



MINISTRY OF EDUCATION MALAYSIA

Integrated Curriculum for Secondary Schools

Curriculum Specifications

BIOLOGY

Form 5



Curriculum Development Centre
Ministry of Education Malaysia
2006

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Ministry of Education Malaysia

First published 2006

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THE NATIONAL PHILOSOPHY

Our nation, Malaysia, is dedicated to achieving a greater unity of all her peoples; to maintaining a democratic way of life; to creating a just society in which the wealth of the nation shall be equitably shared; to ensuring a liberal approach to her rich and diverse cultural traditions; to building a progressive society which shall be oriented towards modern science and technology;

We, her peoples, pledge our united efforts to attain these ends guided by the following principles:

BELIEF IN GOD

LOYALTY TO KING AND COUNTRY

SUPREMACY OF THE CONSTITUTION

RULE OF LAW

GOOD BEHAVIOUR AND MORALITY

NATIONAL PHILOSOPHY OF EDUCATION

Education in Malaysia is an on-going effort towards further developing the potential of individuals in a holistic and integrated manner, so as to produce individuals who are intellectually, spiritually, emotionally and physically balanced and harmonious based on a firm belief in and devotion to God. Such an effort is designed to produce Malaysian citizens who are knowledgeable and competent, who possess high moral standards and who are responsible and capable of achieving a high level of personal well-being as well as being able to contribute to the betterment of the family, society and the nation at large.

NATIONAL SCIENCE EDUCATION PHILOSOPHY

In consonance with the National Education Philosophy, science education in Malaysia nurtures a Science and Technology Culture by focusing on the development of individuals who are competitive, dynamic, robust and resilient and able to master scientific knowledge and technological competency

PREFACE

The aspiration of the nation to become an industrialised society depends on science and technology. It is envisaged that success in providing quality science education to Malaysians from an early age will serve to spearhead the nation into becoming a knowledge society and a competitive player in the global arena. Towards this end, the Malaysian education system is giving greater emphasis to science and mathematics education.

The Biology curriculum has been designed not only to provide opportunities for students to acquire science knowledge and skills, develop thinking skills and thinking strategies, and to apply this knowledge and skills in everyday life, but also to inculcate in them noble values and the spirit of patriotism. It is hoped that the educational process en route to achieving these aims would produce well-balanced citizens capable of contributing to the harmony and prosperity of the nation and its people.

The Biology curriculum aims at producing active learners. To this end, students are given ample opportunities to engage in scientific investigations through hands-on activities and experimentations. The inquiry approach, incorporating thinking skills, thinking strategies and thoughtful learning, should be emphasised throughout the teaching-learning process. The content and contexts suggested are chosen based on their relevance and appeal to students so that their interest in the subject is enhanced.

In a recent development, the Government has made a decision to introduce English as the medium of instruction in the teaching and learning of science and mathematics. This measure will enable students to keep abreast of developments in science and technology in contemporary society by enhancing their capability and know-how to tap the diverse sources of information on science written in the English language. At the same time, this move would also provide opportunities for students to use the English language and hence, increase their proficiency in the language. Thus, in implementing the biology curriculum, attention is given to developing students' ability to use English for study and communication, especially in the early years of learning.

The development of this curriculum and the preparation of the corresponding Curriculum Specifications have been the work of many individuals over a period of time. To all those who have contributed in one way or another to this effort, may I, on behalf of the Ministry of Education, express my sincere gratitude and thanks for the time and labour expended.

(MAHZAN BIN BAKAR SMP, AMP)

Director

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INTRODUCTION

As articulated in the National Education Policy, education in Malaysia is an on-going effort towards developing the potential of individuals in a holistic and integrated manner to produce individuals who are intellectually, spiritually, emotionally and physically balanced and harmonious. The primary and secondary school science curriculum is developed with the aim of producing such individuals.

As a nation that is progressing towards a developed nation status, Malaysia needs to create a society that is scientifically oriented, progressive, knowledgeable, having a high capacity for change, forward-looking, innovative and a contributor to scientific and technological developments in the future. In line with this, there is a need to produce citizens who are creative, critical, inquisitive, open-minded and competent in science and technology.

The Malaysian science curriculum comprises three core science subjects and four elective science subjects. The core subjects are Science at primary school level, Science at lower secondary level and Science at upper secondary level. Elective science subjects are offered at the upper secondary level and consist of Biology, Chemistry, Physics, and Additional Science.

The core science subjects for the primary and lower secondary levels are designed to provide students with basic science knowledge, prepare students to be literate in science, and enable students to continue their science education at the upper secondary level. Core Science at the upper secondary level is designed to produce students who are literate in science, innovative, and able to apply scientific knowledge in decision making and problem solving in everyday life.

The elective science subjects prepare students who are more scientifically inclined to pursue the study of science at post-secondary level. This group of students would take up careers in the field of science and technology and play a leading role in this field for national development.

For every science subject, the curriculum for the year is articulated in two documents: the syllabus and the curriculum specifications. The syllabus presents the aims, objectives and the outline of the curriculum content for a period of 2 years for elective science subjects and 5 years for core science subjects. The curriculum specifications provides the details of the curriculum which includes the aims and objectives of the curriculum, brief descriptions on thinking skills and thinking strategies, scientific skills, scientific attitudes and noble values, teaching and learning strategies, and curriculum content. The curriculum content provides the themes, learning areas, learning objectives, suggested learning activities, the intended learning outcomes, notes and vocabulary.

AIMS

The aims of the biology curriculum for secondary school are to provide students with the knowledge and skills in science and technology and enable them to solve problems and make decisions in everyday life based on scientific attitudes and noble values.

Students who have followed the biology curriculum will have the foundation in biology to enable them to pursue formal and informal further education in science and technology.

The curriculum also aims to develop a concerned, dynamic and progressive society with a science and technology culture that values nature and works towards the preservation and conservation of the environment.

OBJECTIVES

The biology curriculum for secondary school enables students to:

1. Acquire knowledge in biology and technology in the context of natural phenomena and everyday life experiences.
2. Understand developments in the field of biology and technology.
3. Acquire scientific and thinking skills.
4. Apply knowledge and skills in a creative and critical manner to solve problems and make decisions on biology-related issues.
5. Apply knowledge of biology to improve one's health and well-being, and face challenges in the scientific and technological world and be willing to contribute towards the development of science and technology.
6. Evaluate science and technology-related information wisely and effectively.
7. Practise and internalise scientific attitudes and good moral values.
8. Realise the importance of inter-dependence among living things and the management of nature for survival of mankind.
9. Appreciate the contributions of science and technology towards national development and the well-being of mankind.

10. Realise that scientific discoveries are the result of human endeavour to the best of his or her intellectual and mental capabilities to understand natural phenomena for the betterment of mankind.

11. Be aware of the need to love and care for the environment and play an active role in its preservation and conservation.

SCIENTIFIC SKILLS

Science emphasises inquiry and problem solving. In inquiry and problem solving processes, scientific and thinking skills are utilised. Scientific skills are important in any scientific investigation such as conducting experiments and carrying out projects.

Scientific skills encompass science process skills and manipulative skills.

Science Process Skills

Science process skills enable students to formulate their questions and find out the answers systematically.

Descriptions of the science process skills are as follows:

Observing Using the sense of hearing, touch, smell, taste and sight to collect information about an object or a phenomenon.

Classifying Using observations to group objects or events according to similarities or differences.

Measuring and Using Making quantitative observations using numbers and tools with standardised units.

Numbers	Measuring makes observation more accurate.
Inferring	Using past experiences or previously collected data to draw conclusions and explain events.
Predicting	Stating the outcome of a future event based on prior knowledge gained through experiences or collected data.
Communicating	Using words or graphic symbols such as tables, graphs, figures or models to describe an action, object or event.
Using Space-Time Relationship	Describing changes in parameter with time. Examples of parameters are location, direction, shape, size, volume, weight and mass.
Interpreting Data	Giving rational explanations about an object, event or pattern derived from collected data.
Defining Operationally	Defining concepts by describing what must be done and what should be observed.
Controlling Variables	Identifying the fixed variables, manipulated variable, and responding variable in an investigation. The manipulated variable is changed to observe its relationship with the responding variable. At the same time, the fixed variables are kept constant.
Hypothesising	Making a general statement about the relationship between a manipulated variable and a responding variable in order to explain an event or observation. This statement can be tested to determine its validity.
Experimenting	Planning and conducting activities to test a certain hypothesis. These activities include collecting, analysing and interpreting data and making conclusions.

Manipulative Skills

Manipulative skills in scientific investigation are psychomotor skills that enable students to:

- ? use and handle science apparatus and laboratory substances correctly,
- ? handle specimens correctly and carefully,
- ? draw specimens, apparatus and laboratory substances accurately,
- ? clean science apparatus correctly, and
- ? store science apparatus and laboratory substances correctly and safely.

THINKING SKILLS

Thinking is a mental process that requires an individual to integrate knowledge, skills and attitude in an effort to understand the environment.

One of the objectives of the national education system is to enhance the thinking ability of students. This objective can be achieved through a curriculum that emphasises thoughtful learning. Teaching and learning that emphasises thinking skills is a foundation for thoughtful learning.

Thoughtful learning is achieved if students are actively involved in the teaching and learning process. Activities should be organised to provide opportunities for students to apply thinking skills in conceptualisation, problem solving and decision-making.

Thinking skills can be categorised into critical thinking skills and creative thinking skills. A person who thinks critically always evaluates an idea in a systematic manner before accepting it. A person who thinks creatively has a high level of imagination, is able

to generate original and innovative ideas, and modify ideas and products.

Thinking strategies are higher order thinking processes that involve various steps. Each step involves various critical and creative thinking skills. The ability to formulate thinking strategies is the ultimate aim of introducing thinking activities in the teaching and learning process.

Critical Thinking Skills

A brief description of each critical thinking skill is as follows:

Attributing	Identifying characteristics, features, qualities and elements of a concept or an object.
Comparing and Contrasting	Finding similarities and differences based on criteria such as characteristics, features, qualities and elements of a concept or event.
Grouping and Classifying	Separating objects or phenomena into categories based on certain criteria such as common characteristics or features.
Sequencing	Arranging objects and information in order based on the quality or quantity of common characteristics or features such as size, time, shape or number.
Prioritising	Arranging objects and information in order based on their importance or priority.
Analysing	Examining information in detail by breaking it down into smaller parts to find implicit meanings and relationships.

Detecting Bias Identifying views or opinions that have the tendency to support or oppose something in an unfair or misleading way.

Evaluating Making judgements on the quality or value of something based on valid reasons or evidence.

Making Conclusions Making a statement about the outcome of an investigation that is based on a hypothesis.

Creative Thinking Skills

A brief description of each creative thinking skill is as follows:

Generating Ideas Producing or giving ideas in a discussion.

Relating Making connections in a certain situation to determine a structure or pattern of relationship.

Making Inferences Using past experiences or previously collected data to draw conclusions and explain events.

Predicting Stating the outcome of a future event based on prior knowledge gained through experiences or collected data.

Making Generalisations Making a general conclusion about a group based on observations on, or information from, samples of the group.

Visualising Recalling or forming mental images about a particular idea, concept, situation or vision.

Synthesising Combining separate elements or parts to form a general picture in various forms such as writing, drawing or artefact.

Making Hypotheses Making general statement about the relationship between manipulated variables and responding variables to explain observations or events. The statements can be tested to determine validity.

Making Analogies Understanding abstract or complex concepts by relating them to simpler or concrete concepts with similar characteristics.

Inventing Producing something new or adapting something already in existence to overcome problems in a systematic manner.

Thinking Strategy

Description of each thinking strategy is as follows:

Conceptualising Making generalisations based on inter-related and common characteristics in order to construct meaning, concept or model.

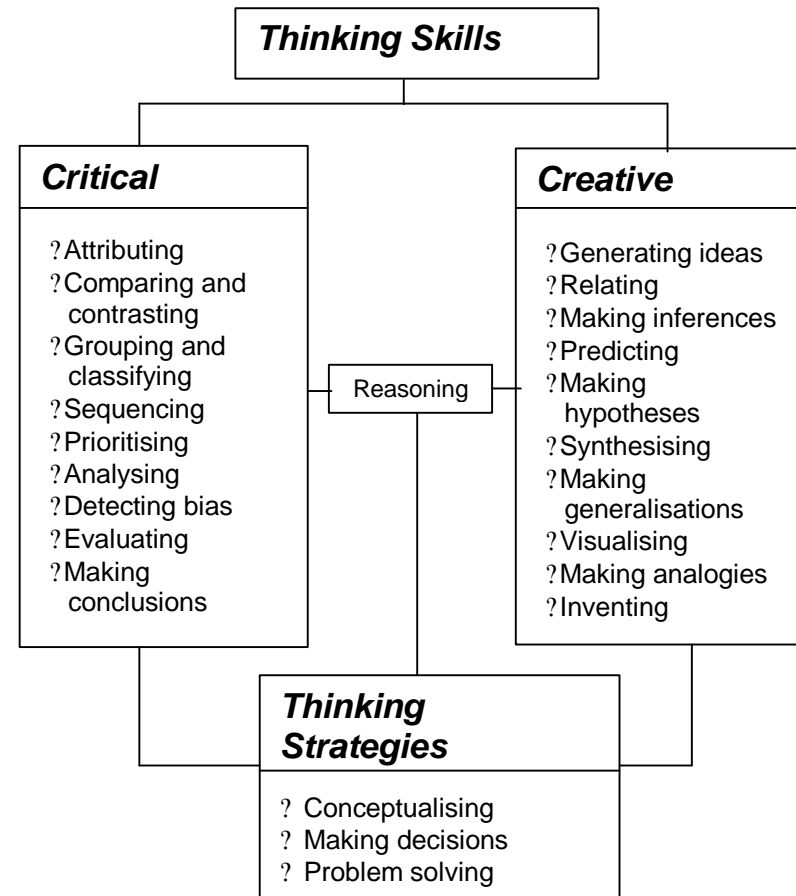
Making Decisions Selecting the best solution from various alternatives based on specific criteria to achieve a specific aim.

Problem Solving Finding solutions to challenging or unfamiliar situations or unanticipated difficulties in a systematic manner.

Besides the above thinking skills and thinking strategies, another skill emphasised is reasoning. Reasoning is a skill used in making logical, just and rational judgements. Mastering of critical and creative thinking skills and thinking strategies is made simpler if an individual is able to reason in an inductive and

deductive manner. Figure 1 gives a general picture of thinking skills and thinking strategies.

Figure 1: TSTS Model in Science



Mastering of thinking skills and thinking strategies (TSTS) through the teaching and learning of science can be developed through the following phases:

1. Introducing TSTS.
2. Practising TSTS with teacher's guidance.
3. Practising TSTS without teacher's guidance.
4. Applying TSTS in new situations with teacher's guidance.
5. Applying TSTS together with other skills to accomplish thinking tasks.

Further information about phases of implementing TSTS can be found in the guidebook *"Buku Panduan Penerapan Kemahiran Berfikir dan Strategi Berfikir dalam Pengajaran dan Pembelajaran Sains"* (Curriculum Development Centre, 1999).

Relationship between Thinking Skills and Science Process Skills

Science process skills are skills that are required in the process of finding solutions to a problem or making decisions in a systematic manner. It is a mental process that promotes critical, creative, analytical and systematic thinking. Mastering of science process skills and the possession of suitable attitudes and knowledge enable students to think effectively.

The mastering of science process skills involves the mastering of the relevant thinking skills. The thinking skills that are related to a particular science process skill are as follows:

Science Process Skills	Thinking Skills
Observing	Attributing Comparing and contrasting Relating
Classifying	Attributing Comparing and contrasting Grouping and classifying
Measuring and Using Numbers	Relating Comparing and contrasting
Making Inferences	Relating Comparing and contrasting Analysing Making inferences
Predicting	Relating Visualising
Using Space-Time Relationship	Sequencing Prioritising
Interpreting data	Comparing and contrasting Analysing Detecting bias Making conclusions Generalising Evaluating
Defining operationally	Relating Making analogy Visualising Analysing
Controlling variables	Attributing Comparing and contrasting Relating Analysing

Science Process Skills	Thinking Skills
Making hypotheses	Attributing Relating Comparing and contrasting Generating ideas Making hypotheses Predicting Synthesising
Experimenting	All thinking skills
Communicating	All thinking skills

Teaching and Learning based on Thinking Skills and Scientific Skills

This biology curriculum emphasises thoughtful learning based on thinking skills and scientific skills. Mastery of thinking skills and scientific skills are integrated with the acquisition of knowledge in the intended learning outcomes. Thus, in teaching and learning, teachers need to emphasise the mastery of skills together with the acquisition of knowledge and the inculcation of noble values and scientific attitudes.

The following is an example and explanation of a learning outcome based on thinking skills and scientific skills.

Example:

Learning Outcome: Compare and contrast animal cell and plant cell based on the structure and organelles

Thinking Skills: Comparing and contrasting

Explanation:

To achieve the above learning outcome, knowledge on the structure and organelles in animal and plant cells are learned through comparing and contrasting. The mastery of the skill of comparing and contrasting is as important as the acquisition of knowledge on animal and plant cells. This would enable students to understand topics on mitosis and meiosis.

SCIENTIFIC ATTITUDES AND NOBLE VALUES

Science learning experiences can be used as a means to inculcate scientific attitudes and noble values in students. These attitudes and values encompass the following:

- ? Having an interest and curiosity towards the environment.
- ? Being honest and accurate in recording and validating data.
- ? Being diligent and persevering.
- ? Being responsible about the safety of oneself, others, and the environment.
- ? Realising that science is a means to understand nature.
- ? Appreciating and practising clean and healthy living.
- ? Appreciating the balance of nature.
- ? Being respectful and well-mannered.

- ? Appreciating the contribution of science and technology.
- ? Being thankful to God.
- ? Having critical and analytical thinking.
- ? Being flexible and open-minded.
- ? Being kind-hearted and caring.
- ? Being objective.
- ? Being systematic.
- ? Being cooperative.
- ? Being fair and just.
- ? Daring to try.
- ? Thinking rationally.
- ? Being confident and independent.

The inculcation of scientific attitudes and noble values generally occurs through the following stages:

- ? Being aware of the importance and the need for scientific attitudes and noble values.
- ? Giving emphasis to these attitudes and values.
- ? Practising and internalising these scientific attitudes and noble values.

When planning teaching and learning activities, teachers need to give due consideration to the above stages to ensure the continuous and effective inculcation of scientific attitudes and values. For example, during science practical work, the teacher should remind pupils and ensure that they carry out experiments in a careful, cooperative and honest manner.

Proper planning is required for effective inculcation of scientific attitudes and noble values during science lessons. Before the first lesson related to a learning objective, teachers should examine all related learning outcomes and suggested teaching-learning activities that provide opportunities for the inculcation of scientific attitudes and noble values.

The following is an example of a learning outcome pertaining to the inculcation of scientific attitudes and values.

Example:

Level: Form Five
 Learning Area: 2.0 Variation
 Learning Objective: 2.3 Be respectful towards one another despite variation.
 Learning Outcome: Accept that people are different and respect each other.

Suggested Learning Activities Participate in games and club activities involving individuals from various ethnic groups.

Conduct a sketch to show respect for all God's creation,

Love and respect each other.

Scientific attitudes and noble values Being kind-hearted and caring.

Appreciating the balance of nature.

Being thankful to God.

Being cooperative.

Inculcating Patriotism

The biology curriculum provides an opportunity for the development and strengthening of patriotism among students. For example, in learning about the process of colonization and succession in an ecosystem, students will learn about the rich biodiversity in the

country, they will appreciate the diversity and uniqueness of this natural resource of the country and deepen their love for the country.

TEACHING AND LEARNING STRATEGIES

Teaching and learning strategies in the biology curriculum emphasise thoughtful learning. Thoughtful learning is a process that helps students acquire knowledge and master skills that will help them develop their minds to the optimum level. Thoughtful learning can occur through various learning approaches such as inquiry, constructivism, contextual learning, and mastery learning. Learning activities should therefore be geared towards activating students' critical and creative thinking skills and not be confined to routine or rote learning. Students should be made aware of the thinking skills and thinking strategies that they use in their learning. They should be challenged with higher order questions and problems and be required to solve problems utilising their creativity and critical thinking. The teaching and learning process should enable students to acquire knowledge, master skills and develop scientific attitudes and noble values in an integrated manner.

Teaching and Learning Approaches in Science

Inquiry-Discovery

Inquiry-discovery emphasises learning through experiences. Inquiry generally means to find information, to question and to investigate a phenomenon that occurs in the environment. Discovery is the main characteristic of inquiry. Learning through discovery occurs when the main concepts and principles of science are investigated and discovered by students themselves. Through activities such as experiments, students investigate a phenomenon and draw conclusions by themselves. Teachers then lead students to understand the science concepts through the results of the inquiry.

Thinking skills and scientific skills are thus developed further during the inquiry process. However, the inquiry approach may not be suitable for all teaching and learning situations. Sometimes, it may be more appropriate for teachers to present concepts and principles directly to students.

Constructivism

Constructivism suggests that students learn about something when they construct their own understanding. The important attributes of constructivism are as follows:

- ✍ Taking into account students' prior knowledge.
- ✍ Learning occurring as a result of students' own effort.
- ✍ Learning occurring when students restructure their existing ideas by relating new ideas to old ones.
- ✍ Providing opportunities to cooperate, sharing ideas and experiences, and reflecting on their learning.

Science, Technology and Society

Meaningful learning occurs if students can relate their learning with their daily experiences. Meaningful learning occurs in learning approaches such as contextual learning and Science, Technology and Society (STS).

Learning themes and learning objectives that carry elements of STS are incorporated into the curriculum. STS approach suggests that science learning takes place through investigation and discussion based on science and technology issues in society. In the STS approach, knowledge in science and technology is to be learned with the application of the principles of science and technology and their impact on society.

Contextual Learning

Contextual learning is an approach that associates learning with daily experiences of students. In this way, students are able to appreciate the relevance of science learning to their lives. In contextual learning, students learn through investigations as in the inquiry-discovery approach.

Mastery Learning

Mastery learning is an approach that ensures all students are able to acquire and master the intended learning objectives. This approach is based on the principle that students are able to learn if they are given adequate opportunities. Students should be allowed to learn at their own pace, with the incorporation of remedial and enrichment activities as part of the teaching-learning process.

Teaching and Learning Methods

Teaching and learning approaches can be implemented through various methods such as experiments, discussions, simulations, projects, and visits. In this curriculum, the teaching-learning methods suggested are stated under the column “Suggested Learning Activities.” However, teachers can modify the suggested activities when the need arises.

The use of a variety of teaching and learning methods can enhance students’ interest in science. Science lessons that are not interesting will not motivate students to learn and subsequently will affect their performances. The choice of teaching methods should be based on the curriculum content, students’ abilities, students’ repertoire of intelligences, and the availability of resources and infrastructure. Besides playing the role of knowledge presenters and experts, teachers need to act as facilitators in the process of teaching and learning. Teachers need to be aware of the multiple intelligences that exist among students. Different teaching and learning activities should be planned to cater for students with different learning styles and intelligences.

The following are brief descriptions of some teaching and learning methods.

Experiment

An experiment is a method commonly used in science lessons. In experiments, students test hypotheses through investigations to discover specific science concepts and principles. Conducting an experiment involves thinking skills, scientific skills, and manipulative skills.

Usually, an experiment involves the following steps:

- ✍ Identifying a problem.
- ✍ Making a hypothesis.
- ✍ Planning the experiment
 - controlling variables.
 - determining the equipment and materials needed.
 - determining the procedure of the experiment and the method of data collection and analysis.
- ✍ Conducting the experiment.
- ✍ Collecting data.
- ✍ Analysing data.
- ✍ Interpreting data.
- ✍ Making conclusions.
- ✍ Writing a report.

In the implementation of this curriculum, besides guiding students to do an experiment, where appropriate, teachers should provide students with the opportunities to design their own experiments. This involves students drawing up plans as to how to conduct experiments, how to measure and analyse data, and how to present the outcomes of their experiment.

Discussion

A discussion is an activity in which students exchange questions and opinions based on valid reasons. Discussions can be conducted before, during or after an activity. Teachers should play the role of a facilitator and lead a discussion by asking questions that stimulate thinking and getting students to express themselves.

Simulation

In simulation, an activity that resembles the actual situation is carried out. Examples of simulation are role-play, games and the use of models. In role-play, students play out a particular role based on certain pre-determined conditions. Games require procedures that need to be followed. Students play games in order to learn a particular principle or to understand the process of decision-making. Models are used to represent objects or actual situations so that students can visualise the said objects or situations and thus understand the concepts and principles to be learned.

Project

A project is a learning activity that is generally undertaken by an individual or a group of students to achieve a certain learning objective. A project generally requires several lessons to complete. The outcome of the project either in the form of a report, an artefact or in other forms needs to be presented to the teacher and other students. Project work promotes the development of problem-solving skills, time management skills, and independent learning.

Visits and Use of External Resources

The learning of science is not limited to activities carried out in the school compound. Learning of science can be enhanced through the use of external resources such as zoos, museums, science centres, research institutes, mangrove swamps, and factories.

Visits to these places make the learning of science more interesting, meaningful and effective. To optimise learning opportunities, visits need to be carefully planned. Students may be involved in the planning process and specific educational tasks should be assigned during the visit. No educational visit is complete without a post-visit discussion.

Use of Technology

Technology is a powerful tool that has great potential in enhancing the learning of science. Through the use of technology such as television, radio, video, computer, and Internet, the teaching and learning of science can be made more interesting and effective.

Computer simulation and animation are effective tools for the teaching and learning of abstract or difficult science concepts. Computer simulation and animation can be presented through courseware or Web page. Application tools such, as word processor, graphic presentation software and electronic spreadsheet are valuable tools for the analysis and presentation of data.

The use of other tools such as data loggers and computer interfacing in experiments and projects also enhance the effectiveness of teaching and learning of science.

CONTENT ORGANISATION

The biology curriculum is organised around themes. Each theme consists of various learning areas, each of which consists of a number of learning objectives. A learning objective has one or more learning outcomes.

Learning outcomes are written based on the hierarchy of the cognitive and affective domains. Levels in the cognitive domain are: knowledge, understanding, application, analysis, synthesis and

evaluation. Levels in the affective domain are: to be aware of, to be in awe, to be appreciative, to be thankful, to love, to practise, and to internalise. Where possible, learning outcomes relating to the affective domain are explicitly stated. The inculcation of scientific attitudes and noble values should be integrated into every learning activity. This ensures a more spontaneous and natural inculcation of attitudes and values. Learning areas in the psychomotor domain are implicit in the learning activities.

Learning outcomes are written in the form of measurable behavioural terms. In general, the learning outcomes for a particular learning objective are organised in order of complexity. However, in the process of teaching and learning, learning activities should be planned in a holistic and integrated manner that enables the achievement of multiple learning outcomes according to needs and context. Teachers should avoid employing a teaching strategy that tries to achieve each learning outcome separately according to the order stated in the curriculum specifications.

The Suggested Learning Activities provide information on the scope and dimension of learning outcomes. The learning activities stated under the column Suggested Learning Activities are given with the intention of providing some guidance as to how learning outcomes can be achieved. A suggested activity may cover one or more learning outcomes. At the same time, more than one activity may be suggested for a particular learning outcome. Teachers may modify the suggested activity to suit the ability and style of learning of their students. Teachers are encouraged to design other innovative and effective learning activities to enhance the learning of biology.

THEME: PHYSIOLOGY OF LIVING THINGS
LEARNING AREA: 1.0 TRANSPORT

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>1.1 Understanding the importance of having a transport system in some multicellular organisms</p>	<p>Carry out activities to identify the problem that could be faced by multicellular organisms and explain how the problem is overcome in multicellular organisms as compared to unicellular organisms:</p> <ul style="list-style-type: none"> a) correlate different sizes of cubes to total surface area / volume (TSA/V) ratio, b) discuss how the (TSA/V) ratio affects the movement of solutes to the interior of cubes, c) relate the outcome of a) and b) to the problem faced by multicellular organisms in getting cell requirements to the cells in the interior of the organisms, d) suggest ways to improve the movement of solutes to the interior of cubes without changing the size of cubes, e) explain why there is a need for a transport system in some multicellular organisms. 	<p>A student is able to:</p> <ul style="list-style-type: none"> ? identify the problem that could be faced by multicellular organisms in obtaining their cellular requirements and getting rid of their waste products, ? suggest how the problem is overcome in multicellular organisms. 	<p>As compared to unicellular organisms</p>	<p>cell requirements – <i>keperluan sel</i></p> <p>waste products – <i>hasil buangan</i></p> <p>transport – <i>pengangkutan</i></p> <p>total surface area – <i>jumlah luas permukaan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.2 Synthesising the concept of circulatory system	Read text materials and view computer simulations on circulatory system and discuss the following: a) what is a circulatory system, b) the three components of the circulatory system, i.e. medium, vessels and pump, c) blood and haemolymph as a medium of transport, d) the composition of human blood, e) the function of blood and hemolymph in transport, f) the structure of human blood vessels: arteries, veins and capillaries, g) the basic structure and function of the human heart, h) the circulation of blood in humans in terms of: i. pumping of the heart, ii. contraction of skeletal muscles around veins, i) the regulatory mechanism of blood pressure.	A student is able to: ? state what a circulatory system is, ? state the three components of circulatory system in humans and animals, ? state the medium of transport in humans and animals, ? state the composition of human blood, ? explain the function of blood and haemolymph in transport, ? describe the structure of human blood vessels, ? explain how blood is propelled through the human circulatory system, ? explain briefly how blood pressure is regulated,	Only a brief description of human blood vessels is required. Cardiac cycle is not required. Baroreceptors in the aorta and carotid arteries are mentioned. Effectors are smooth muscles of the arteries and cardiac muscles.	circulatory system – sistem peredaran composition – komposisi <i>blood vessel</i> – salur darah heart – <i>jantung</i> cardiac muscle – <i>otot kardium</i> skeletal muscle – <i>otot rangka</i> regulatory mechanism – <i>mekanisme kawal atur</i> blood pressure – <i>tekanan darah</i>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Look at the heart of the fish, chicken and/or cow, and note similarities and differences in terms of size, and number of compartments.</p> <p>Use schematic diagrams to compare the circulatory system in the following: humans, fish and amphibians.</p> <p>Visualise and draw concept maps on the circulatory system in humans.</p>	<p>? compare and contrast the circulatory systems in the following: humans, fish and amphibians,</p> <p>? conceptualise the circulatory system in humans.</p>		
<p>1.3 Understanding the mechanism of blood clotting</p>	<p>Show photomicrographs of blood clots. Discuss the necessity for blood clotting with respect to:</p> <ol style="list-style-type: none"> preventing serious blood loss, preventing the entry of microorganisms and foreign particles, maintaining blood pressure, maintaining circulation of blood in a closed circulatory system. <p>Use a schematic diagram to illustrate the mechanism of blood clotting.</p> <p>Predict the consequences of blood clotting related problems such as haemophilia or thrombosis.</p>	<p>A student is able to:</p> <p>? explain the necessity for blood clotting at the site of damaged blood vessels,</p> <p>? explain the mechanism of blood clotting,</p> <p>? predict the consequences of impaired blood clotting mechanism in an individual.</p>		<p>blood clotting – <i>pembekuan darah</i></p> <p>damaged blood vessel – <i>salur darah tercedera</i></p> <p>impaired blood clotting – <i>pembekuan darah terjejas</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>1.4 Synthesising the concept of lymphatic system</p>	<p>Draw a schematic diagram on the formation of interstitial fluid and lymph, and discuss the following:</p> <ul style="list-style-type: none"> a) spaces between cells, b) materials from blood capillaries entering these spaces, c) composition of interstitial fluid, d) the importance of interstitial fluid, e) the need for interstitial fluid to return to the circulatory system directly or via the lymphatic system. <p>Discuss the following:</p> <ul style="list-style-type: none"> a) the structure of the lymphatic system, b) the flow of lymph, c) the role of the lymphatic system in transport. 	<p>A student is able to:</p> <ul style="list-style-type: none"> ? describe the formation of interstitial fluid, ? state the composition of interstitial fluid, ? state the importance of interstitial fluid, ? describe the fate of interstitial fluid, ? describe the structure of the lymphatic system, ? explain how the lymphatic system complements the circulatory system, 	<p>With the exception of thoracic duct and right lymphatic duct, specific names of lymph vessels and lymph nodes are not required.</p>	<p>interstitial fluid – <i>bendalir interstis</i></p> <p>lymphatic system – sistem limfa</p> <p>lymph nodes – nodus limfa</p>
	<p>Use a graphic organiser to compare the content of blood, interstitial fluid and lymph.</p> <p>Brainstorm to predict what will happen if interstitial fluid fails to return to the circulatory system.</p> <p>Study diagram or computer simulation on the lymphatic system, and discuss the relationship</p>	<ul style="list-style-type: none"> ? compare the content of blood, interstitial fluid and lymph, ? predict what will happen if interstitial fluid fails to return to the circulatory system, ? conceptualise the relationship between the lymphatic system and circulatory system. 		

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	between the lymphatic system and circulatory system.			
1.5 Understanding the role of the circulatory system in body defence mechanism	<p>Discuss the necessity for a body defence mechanism in humans.</p> <p>Gather information and discuss the body's defence mechanism with reference to:</p> <p>a) first line of defence - skin, - mucous membrane,</p> <p>b) second line of defence - phagocytic white blood cells,</p> <p>c) third line of defence - lymphocytes.</p> <p>Draw and label the various stages of phagocytosis.</p> <p>Discuss the following:</p> <p>a) antigens, antibodies, immunity and immunisation,</p> <p>b) how antigens and antibodies are related to immunity,</p> <p>c) the various types of immunity: i. active immunity (natural, artificial), ii. passive immunity (natural, artificial).</p>	<p>A student is able to:</p> <p>? state another function of the circulatory system besides transport,</p> <p>? identify the three lines of defence mechanism of the body,</p> <p>? describe the process of phagocytosis,</p> <p>? state the meaning of antigen and antibody,</p> <p>? state the meaning of immunity and immunisation,</p> <p>? relate antigen and antibody to immunity,</p> <p>? name and give examples of various types of immunity,</p>		<p>body's defence mechanism – <i>mekanisme pertahanan badan.</i></p> <p>immunity – <i>keimunan</i></p> <p>immunisation – <i>pengimunan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	Carry out small group discussion on the following and present the findings: a) the effects of HIV on the body's immune system, b) transmission of HIV, c) prevention of AIDS.	? state the effects of human immunodeficiency virus (HIV) on the body's defence mechanism, ? describe the transmission of HIV, ? suggest ways to prevent the spread of acquired immune deficiency syndrome (AIDS).		acquired immune deficiency syndrome (AIDS) – <i>sindrom kurang daya tahan</i>
1.6 Appreciating a healthy cardiovascular system	Research and discuss nutrition and lifestyle which can lead to a healthy cardiovascular system. Then select ways that are suitable and practise them.	A student is able to: ? select and practise suitable ways to maintain a healthy cardiovascular system.		
1.7 Understanding the transport of substances in plants	Discuss the following: a) the necessity for transport of substances in plants, b) the problem that could be faced by plants in transporting substances and how it is overcome in plants.	A student is able to: ? state the necessity for transport of substances in plants,		

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Carry out the following activities:</p> <p>a) to show the presence of xylem as a continuous tube system to transport water and minerals,</p> <p>b) prepare slides and look at the cross section (XS) and longitudinal section (LS) of a dicot stem,</p> <p>c) study prepared slides of XS of stem, root and leaf of a dicot plant, and draw plan diagrams.</p> <p>Relate the following:</p> <p>a) the structure of xylem to the transport of water and minerals,</p> <p>b) the structure of phloem to the transport of organic substances.</p> <p>Carry out bark ringing to show the role of phloem in the continuous transport of organic substances.</p>	<p>? identify the vascular tissue in stem, root and leaf,</p> <p>? state the role of vascular tissue in the transport of substances,</p> <p>? describe the structure of vascular tissue,</p> <p>? relate the structure of xylem to transport,</p> <p>? relate the structure of phloem to transport,</p> <p>? predict the effect of removing a ring of phloem tissue from a plant.</p>	<p>Bark ringing is the removal of a ring of tissue external to the xylem from around the trunk of a woody plant.</p>	<p>cross section – <i>keratan rentas</i></p> <p>longitudinal section – <i>keratan membujur</i></p>
<p>1.8 Synthesising the concept of transport of substances in plants</p>	<p>Discuss the following:</p> <p>a) the transport of organic substances in plants,</p> <p>b) the importance of translocation in plants.</p>	<p>A student is able to:</p> <p>? state what translocation is,</p> <p>? explain the importance of translocation in plants,</p>	<p>Mechanism to explain translocation is not required.</p>	<p>pathway of water - <i>laluan air</i></p> <p>environmental factor - <i>factor persekitaran</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Carry out small group discussion on the following and present the findings:</p> <p>a) the process of transpiration, b) the importance of transpiration, c) the pathway of water from soil to leaves using a schematic diagram, d) the external conditions affecting the rate of transpiration</p> <p>Design and conduct experiments to study factors affecting the rate of transpiration, i.e. :</p> <p>a) air movement, b) temperature, c) light intensity, d) relative humidity.</p> <p>Carry out an activity to show the following:</p> <p>a) root pressure, b) cohesion and adhesion of water.</p> <p>Discuss and draw a concept map of the movement of water in plants in terms of the following: osmosis, transpiration pull, cohesion and adhesion of water, opening and closing of stomata, root pressure.</p>	<p>? describe the process of transpiration,</p> <p>? explain the importance of transpiration,</p> <p>? describe the pathway of water from the soil to the leaves,</p> <p>? state external conditions affecting transpiration,</p> <p>? design experiments to study factors affecting the rate of transpiration,</p> <p>? explain the role of root pressure in the movement of water in plants,</p> <p>? explain the role of cohesion and adhesion of water in the movement of water in plants,</p> <p>? conceptualise the transport mechanism in plants.</p>		<p>light intensity - <i>keamatan cahaya</i></p> <p>relative humidity - <i>kelembapan relatif</i></p> <p>rate of transpiration - <i>kadar transpirasi</i></p> <p>root pressure - <i>tekanan akar</i></p> <p>transpiration pull - <i>tarikan transpirasi</i></p> <p>capillary action - <i>tindakan kapilari</i></p>

LEARNING AREA: 2.0 LOCOMOTION AND SUPPORT

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>2.1 Understanding support and locomotion in humans and animals</p>	<p>Carry out small group discussion on the following:</p> <p>a) the necessity for support and locomotion in humans and animals,</p> <p>b) the problems that could be faced by humans and animals in support and locomotion,</p> <p>c) how the above problems are overcome in humans and animals.</p>	<p>A student is able to:</p> <p>? explain the necessity for support and locomotion in humans and animals,</p> <p>? describe problems that could be faced by humans and animals in support and locomotion,</p> <p>? explain how problems in support and locomotion are overcome in humans and animals,</p>		<p>support - <i>sokongan</i></p> <p>locomotion - <i>gerak alih</i></p>
	<p>Study a model of human skeleton to identify the following:</p> <p>a) axial skeleton consisting of the skull, cervical vertebrae, thoracic vertebrae, lumbar vertebrae, sacrum, coccyx, sternum and ribs,</p> <p>b) appendicular skeleton consisting of the scapula, clavicle, humerus, ulna, radius, pelvic girdle, femur, tibia and fibula.</p> <p>Observe a chicken wing to note the position and nature of muscles, ligaments and tendons.</p> <p>Draw and label a simple diagram of an arm to show the arrangement of bones, skeletal muscles and tendons.</p>	<p>? name the bones that make up the axial skeleton and appendicular skeleton of the human body,</p> <p>? label the bones, the skeletal muscles and tendons in a diagram of the arm,</p>		<p>axial skeleton - <i>rangka paksi</i></p> <p>appendage skeleton - <i>rangka apendaj</i></p> <p>pelvic girdle - <i>lengkungan pelvic</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Briefly discuss:</p> <p>a) how the bones, skeletal muscles, tendons and joints bring about movement in the arm or leg,</p> <p>b) the necessity of nerve impulses in skeletal muscle contraction,</p> <p>c) the antagonistic action of skeletal muscles,</p> <p>d) all muscle has two primary proteins,</p>	<p>? explain how movement is brought about in a limb,</p>	<p>The Sliding –Filament Model of Muscle Contraction is not required.</p>	<p>joint - <i>sendi</i></p> <p>contraction - <i>pengecutan</i></p>
	<p>e) source of energy is from ATP produced in adjacent mitochondria,</p> <p>f) the function of cartilage and synovial fluid at joints.</p> <p>Observe and discuss the mechanism of locomotion in an earthworm, grasshopper, fish or bird.</p> <p>Discuss and present findings on muscle cramp, osteoporosis, muscular dystrophy, and arthritis.</p>	<p>? state the function of cartilage and synovial fluid at joints,</p> <p>? describe briefly the mechanism of locomotion in an animal,</p> <p>? state some consequences of impaired musculoskeletal system on support and locomotion.</p>	<p>Only a simple account is required.</p>	<p>cartilage - <i>rawan</i></p> <p>impaired - <i>terjejas</i></p> <p>muscle cramp - <i>kejang otot</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>2.2 Appreciating a healthy musculo-skeletal system</p>	<p>Discuss and share ways of caring for the musculoskeletal system such as:</p> <ul style="list-style-type: none"> a) following a balanced diet, b) having a good posture, c) using of proper attire for daily activities, d) taking appropriate precautions during vigorous activities, e) practising correct and safe exercise techniques. 	<p>A student is able to:</p> <ul style="list-style-type: none"> ? practise ways to care for the musculoskeletal system. 		
<p>2.3 Understanding support in plants</p>	<p>Discuss the following:</p> <ul style="list-style-type: none"> a) the necessity for support in plants, b) what could be the support related problems faced by: <ul style="list-style-type: none"> i. aquatic plants, ii. terrestrial plants. c) how is support achieved in aquatic and terrestrial plants. <p>Carry out the following activities:</p> <ul style="list-style-type: none"> a) study the adaptations for support (aerenchyma and air sacs) in floating aquatic plants, e.g. water hyacinth, b) study prepared slides of cross sections of old stems to identify tissue that help in support, c) investigate how support in herbaceous plant, e.g. spinach and balsam, is achieved without woody tissue. 	<p>A student is able to:</p> <ul style="list-style-type: none"> ? explain the necessity for support in plants, ? explain how support is achieved in aquatic plants, ? explain how support in terrestrial plants are achieved through tissue modifications. 		

LEARNING AREA: 3.0 COORDINATION AND RESPONSE

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>3.1 Understanding response and coordination</p>	<p>Carry out small group discussion on the following and present the findings:</p> <p>a) external stimuli, e.g. light, sound, smell, taste, temperature, pressure and touch,</p> <p>b) internal stimuli e.g. sugar level in the blood and osmotic pressure of blood,</p> <p>c) the necessity for living organisms to respond to stimuli,</p> <p>Carry out activities to study:</p> <p>a) human and animal responses to external and internal environment,</p> <p>b) plant responses to external environment.</p> <p>View computer simulations on the pathways in detecting and responding to external and internal stimuli in humans and animals and draw schematic diagrams involving the main components.</p> <p>Discuss what is meant by 'coordination'.</p>	<p>A student is able to:</p> <p>? list the changes in external and internal environment faced by an organism,</p> <p>? state why organisms have to be sensitive to changes in internal and external environment,</p> <p>? clarify through examples the meaning of 'stimulus' and 'response',</p> <p>? state the main components and pathways involved in detecting and responding to changes in external environment,</p> <p>? state the main components and pathways involved in detecting and regulating changes in internal environment,</p> <p>? clarify through examples the meaning of 'coordination'.</p>	<p>Main components are receptors, integrating centre and effectors. Afferent and efferent pathways are involved. In regulating the internal environment, negative feedback is involved..</p>	<p>external environment - <i>persekitaran luar</i></p> <p>internal environment - <i>persekitaran dalam</i></p> <p>stimulus - <i>rangsangan</i></p> <p>response - <i>gerak balas</i></p> <p>negative feedback - <i>suap balik negatif</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>3.2 Analysing the role of human nervous system</p>	<p>Discuss the role of nervous system.</p> <p>Draw a diagram to show the organisation of the nervous system.</p> <p>View graphics of the brain and label the main parts of the brain, and state their respective function(s).</p> <p>Draw and label diagram of a cross section of the spinal cord.</p> <p>Discuss the main functions of the spinal cord.</p> <p>Draw and label the structure of the efferent neurone (nucleus, cell body, cytoplasm, dendrites, axon, synaptic dendrites, myelin sheath).</p> <p>Identify and discuss the function of the three types of neurone.</p> <p>View computer animations on the transmission of information in the form of electrical signals.</p> <p>Discuss the mode of transmission of information along the neurone.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? state the role of nervous system, ? draw and label a diagram to show the organisation of the nervous system, ? name the main parts of the brain and state their functions, ? draw and label a diagram of a cross section of the spinal cord, ? state the main functions of the spinal cord, ? label the structure of an efferent neurone, ? identify the type of the neurone from diagrams given, ? state the function of each type of neurone, ? state the mode of transmission of information along the neurone, 	<p>The parts of the brain to be studied are the cerebrum, cerebellum, medulla oblongata, pituitary, hypothalamus and thalamus.</p> <p>Cross section of spinal cord includes grey matter, white matter, dorsal root, ventral root, ganglion, spinal nerve.</p>	<p>nervous system - <i>sistem saraf</i></p> <p>spinal cord - <i>saraf tunjang</i></p> <p>transmission of information - <i>penghantaran maklumat</i></p> <p>electrical signals - <i>isyarat elektrik</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Draw a schematic diagram to show the pathway of transmission of information, and discuss the following:</p> <ul style="list-style-type: none"> a) reception of stimuli by receptors, b) from receptors to the central nervous system, c) integration and interpretation by the central nervous system, d) from the central nervous system to the effectors, e) response by the effectors. <p>Draw and label a simple diagram of a synapse,</p> <p>Conduct small group discussion on the following:</p> <ul style="list-style-type: none"> a) transmission of information across the synapse. b) the role of the synapse in transmission, <p>Discuss voluntary action and involuntary action with examples.</p> <p>Discuss the following:</p> <ul style="list-style-type: none"> a) voluntary action eg. raising your hand to answer a question, 	<ul style="list-style-type: none"> ? describe briefly the pathway of transmission of information from receptors to effectors, ? draw and label a simple diagram of a synapse, ? describe the transmission of information across synapses, ? state the role of the synapse in transmission, ? give examples of voluntary action, ? give examples of involuntary action, ? outline the transmission of information in voluntary action, 	<p><i>Note: Conditional reflex is not required.</i></p>	<p>voluntary action – <i>tindakan terkawal</i></p> <p>involuntary action – <i>tindakan luar kawal</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>b) involuntary action involving skeletal muscles eg. knee jerk, c) involuntary action involving smooth muscles, cardiac muscles or glands eg. normal blood pressure.</p> <p>Work in small groups to draw a schematic diagram of a reflex arc.</p> <p>Visit homes for the aged. Show compassion towards senior citizens and patients with Alzheimer's and Parkinson's diseases.</p>	<p>? outline the transmission of information in involuntary action,</p> <p>? draw a schematic diagram showing a reflex arc,</p> <p>? give examples of nervous system related diseases.</p>		<p>knee jerk – <i>sentakan lutut</i> skeletal muscles – <i>otot rangka</i> smooth muscles – <i>otot licin</i></p> <p>reflex arc – <i>arka refleks</i></p>
<p>3.3 Analysing the role of hormones in humans</p>	<p>Carry out small group discussion on the following and present the findings:</p> <p>a) what a hormone is, b) what the endocrine system is, c) why the endocrine system is necessary, despite having the nervous system, d) the physiological processes which are not directly regulated by the nervous system e.g. menstrual cycle, development of secondary sex characteristics, growth, etc., e) how the endocrine system complements the nervous system.</p>	<p>A student is able to:</p> <p>? state what a hormone is, ? state what the endocrine system is, ? state why the endocrine system is necessary, ? state physiological processes not directly regulated by the nervous system, ? describe how the endocrine system complements the nervous system,</p>		<p>endocrine glands – <i>kelenjar endokrin</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Carry out group activity to label the main glands of the endocrine system.</p> <p>Name the main hormones produced by each endocrine gland.</p> <p>Match the hormones with their functions in the following physiological processes: (a) reproduction, (b) growth, (c) homeostasis.</p> <p>Discuss how secretion of a hormone can be regulated by: a) another hormone, e.g. thyroid stimulating hormone (TSH), b) level of certain substances, e.g. glucose, c) nervous system.</p>	<p>? label the main glands of the endocrine system,</p> <p>? name the main hormones produced by each endocrine gland,</p> <p>? state the functions of the hormones involved in some physiological processes,</p> <p>? describe briefly how secretion of hormone is regulated,</p>	<p>The main hormones required are:</p> <ul style="list-style-type: none"> - follicle stimulating hormone, - luteinising hormone, - estrogen, - progesterone, - androgens - growth hormone, - thyroid-stimulating hormone, - thyroxine, - insulin, - glucagon, - antidiuretic hormone, and - adrenaline. 	

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Discuss the involvement of both the nervous system and the endocrine system in a “fight or flight” situation (involving adrenaline).</p> <p>Carry out small group discussion on the following and present the findings on:</p> <p>a) the effects of imbalance of thyroxine, growth hormone, antidiuretic hormone, and insulin,</p> <p>b) the use of hormone in the treatment of diabetes mellitus and dwarfism.</p>	<p>? describe briefly coordination involving both the nervous system and endocrine system, in a “fight or flight” situation,</p> <p>? state the effects of hormonal imbalance,</p> <p>? state the use of hormone in medicine.</p>		<p>hormonal imbalance - <i>ketidakseimbangan hormon</i></p> <p>dwarfism - <i>kekerdilan</i></p>
<p>3.4 Synthesising the concept of homeostasis in humans</p>	<p>Discuss the following :</p> <p>a) physical factors – body temperature and blood pressure,</p> <p>b) chemical factors in the blood - partial pressure of oxygen and of carbon dioxide, osmotic pressure, and sugar level,</p> <p>c) the necessity to maintain an optimal physical and chemical condition in the internal environment.</p> <p>d) the meaning of homeostasis,</p>	<p>A student is able to:</p> <p>? explain the necessity to maintain an optimal physical and chemical condition in the internal environment,</p> <p>? state the meaning of homeostasis,</p>	<p>Regulation of the physical and chemical factors in internal environment is vital for survival.</p>	

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Design an experiment to show the effect of different quantities of water intake on urine output.</p> <p>Discuss the following:</p> <p>a) the relationship between the regulation of osmotic pressure and the formation of urine,</p> <p>c) the formation of urine,</p> <p>d) the relationship between urine formation and excretion.</p> <p>Draw and label the following structures:</p> <p>a) kidney, b) nephron.</p> <p>View computer simulations and draw a schematic diagram on the process of urine formation and discuss the following processes:</p> <p>a) ultrafiltration, b) reabsorption, c) secretion.</p>	<p>? design an experiment to study the effect of different quantities of water intake on urine output,</p> <p>? relate changes in blood osmotic pressure to urine output,</p> <p>? describe the formation of urine,</p> <p>? relate the formation of urine to excretion,</p>	<p>The action of sodium pump is not required.</p>	<p>regulation – <i>kawal atur</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Draw a schematic diagram on the action of antidiuretic hormone (ADH), and discuss the following:</p> <ul style="list-style-type: none"> a) the process of osmoregulation by the kidneys, b) negative feedback control in osmoregulation. <p>Gather information and discuss the following:</p> <ul style="list-style-type: none"> a) haemodialysis, b) kidney donation and kidney transplant. <p>Recall, discuss and draw a concept map on various mechanisms that together keep the physical and chemical conditions inside the organism constant in terms of:</p> <ul style="list-style-type: none"> a) blood sugar level, b) body temperature, c) partial pressure of oxygen and of carbon dioxide, d) blood pressure. 	<ul style="list-style-type: none"> ? describe briefly the mechanism of osmoregulation, ? predict the consequences of impaired kidney function, ? describe the regulation of blood sugar level, ? describe the regulation of body temperature, ? conceptualise homeostasis. 		

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>3.5 Practising a healthy lifestyle</p>	<p>Show pictures of drug addicts and alcoholics, then discuss drug and alcohol abuse. Research and report on: a) effects of drugs and alcohol abuse such as on the nervous system, b) social factors that can lead to drug and alcohol abuse.</p> <p>Attend talks on drug and alcohol abuse.</p> <p>Participate in anti-drug abuse and anti-alcohol abuse campaigns.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? describe effects of drug and alcohol abuse on humans, ? explain the factors that can lead to drug and alcohol abuse, ? practise a healthy lifestyle. 	<p>Only a simple account is required.</p>	<p>drug abuse - <i>penyalahgunaan dadah</i></p>
<p>3.6 Understanding plant hormones</p>	<p>Research and report on: a) the meaning of plant hormone, b) plant hormones e.g. auxins, ethylene, c) effect of auxins based on scientific findings on phototropism, d) role of auxins in phototropism and geotropism, e) the use of hormones in agriculture.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? state what plant hormones are, ? give some examples of plant hormones, ? infer the effects of auxins on growth responses, ? explain the role of auxins in tropism, ? state the use of hormones in agriculture. 	<p>Ethylene is also known as ethene.</p>	<p>responses - <i>gerak balas</i></p>

LEARNING AREA: 4.0 REPRODUCTION AND GROWTH

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>4.1 Analysing gamete formation</p>	<p>Discuss the following about reproduction:</p> <p>a) the necessity to reproduce,</p> <p>b) the two types of reproduction,</p> <p>c) the necessity for formation of gametes,</p> <p>Study diagrams of the stages in the formation of a sperm and an ovum.</p> <p>Compare the formation of a sperm with that of an ovum.</p>	<p>A student is able to:</p> <p>? explain the necessity for organisms to reproduce,</p> <p>? state types of reproduction,</p> <p>? explain the necessity for formation of gametes,</p> <p>? describe formation of sperm in humans,</p> <p>? describe formation of ovum in humans,</p> <p>? compare the formation of sperm with that of ovum.</p>		<p>reproduce – <i>membiak</i></p>
<p>4.2 Analysing the role of hormones in the menstrual cycle</p>	<p>Discuss the following:</p> <p>a) what menstruation is,</p> <p>b) the relation between menstruation and menstrual cycle,</p> <p>c) the importance of the menstrual cycle,</p> <p>d) hormones involved in the menstrual cycle,</p> <p>Study and interpret graphs on hormonal levels during the menstrual cycle.</p>	<p>A student is able to:</p> <p>? state what menstruation is,</p> <p>? relate menstruation to menstrual cycle,</p> <p>? state the importance of the menstrual cycle,</p> <p>? state the hormones involved in the menstrual cycle,</p> <p>? explain the role of hormones in regulating the menstrual cycle,</p>		<p>menstrual cycle – <i>kitar haid</i></p> <p>ovulation – <i>pengovuman</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Study diagrams, and discuss the effect of hormonal levels on the following:</p> <ol style="list-style-type: none"> follicle development, ovulation, formation of corpus luteum, thickness of the endometrium. <p>Discuss the following:</p> <ol style="list-style-type: none"> premenstrual syndrome, menopause. 	<p>? relate hormonal levels to the development of follicles, the process of ovulation, and the formation of corpus luteum,</p> <p>? relate hormonal levels to the changes in thickness of the endometrium,</p> <p>? state what premenstrual syndrome (PMS) is,</p> <p>? state what menopause is.</p>		<p>premenstrual syndrome (PMS) – <i>sindrom prahaid</i></p> <p>menopause – <i>putus haid</i></p>
<p>4.3 Understanding the early development of a zygote in humans</p>	<p>Use diagram and computer simulations to discuss the following:</p> <ol style="list-style-type: none"> the formation of zygote, the early development of a zygote as the formation of a ball of cells which becomes implanted in the wall of the uterus, identify morula and blastocyst from the diagrams given, formation of identical twins, fraternal twins and Siamese twins. <p>Illustrate how identical and fraternal twins are formed, and give some differences between them.</p> <p>Research and report on:</p> <ol style="list-style-type: none"> functions of the placenta in foetal development, 	<p>A student is able to:</p> <p>? describe what fertilisation is,</p> <p>? describe in simple terms the early development of a zygote,</p> <p>? name the two main stages in the development of a zygote in preparation for implantation,</p> <p>? describe the formation of twins,</p> <p>? compare identical twins with fraternal twins,</p> <p>? state the functions of the placenta in foetal development,</p>	<p>Only a simple account is required.</p>	<p>fertilisation – <i>persenyawaan</i></p> <p>implantation – <i>penempelan</i></p> <p>umbilical cord – <i>tali pusat</i></p> <p>identical twins – <i>kembar seiras</i></p> <p>fraternal twins – <i>kembar tak seiras</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	b) the advantages of fetus having a separate circulatory system from that of the mother.	? explain the advantages of fetus having a separate circulatory system from that of the mother.		
4.4 Appreciating the contribution of science and technology to human reproduction	Research and report on: a) family planning, b) sperm bank, c) artificial insemination, d) <i>in vitro</i> fertilisation, e) surrogate mother, f) sexually transmitted diseases.	A student is able to: ? explain the contribution of science and technology to human reproduction, ? explain some moral issues related to the application of science and technology to human reproduction, ? what sexually transmitted diseases are, ? give examples of sexually transmitted diseases.		artificial insemination – <i>permanian beradas</i> <i>in vitro</i> fertilisation – persenyawaan <i>in vitro</i> surrogate mother – <i>ibu tumpang</i>
4.5 Synthesising the concept of sexual reproduction in flowering plants	Examine a flower to identify: a) various flower parts, b) the structures which produce male and female reproductive cells. Draw diagrams to show the stages in the formation of: a) pollen grains from pollen mother cell, b) embryo sac from embryo sac mother cell. Describe briefly what happens at each stage in both a) and b).	A student is able to: ? identify male and female structures in a flower, ? describe the formation of pollen grains, ? describe the formation of the embryo sac in the ovule,		pollen – <i>debunga</i> embryo sac – <i>pundi embrio</i>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Conduct an activity to observe the germination of pollen grains in sugar solution.</p> <p>Discuss the following:</p> <p>a) the formation of two male nuclei from the generative nucleus,</p> <p>b) the formation of a zygote,</p> <p>c) the formation of triploid nucleus,</p> <p>Discuss and draw a concept map of double fertilisation in flowering plants.</p> <p>Examine the structure of fruits, e.g. mango, long beans, and relate them to the flower parts:</p> <p>a) seed from the ovule,</p> <p>b) seed coat from the integument,</p> <p>c) fruit from the ovary.</p> <p>Discuss the importance of double fertilisation for the survival of flowering plants.</p>	<p>? describe the formation of pollen tube,</p> <p>? describe the formation of zygote,</p> <p>? describe the formation of triploid nucleus,</p> <p>? conceptualise double fertilisation,</p> <p>? relate the structure of a fruit to the flower parts,</p> <p>? explain the importance of double fertilisation for the survival of flowering plants.</p>		<p>germination – <i>percambahan</i></p> <p>pollen tube – <i>tiub debunga</i></p> <p>double fertilisation – <i>persenyawaan ganda dua</i></p> <p>seed coat – <i>kulit biji</i></p>
<p>4.6 Understanding growth in multicellular organisms</p>	<p>Discuss the necessity for growth.</p> <p>Carry out small group discussion on growth in terms of:</p> <p>a) growth being an irreversible process,</p> <p>b) increase in the number of cells,</p> <p>c) increase in cell size,</p> <p>d) cell differentiation.</p>	<p>A student is able to:</p> <p>? explain briefly the necessity for growth in organisms,</p> <p>? explain what growth is,</p>		<p>growth – <i>pertumbuhan</i></p> <p>irreversible – <i>tidak berbalik</i></p> <p>cell differentiation</p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	Study diagrams or prepared slides to identify the growth zones at root tip and shoot tip.			– <i>pembezaan sel</i>
4.7 Understanding the growth curve	<p>Generate ideas on the appropriate parameters used in the measurement of growth.</p> <p>Conduct an activity to study the growth of a plant, e.g. onion, maize, or balsam.</p> <p>Study and interpret the data on growth in humans and discuss the following:</p> <ol style="list-style-type: none"> the shape of growth curve, phases of growth, the relationship between the phases of growth and the growth curve. <p>Study and interpret a growth curve of an insect and relate the shape of the curve to its growth.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? identify the parameters used in the measurement of growth, ? describe the sigmoid growth curve of an organism, ? relate the shape of the growth curve to the growth phases of an organism, ? explain the shape of the growth curve of an insect. 	The parameters that can be used include height, length, volume, dry mass, and fresh mass.	growth curve – <i>lengkung pertumbuhan</i>
4.8 Understanding primary and secondary growth in plants	Discuss the types of growth in plants.	<p>A student is able to:</p> <ul style="list-style-type: none"> ? state the types of growth in plants, 		primary growth – <i>pertumbuhan primer</i>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Conduct a field study to identify plants that undergo primary and secondary growth.</p> <p>Examine prepared slides or diagrams of a cross section of a young stem, matured stem, young root, matured root, in dicots to identify the primary and secondary tissues.</p> <p>Research and report on the following:</p> <p>a) relate primary growth to height, support and transport of substances,</p> <p>b) relate secondary growth to additional support and transport,</p> <p>c) state the importance of vascular cambium and cork cambium to secondary growth,</p> <p>d) compare plants that undergo secondary growth with those that do not,</p> <p>e) the economic importance of plants that undergo secondary growth.</p>	<p>? state what primary and secondary growth are,</p> <p>? name the tissue involved in primary and secondary growth,</p> <p>? state the location of the tissue involved in primary and secondary growth,</p> <p>? explain the importance of primary growth,</p> <p>? explain the importance of secondary growth,</p> <p>? compare and contrast plants that undergo secondary growth with plants that do not undergo secondary growth,</p> <p>? state the economic importance of plants that undergo secondary growth.</p>		<p>secondary growth – <i>pertumbuhan sekunder</i></p> <p>cork cambium – <i>kambium gabus</i></p>

THEME: VARIATION AND INHERITANCE
LEARNING AREA: 1.0 INHERITANCE

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.1 Synthesising the concept of inheritance based on Mendel's experiment	<p>Discuss the following base on examples:</p> <p>a) inheritance,</p> <p>b) characters and traits.</p> <p>Study diagrams showing the results of Mendel's monohybrid cross experiment, then discuss the following:</p> <p>a) characters and traits in Mendel' experiments,</p> <p>b) there is a hereditary factor that determines a particular character,</p> <p>c) dominant traits and recessive traits,</p> <p>d) genes and alleles,</p> <p>e) dominant alleles and recessive alleles,</p>	<p>A student is able to:</p> <p>? state what is meant by inheritance,</p> <p>? differentiate traits from characters,</p> <p>? identify characters and traits in Mendel's experiments,</p> <p>? state that there is a hereditary factor that determines a particular character,</p> <p>? identify dominant and recessive traits,</p> <p>? explain genes and alleles,</p> <p>? explain dominant alleles and recessive alleles,</p>	<p>Example: character : height trait : tall, short</p> <p>character : colour trait : white, red, ...</p>	<p>inheritance – <i>pewarisan</i></p> <p>characteristic – <i>ciri</i></p> <p>hereditary factor – <i>faktor pewarisan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>f) phenotype and genotype,</p> <p>g) homozygote and heterozygote,</p> <p>h) phenotypic ratio and genotypic ratio in the first and second filial generation,</p> <p>i) the importance of meiosis I in the segregation of alleles,</p> <p>j) meaning of monohybrid inheritance.</p> <p>Conduct an activity using coloured buttons/beans to illustrate Mendel's First Law.</p> <p>Discuss Mendel's First Law as The Law of Segregation.</p> <p>Study diagrams showing the results of Mendel's dihybrid cross experiment, then discuss the following:</p> <p>a) meaning of 'dihybrid inheritance',</p>	<p>? state the meaning of phenotype,</p> <p>? state the meaning of genotype,</p> <p>? relate allele combination to genotype,</p> <p>? relate phenotype to genotype,</p> <p>? state the meaning of homozygote and heterozygote,</p> <p>? determine the phenotypic ratio of the first filial generation and second filial generation,</p> <p>? determine the genotypic ratio of the first filial generation and second filial generation,</p> <p>? state the meaning of monohybrid inheritance,</p> <p>? conceptualise Mendel's First Law,</p> <p>? state the meaning of 'dihybrid inheritance',</p>	<p>Schematic diagrams should show the segregation of alleles in meiosis.</p>	

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	b) the importance of meiosis in terms of independent assortment of chromosomes. Discuss Mendel's Second Law as The Law of Independent Assortment.	? conceptualise Mendel's Second Law.	The use of Punnett's square is required.	
1.2 Understanding inheritance	Discuss: a) blood groups and Rhesus factor (Rh factor), b) inheritance of ABO blood group in humans. Examine a drawing of a micrograph of human chromosomes and: a) determine the number of chromosomes, b) arrange the homologous pairs based on the location of the centromere and size of chromosome, c) identify autosomes and sex chromosomes. Compare the karyotypes of a normal human being with that of a person with Down's syndrome. Draw a schematic diagram to show the following: a) sex determination in off-springs,	student is able to: ? state the blood groups in the ABO system and Rhesus factor in humans, ? explain the inheritance of ABO blood group in humans, ? differentiate autosomes from sex chromosomes, ? identify the different human karyotypes, ? explain sex determination in off-springs,		sex determination – <i>penentuan seks</i>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Research and report on the following:</p> <ul style="list-style-type: none"> a) DNA fingerprinting, b) human genome project, c) potential of stem cell research, d) genetic engineering, <ul style="list-style-type: none"> i. gene therapy, ii. genetically modified organisms, iii. genetically modified food, iv. medicine (production of insulin). <p>Discuss the implications of the above to mankind.</p> <p>Conduct a forum or debate on ethical and moral issues in the application of knowledge in genetics.</p> <p>Visit research centres that conduct research in genetic engineering.</p>	<ul style="list-style-type: none"> ? explain briefly the importance of genetics to mankind, ? describe the application and abuse of knowledge in genetics, ? argue on the need for ethics and moral in the application of genetics. 		<p>DNA fingerprinting – <i>cap jari DNA</i></p> <p>genetic engineering – <i>kejuruteraan genetik</i></p> <p>ethics – <i>etika</i></p>

LEARNING AREA: 2.0 VARIATION

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>2.1 Understanding variation in organisms</p>	<p>Discuss the importance of variation in organisms.</p> <p>Conduct an activity to investigate variation in humans and present the data graphically.</p> <p>Discuss continuous and discontinuous variation based on the graphs.</p> <p>Compare continuous variation with discontinuous variation.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? state the importance of variation in organisms, ? give examples of variation in humans, ? state the types of variation, ? compare continuous variation with discontinuous variation. 		<p>variations – <i>variasi</i></p> <p>continuous variation – <i>variasi selanjur</i></p> <p>discontinuous variation – <i>variasi tak selanjur</i></p>
<p>2.2 Understanding the causes of variation</p>	<p>Discuss the cause of variation in terms of:</p> <ul style="list-style-type: none"> a) genetic factors, b) environmental factors. <p>Discuss the effects of genetic factor on variation.</p> <p>Conduct an activity, such as role-playing or model-building, to show the process of genetic recombination.</p> <p>Conduct an activity to study the effects of different environmental factors on the variation of plants.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? state the factors causing variation, ? explain the effects of genetic factors on variation, ? explain the effects of environmental factors on variation, ? explain the effects of the interaction between genetic factors and environmental factors on variation, 		

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Discuss the following: a) chromosomal mutation, b) gene mutation.</p> <p>Discuss examples of mutation and mutagens.</p> <p>Discuss the importance of variation in the survival of a species.</p>	<p>? explain mutation,</p> <p>? explain the importance of variation in the survival of a species.</p>		
<p>2.3 Be respectful towards one another despite variation</p>	<p>Participate in games and club activities involving individuals from various ethnic groups.</p> <p>Conduct a sketch to show respect for all God's creation.</p>	<p>A student is able to:</p> <p>? accept that people are different,</p> <p>? respect each other.</p>		

ACKNOWLEDGEMENTS

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Curriculum Development Centre
Ministry of Education Malaysia
2006