply Mendel's laws of inheritance to solve genetic problems[2].<br><br>• Understand the inheritance of ABO blood groups and sex-linked traits.<br>• Recognise the role of sex chromosomes in sex determination of humans. | • Read articles about how Gregor Mendel contributed to the study of genetics.<br>• Use computer simulations and other materials (e.g. genetic corn) to study patterns of inheritance. | ① Make careful observations and accurate records.<br>① Use diagrams and physical models as visual representations of phenomena and relationships arising from the data (e.g. genetic diagrams).<br><br>② Be aware of the application of knowledge of basic genetics in society and its social, ethical and economic implications.<br><br>③ Recognise the contributions of various people (e.g. Gregor Mendel) to the understanding of genetics and evolution.<br>③ Be aware that biological knowledge and theories are developed through observations, hypotheses, experimentations and analyses (e.g. Mendel's work). |

[1] Codominance, incomplete dominance and linkage are not the learning and assessment focus.
[2] The learning and assessment focus is confined to solving genetic problems involving monohybrid cross.

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| Pedigree analysis | • Analyse pedigree to study the inheritance of characteristics. | • Construct and/or analyse a pedigree of the inheritance of some human traits (e.g. haemophilia, tongue rolling and ear lobes). | ① Classify, collate and display both first and second hand data (e.g. construct a pedigree of the inheritance of some human traits). |
| Variations in characteristics<br>• Continuous variation<br>• Discontinuous variation | | • Observe and analyse variations in humans (e.g. height and tongue rolling). | ① Make careful observations and accurate records (e.g. observe variations in humans). |
| • Causes of variation<br>– hereditary information<br>– environmental factors<br>– mutation | • Explain the causes of different types of variations in characteristics. | | |
| **b. Molecular genetics**<br>Chromosomes, genes and nucleic acids | • Describe the structural and functional relationships of chromosomes, genes and nucleic acids. | • Construct models of DNA and RNA.<br>• Read about the work of some biologists (e.g. James Watson and Francis Crick) in the discovery of DNA. | ① Use diagrams and physical models as visual representations of phenomena and relationships arising from the data (e.g. DNA model).<br>② Be aware of the application of knowledge of molecular genetics in society and its social, ethical and economic implications. |

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| | | | ③ Be aware of the dynamic nature of biological knowledge (e.g. from basic genetics to molecular genetics).<br>③ Recognise the contributions of various people (e.g. James Watson, and Francis Crick) to the understanding of genetics. |
| Biotechnology<br>• Recombinant DNA technology[3]<br>• DNA fingerprinting[4]<br>• Human Genome Project (HGP) and its implications | • Recognise the applications of recombinant DNA technology and DNA fingerprinting.<br>• Recognise the contributions and limitations of the data obtained from the HGP.<br>• Appreciate the joint efforts of scientists in international genomics projects. | • Use audiovisual materials to illustrate the processes of recombinant DNA technology and DNA fingerprinting.<br>• Perform practical work to extract DNA from living tissues (e.g. onion tissues), and to separate DNA fragments by gel-electrophoresis.<br>• Search for information on the use of DNA fingerprinting in forensic science.<br>• Make a chart or create a timeline of the discoveries that have arisen from the HGP. | ① Use appropriate instruments and proper techniques for carrying out practical work on molecular genetics (e.g. DNA extraction and gel-electrophoresis).<br>② Be aware that societal needs have led to technological advances (e.g. recombinant DNA technology and DNA fingerprinting).<br>② Appreciate the contribution of the Human Genome Project (HGP) and the application of biotechnology to humans and society.<br>② Explain how the knowledge of biotechnology may lead to the |

[3] Detailed mechanism of recombinant DNA technology is not the learning and assessment focus. Recombinant DNA technology involves restriction and ligation.
[4] Detailed mechanism of DNA fingerprinting is not the learning and assessment focus.

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| | | | development of new technologies and how new technologies may lead to further understanding of inheritance.<br><br>③ Appreciate the advancement of the study of genetics from traditional breeding experiments to molecular experimentation and analysis. |
| **c. Biodiversity and evolution**<br>Diversity of life forms<br><br>Classification of organisms<br>• Need for classification | • Appreciate the existence of various life forms in the world, and the different ways through which organisms adapt to their habitats.<br><br>• Be aware that modern classification is based on the phylogenetic relationships of organisms.<br>• Recognise the use of classification systems and binomial nomenclature.<br>• Construct and use dichotomous keys to identify unknown organisms. | • Visit a herbarium, country park or special area (e.g. Lions Nature Education Centre, and Tai Po Kau Nature Reserve).<br>• Use specimens, audiovisual materials, games, etc. to study the diversity of organisms, and their ways of life.<br>• Classify organisms into major categories according to a classification system. | ① Make careful observations and accurate records (e.g. observe distinguishing features for identifying organisms).<br><br>② Appreciate the role of science and technology in understanding the complexity of life forms and their genetics. |

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| • Classification approaches proposed by Carl Woese<br>– Six kingdoms (Eubacteria, Archaebacteria, Protista, Fungi, Plantae and Animalia)<br>– Three domains (Bacteria, Archaea and Eukarya) | • Classify organisms into six kingdoms.<br>• Appreciate that classification systems are subject to change when new evidence appears. | • Search for information on other classification systems, and binomial naming of some organisms.<br>• Construct and use dichotomous keys to identify organisms from a local habitat.<br>• Read about the work of Carl Linnaeus and his system of naming organisms.<br>• Discuss the advantages and limitations of different classification systems, and why the classification of some organisms has been changed over time. | ③ Be aware of the dynamic nature of biological knowledge (e.g. the development of classification systems). |
| Origins of life | • Appreciate that there are various explanations for the origins of life. | • Read article about the Miller-Urey experiment. | ① Formulate and revise scientific explanations and models using logic and evidence (e.g. use of fossil records as evidence for evolution).<br>② Understand how science has been influenced by societies (e.g. various views on the origins of life and evolution). |

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| Evolution<br>• Origin of species<br>• Evidence of evolution (e.g. fossil record) | • Be aware of the limitations of using fossil record as evidence of evolution, and the presence of other evidence. | • Read about the different explanations for the origins of life, and the work of some biologists (e.g. Jean Baptiste Lamarck, Charles Darwin and Sir Alfred Russel Wallace) on evolution. | ③ Recognise the contributions of various people (e.g. Charles Darwin, Sir Alfred Russel Wallace and Jean Baptiste Lamarck) to the understanding of evolution. |

## III. Organisms and Environment

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
|---|---|---|---|
| **a. Essential life processes in plants**<br>Nutrition in plants<br>• Plants as autotrophs<br>• Photosynthesis*<br>• Need for minerals[1]<br>• Absorption of water and minerals<br>Gas exchange in plants<br>• Occurrence of gas exchange in different parts of plant<br>• Gas exchange in leaves | • Appreciate the significance of plants as autotrophs.<br>• Explain the need for minerals in plants.<br>• Relate the structure of roots to their functions in water absorption.<br>• Relate the features of leaves to gas exchange and prevention of water loss.<br>• Explain the effects of light intensity on gas exchange in plants. | • Design and perform investigations to study the effects of different minerals on plant growth using potted plants.<br>• Examine the structure of the root of young seedlings using live specimens or prepared slides.<br>• Design and perform investigations to study the effects of light intensity on gas exchange in land or water plants using hydrogencarbonate indicator solution or data loggers. | ① Make careful observations and accurate records (e.g. examine prepared slides or temporary mounts of roots, stems and leaves, and make biological drawings).<br>① Ask relevant questions, identify problems and formulate hypotheses for investigations related to life processes.<br>① Plan, conduct and write reports on scientific investigations in areas of life processes.<br>① Identify and explain the importance of control variables in scientific investigations (e.g. the study of the effects of different minerals on plant growth).<br>① Use appropriate instruments and proper techniques for carrying out practical work (e.g. preparation of temporary mounts and microscopic examinations). |

* Refer to *Photosynthesis* in topic I Cells and Molecules of Life.
[1] Using nitrogen, phosphorus and magnesium as examples.

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| Transpiration<br>• Process[2] and significance<br>• Factors (humidity, light intensity and wind) affecting the rate of transpiration<br><br>Transport of substances in plants<br>• Transport of water[3] and minerals<br>• Translocation of organic nutrients[4]<br><br>Support in plants<br>• Cell turgidity<br>• Physical nature of xylem | • Make connections between transpiration, absorption and transport of water, and cooling of plants.<br>• Explain the effects of environmental factors on the rate of transpiration.<br>• Describe the path of materials transport in flowering plants.<br>• Compare the means of support in herbaceous and woody dicotyledonous plants. | • Design and perform investigation to compare the distribution of stomata on both sides of a leaf.<br>• Perform practical work to demonstrate the occurrence of transpiration, and to trace the uptake of water in herbaceous plant using eosin solution.<br>• Design and perform investigations to study the effects of environmental factors on the rate of transpiration using potometer.<br>• Examine the cross sections of the leaf, stem and root of a young dicotyledonous plant using temporary mounts or prepared slides. | ② Analyse ways in which scientific and technological advancement (e.g. computing technology and image analysing technology) have enhanced our understanding of complex life processes.<br>③ Understand that science is a human endeavour through the study of essential life processes of plants and interactions with our environment.<br>③ Be aware that biological knowledge and theories are developed through observations, hypotheses, experimentations and analyses (e.g. the study of transpiration pull).<br>③ Recognise the complexity of the physiological processes of plants.<br>③ Understand the nature and limitations of scientific activity (e.g. investigations on various physiological processes). |

[2] The explanation of transpiration pull should be linked with the sub-topic *Movement of substances across membrane*. Cohesion-tension theory is not the learning and assessment focus.
[3] Cohesion-tension theory is not the learning and assessment focus.
[4] Mass flow hypothesis of phloem transport is not the learning and assessment focus.

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| **b. Essential life processes in animals**<br>Nutrition in humans<br>• Humans as heterotrophs<br>• Food requirements and functions of different food substances<br>– Carbohydrates<br>– Lipids<br>– Proteins<br>– Vitamins<br>– Minerals (e.g. calcium and iron)<br>– Dietary fibre<br>• Balanced diet<br>• Ingestion<br>– Dentition<br>– Mastication<br>• Digestion<br>– General plan of the digestive system<br>– Digestion of carbohydrates, proteins and lipids in various parts of the alimentary canal<br>• Absorption and assimilation<br>– Structural adaptation of small intestine for food absorption<br>– Role of liver<br>– Fate of absorbed food | • Explain the effect of age, activity and pregnancy on dietary requirements.<br>• Relate health problems to improper diet.<br>• Explain the significance of mechanical and chemical digestion.<br>• Understand the digestion and absorption processes in various parts of the alimentary canal.<br>• Illustrate the adaptive features of the small intestine for food absorption.<br>• Describe the routes of the transport of absorbed food and their fates in cells and tissues. | • Perform practical work to identify composition in some common foodstuffs.<br>• Design and perform investigation to compare the amount of vitamin C in different fruits and vegetables.<br>• Examine the alimentary canal and its associated glands of a dissected mammal or a human torso.<br>• Perform practical work to demonstrate the effect of bile salt on oil.<br>• Design and perform investigations to study the action of digestive enzymes (e.g. amylase on starch-agar plate, protease on milk-agar plate or egg white). | ① Ask relevant questions, identify problems and formulate hypotheses for investigations related to life processes.<br>① Plan, conduct and write reports on scientific investigations in areas of life processes.<br>① Identify and explain the importance of control variables in scientific investigations (e.g. the study of the action of digestive enzymes).<br>① Use appropriate instruments and proper techniques for carrying out practical work (e.g. food tests and dissection).<br>② Evaluate the impact of the application of biology to human activities (e.g. dietary requirement).<br>② Be aware of the application of biological knowledge (e.g. balanced diet) in society.<br>③ Understand that science is a human endeavour through the study of essential life processes of animals and interactions with our environment.<br>③ Recognise the complexity of the physiological processes of animals. |

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| • Egestion | | • Perform practical work to simulate digestion and absorption in the alimentary canal using dialysis tubing. | ③ Understand the nature and limitations of scientific activity (e.g. investigations on various physiological processes). |
| Gas exchange in humans | | | |
| • General plan of the breathing system | • Relate the structure of various parts of the breathing system to gas exchange. | • Examine the breathing system of a dissected mammal or a human torso.<br>• Examine a pig's lungs. | ① Make careful observations and accurate records (e.g. examine prepared slides and make biological drawings).<br>① Use appropriate instruments and proper techniques for carrying out practical work (e.g. microscopic examinations and dissections). |
| • Gas exchange in air sacs<br>• Routes of transport of respiratory gases | • Understand the exchange of respiratory gases between the body cells and the external environment. | • Examine the structure of air sacs, using prepared slide or photomicrograph. | |
| • Mechanism of ventilation | | • Perform practical work to compare the differences in composition between inhaled and exhaled air. | |
| Transport of substances in humans | | | |
| • General plan of the circulatory system and lymphatic system<br>• Composition and functions of blood, tissue fluid and lymph | • Relate the structure of various components of the circulatory system and lymphatic system to transport. | • Perform dissection of a pig's heart and examine its structures.<br>• Examine the capillary flow in a fish's tail fin or frog's web. | ① Make careful observations and accurate records (e.g. examine prepared slides and make biological drawings).<br>① Use appropriate instruments and proper techniques for carrying out practical work (e.g. microscopic examinations and dissections). |
| • Exchange of materials between blood and body cells<br>• Formation of tissue fluid | • Describe the exchange of materials and the formation of tissue fluid. | • Examine the structure of arteries and veins, and the components of blood using prepared slides or photomicrographs. | |

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| **c. Reproduction, growth and development**<br>Reproduction in humans | | | ① Make careful observations and accurate records (e.g. examine photomicrographs and make biological drawings). |
| • General plan of the male and female reproductive systems | • Relate the structure of various parts of the reproductive systems to their functions. | • Examine the male and female reproductive systems of dissected mammals or a human torso. | |
| • Structure of sperm and ovum | • Recognise the roles of sperm and ovum in sexual reproduction. | • Examine photomicrographs, video clips or live cell images of sperms and ova. | ② Evaluate the impact of the application of biology to human activities (e.g. birth control). |
| • Menstrual cycle[5]<br>– Cyclic changes in uterine lining<br>– Ovulation | | | ② Analyse ways in which scientific and technological advancement (e.g. computing technology and image analysing technology) have enhanced our understanding of complex life processes. |
| • Fertilisation | • Describe the transfer of semen during sexual intercourse and the process of fertilisation. | • Use audiovisual materials to study the process of fertilisation. | |
| • Development of embryo and foetus<br>– Placenta<br>– Identical twins and fraternal twins | • Relate the structure of the placenta to its role in the development of foetus. | • Examine photos or video clips taken by ultrasound showing different stages of foetal development.<br>• Discuss the harmful effects of drinking and smoking habits of a pregnant woman on the development of the foetus. | ② Be aware of the application of biological knowledge (e.g. birth control) in society and its social, ethical, economic and environmental implications. |
| • Birth process | | | |
| • Parental care | • Recognise the significance of parental care and the advantages of breast-feeding. | | |

[5] Hormonal control of menstrual cycle is not the learning and assessment focus.

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| • Birth control | • Understand the biological basis of various methods of birth control. | • Search for information on the effectiveness and possible side effects of various birth control methods, *in vitro* fertilisation and termination of pregnancy. | |
| **d. Coordination and response**<br>Stimuli, receptors and responses<br>• Light as stimulus: the human eye<br>– Major parts of the eye<br>– Rod cells and cone cells<br>– Colour vision<br>– Eye accommodation<br>– Eye defects (long sight, short sight and colour blindness) | • Understand the roles of sense organs and receptors in detecting changes in the environment.<br>• Relate the structure of major parts of the eye to vision.<br>• Explain the causes of eye defects.<br>• Describe how long sight and short sight are corrected with glasses.<br>• Be aware of the surgical methods for eyesight correction. | • Examine model of the human eye.<br>• Perform dissection of an ox's eye and examine its structures.<br>• Search for information on how modern technology helps in rectifying eye defects (e.g. short/long sight, astigmatism, cataract or glaucoma). | ① Use appropriate instruments and proper techniques for carrying out practical work (e.g. dissections).<br>① Ask relevant questions, identify problems and formulate hypotheses for investigations related to life processes.<br>① Plan, conduct and write reports on scientific investigations in areas of life processes.<br>① Identify and explain the importance of control variables in scientific investigations. |
| • Light as stimulus: phototropic response in plants<br>– Responses of root and shoot<br>– Role of auxins | • Recognise the significance of phototropism.<br>• Understand the mechanism of phototropic responses in root and shoot. | • Design and perform investigations on the phototropic responses of roots and shoots. | ③ Be aware that biological knowledge and theories are developed through observations, hypotheses, experimentations and analyses (e.g. the study of tropism). |

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
|---|---|---|---|
| • Sound as stimulus: the human ear[6]<br>– Major parts of the ear | • Relate the structure of major parts of the ear to hearing. | • Examine model of the human ear. | |
| Nervous coordination in humans | | | |
| • General plan of the nervous system | | | ② Analyse ways in which scientific and technological advancement (e.g. computing technology and image analysing technology) have enhanced our understanding of complex life processes. |
| • Central nervous system<br>– Functions of main parts of the brain: cerebrum, cerebellum and medulla oblongata<br>– Functions of spinal cord | • Recognise the role of the central nervous system. | • Examine model of the human brain. | |
| – Neurone: sensory neurone, interneurone and motor neurone | • Distinguish different types of neurones in terms of structure and function. | | ③ Recognise the complexity of the physiological processes in humans. |
| – Synapse[7] | • Describe the transmission of nerve impulses across a synapse. | | ③ Understand the nature and limitations of scientific activity (e.g. investigations on various physiological processes). |
| • Reflex arc and reflex action<br>• Voluntary actions | • Compare the nature of reflexes and voluntary actions with examples. | • Perform practical work of a reflex action (e.g. knee jerk reflex). | |
| Hormonal coordination in humans | | | ③ Recognise the complexity of the physiological processes in humans. |
| • Nature of hormonal coordination<br>• General plan of the endocrine system | • Understand the nature of hormonal coordination.<br>• Use an example to illustrate hormone mediated response.<br>• Compare hormonal and nervous coordination. | | |

[6] Mechanism of hearing is not the learning and assessment focus.
[7] Specific names of neurotransmitters are not the learning and assessment focus.

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| **e. Homeostasis**<br>Concept of homeostasis<br>• Importance of homeostasis<br>• Feedback mechanism[8]<br><br>Parameters of the internal environment<br>• Glucose level and gas content in blood, water content and body temperature<br><br>Regulation of blood glucose level<br>• Roles of liver, pancreas, insulin and glucagon | • Appreciate that the internal environment of the human body is maintained by the nervous system and the endocrine system.<br>• Explain the principle of feedback mechanism with reference to the regulation of blood glucose level. | • Construct a flow chart to illustrate the feedback mechanism.<br>• Search for information about the physiological consequences of hormonal imbalance (e.g. insulin) and the remedies, especially through modern advances in science and technology. | ③ Recognise the complexity of the physiological processes in humans. |
| **f. Ecosystems**<br>Levels of organisation<br>• Species, population, community, ecosystem, biome and biosphere<br>Major ecosystem types<br>• Freshwater stream, rocky shore, mangrove, grassland and woodland | • Be aware that organisms and their environment are studied at different levels of organisation.<br>• Appreciate the existence of a variety of ecosystems in the local environment. | • Visit nature reserves, country parks, marine parks, field study centres and other local habitats. | ③ Recognise the complexity of the environment. |

[8] The learning and assessment focus is confined to negative feedback mechanism.

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| Components of an ecosystem<br>• Abiotic factors<br>• Biotic community<br>– Niche and habitat<br>– Species diversity and dominant species | • Identify the abiotic factors of a habitat and explain their effects. | | ③ Understand that science is a human endeavour through the study of essential life processes of animals and interactions with our environment. |
| – Relationships between organisms<br>▪ Predation, competition, commensalism, mutualism and parasitism | • Describe the different types of relationships between organisms in a habitat. | • Use live or audiovisual materials to show the relationships of organisms in an ecosystem. | |
| – Ecological succession<br>▪ Primary and secondary succession<br>▪ Climax community | • Outline the process of ecological succession. | | |
| Functioning of an ecosystem<br>• Energy flow<br>– Source of energy<br>– Energy flow between different trophic levels | • Use food chains, food webs, pyramids of numbers and biomass to represent the feeding relationships of organisms and energy flow between different trophic levels. | • Construct and interpret food chains, food webs, and pyramids of numbers and biomass. | ① Use diagrams, graphs, flow charts and physical models as visual representations of phenomena and relationships arising from the data (e.g. use food chains, food webs, and |

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
|---|---|---|---|
| – Feeding relationships of organisms | • Understand the efficiency of energy transfer in an ecosystem. | | pyramid of numbers to represent relationships between organisms in ecosystems and distribution of organisms). |
| • Materials cycling<br>– Carbon cycle | • Understand the cycling of materials in an ecosystem. | | |
| • Roles of producers, consumers and decomposers in energy flow and materials cycling | • Be aware of the interactions between the biotic community and the abiotic factors of an ecosystem. | | |
| Conservation of ecosystem | | | |
| • Impacts of human activities | • Recognise the need for conservation. | | ② Evaluate the impact of the application of biology to human activities (e.g. pollution control).<br>② Develop sensitivity and responsibility in striking a balance between the needs of humans and a sustainable environment.<br>② Be aware of the application of biological knowledge (e.g. sewage treatment) in society and its social, ethical, economic and environmental implications |

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| Study of a local habitat<br>• Distribution and abundance of organisms<br>– Sampling methods<br>▪ Quadrats<br>▪ Line and belt transects<br>• Measurement of abiotic factors (e.g. light intensity, pH, wind, temperature, oxygen, humidity and salinity) | • Conduct and report an ecological study of a local habitat. | • Conduct an ecological study of a local habitat (e.g. freshwater stream and rocky shore). | ① Ask relevant questions, identify problems and formulate hypotheses for investigations related to ecosystems.<br>① Plan, conduct and write reports on scientific investigations of ecosystems.<br>① Select and design appropriate methods of investigations for specific purposes (e.g. use transects and quadrats to collect samples in field studies).<br>① Explain why sample size, random sampling, replicates and repeat procedures are important in scientific investigations (e.g. field studies).<br>① Use appropriate instruments and proper techniques for carrying out practical work (e.g. field study techniques).<br>③ Be aware that biological knowledge and theories are developed through observations, hypotheses, experimentations and analyses (e.g. field ecology).<br>③ Understand the nature and limitations of scientific activity (e.g. investigations on ecosystems). |

## IV. Health and Diseases

| Students should learn | Students should be able to | Suggested Learning and Teaching Activities | Curriculum Emphases<br>①Scientific Inquiry ②STSE Connections<br>③Nature and History of Biology |
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| **a. Personal health**<br>Meaning of health | • Recognise the meaning of health. | | ② Be aware of the application of biological knowledge in maintaining a healthy community and its social, ethical, economic and environmental implications. |
| **b. Diseases**<br>Types of diseases<br>• Infectious diseases<br>• Non-infectious diseases<br><br>Infectious diseases (e.g. Cholera, dengue fever, hepatitis B, influenza and tuberculosis)<br>• Causes<br>• Ways of transmission<br>– Water, air, droplets, food, body fluids, vector and direct contact | • Understand the concept of disease.<br><br>• Distinguish between infectious and non-infectious diseases.<br><br>• Understand how infectious diseases are transmitted. | • Conduct a project on infectious diseases (e.g. Cholera, dengue fever, hepatitis B, influenza and tuberculosis) with reference to their ways of transmission and symptoms.<br><br>• Examine photomicrographs, prepared slides or live cell images of some pathogens (e.g. viruses, bacteria, fungi and protists). | ① Make careful observations and accurate records (e.g. examine prepared slides or photomicrographs of pathogens and make biological drawings).<br>① Identify questions and carry out appropriate studies to understand various infectious diseases in our society.<br>① Classify, collate and display both first and second hand data (e.g. collect information related to health and diseases from the Centre for Health Protection or the Internet).<br><br>② Be aware of the application of biological knowledge in maintaining a healthy community and its social, |

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| | | • Search for information on the major outbreaks of infectious diseases in Hong Kong. | ethical, economic and environmental implications.<br>② Analyse ways in which societal needs have led to technological advances.<br>③ Be aware of the dynamic nature of biological knowledge related to diseases, and understand that science is a human endeavour.<br>③ Understand the nature and limitations of scientific activity (e.g. the causes and transmission of some diseases are not yet known). |