



MINISTRY OF EDUCATION MALAYSIA

Integrated Curriculum for Secondary Schools

Curriculum Specifications

BIOLOGY

Form 4



Curriculum Development Centre
Ministry of Education Malaysia
2005

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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
Curriculum Development Centre
Ministry of Education Malaysia

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 Numbers	Making quantitative observations using numbers and tools with standardised units. 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.
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Inventing	Producing something new or adapting something already in existence to overcome problems in a systematic manner.
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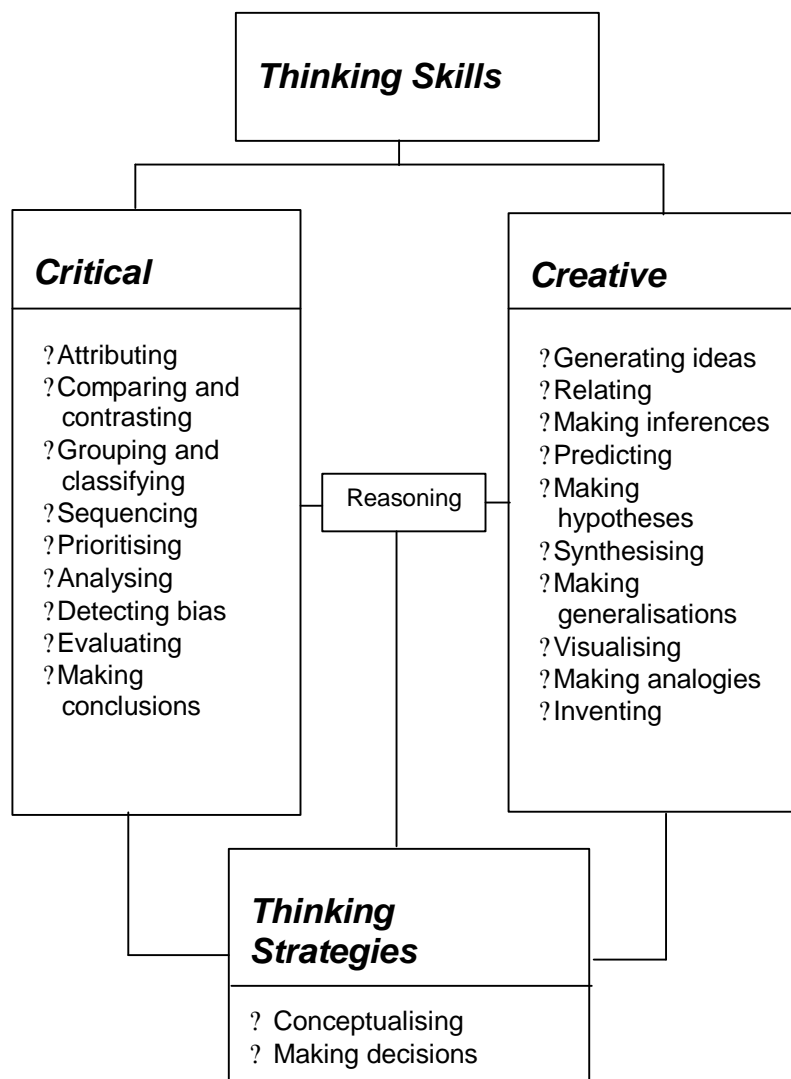
Thinking Strategy

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

Science Process Skills	Thinking Skills
Controlling variables	Attributing Comparing and contrasting Relating Analysing
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 Four
Learning Area:	2.0 Endangered Ecosystem
Learning Objective:	2.3 Realising the importance of proper management of development activities and the ecosystem.
Learning Outcome:	Explain measures taken in the management of development activities and the ecosystem to ensure a balance of nature is maintained.
Suggested Learning Activities	Carry out small group discussion and present the findings, based on the following: a) implementation of laws, b) education on the management of resources, include the reduce, reuse, and recycle of resources,
Scientific attitudes and noble values	Love and respect for the environment. Being responsible for the safety of oneself, others and the environment.

Appreciating the balance of nature.

Being systematic.

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: INTRODUCING BIOLOGY**LEARNING AREA: 1.0 INTRODUCTION TO BIOLOGY**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.1 Understanding the study of Biology	<p>Carry out small group discussion on the following and present the findings:</p> <p>a) what is the study of Biology? b) the importance of Biology with respect to the study of living things, environment, interaction between living things and the environment.</p> <p>Construct a concept map based on information gathered on the different fields of study and careers related to Biology.</p> <p>Small group discussion on the importance of the following: a) acquiring scientific skills, b) scientific method, c) practising scientific attitudes and noble values.</p>	<p>A student is able to:</p> <p>? state what the study of Biology is,</p> <p>? explain the importance of Biology,</p> <p>? list the different fields of study in Biology,</p> <p>? list the careers related to Biology,</p> <p>? state various ways of studying Biology,</p>		<p>fields – <i>bidang</i></p> <p>career – <i>kerjaya</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.2 Applying scientific investigation	<p>Observe a situation and identify all the variables. Suggest a question that is suitable for a scientific investigation. Discuss to:</p> <ul style="list-style-type: none"> a) form a hypothesis, b) plan the method of investigation including selection of apparatus and work procedures. <p>Carry out an experiment:</p> <ul style="list-style-type: none"> a) to collect and tabulate data, b) present data in a suitable form, c) interpret the data and draw conclusion, d) write a complete report. <p>Carry out an experiment on the making of bread using yeast in the absence and presence of sugar. Record the time taken for the dough to double its size. For further investigations, salt is used.</p> <p>During investigation, highlight the need to practise scientific attitudes and noble values such as honesty and accuracy in recording and verifying data.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? identify variables in a given situation, ? identify the relationship between two variables to form a hypothesis, ? design and carry out a simple experiment to test the hypothesis, ? record and present data in a suitable form, ? interpret data to draw conclusions, ? write a report on an experiment, ? practise scientific attitudes and noble values. 	<p>This activity helps the teacher to assess students' capabilities to carry out a scientific investigation.</p> <p>These attitudes and values should be observed in all investigations in other learning areas.</p>	<p>scientific investigation – <i>penyiasatan saintifik</i></p> <p>scientific attitudes – <i>sikap saintifik</i> noble values – <i>nilai murni</i></p>

LEARNING AREA: 1.0 CELL STRUCTURE AND CELL ORGANISATION

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Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Work in small groups to match cellular components to their functions.</p> <p>Students present a comparison between the structure of an animal cell and a plant cell.</p> <p>Discuss the relationship between the density of certain organelles with the function of specific cells:</p> <p>a) mitochondria with the function of sperm cells, flight muscle cells in insects and birds, cells in the meristems,</p> <p>b) chloroplasts with the function of palisade cells.</p>	<p>? state the functions of the cellular components in an animal cell,</p> <p>? state the functions of the cellular components in a plant cell,</p> <p>? compare and contrast an animal cell and a plant cell,</p> <p>? relate the density of certain organelles with the functions of specific cells.</p>		<p>relate – <i>mengiatkan</i></p> <p>density - <i>ketumpatan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.2 Understanding cell organisation	<p>Observe the living processes of unicellular organisms such as feeding, locomotion and reproduction through computerised animation / video / microscope.</p> <p>Carry out small group discussion on the following and present the findings:</p> <ul style="list-style-type: none"> a) cell specialisation in multicellular organisms, b) the necessity for cell specialization in multicellular organisms c) cell organisation in the formation of tissues, organs and systems in humans, animals and plants. <p>Construct models of tissues, organs and systems in human, animals and plants.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? state the necessity for cell specialisation in multicellular organism as compared to unicellular organism, ? describe cell specialisation in multicellular organisms, ? describe cell organisation in the formation of tissues, organs and systems in multicellular organisms, 		<p>living processes – <i>proses - proses kehidupan</i></p> <p>cell specialisation – <i>pengkhususan sel</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Conduct a discussion on the following:</p> <ul style="list-style-type: none"> a) the meaning of internal environment, b) factors affecting the internal environment including temperature, pH, osmotic pressure and glucose level. c) it is important that the organism's cells always experience conditions which permit efficient functioning, the involvement of various systems in maintaining optimal internal environment. 	<ul style="list-style-type: none"> ? state the meaning of internal environment, ? identify factors affecting the internal environment, ? explain the necessity to maintain optimal internal environment, ? describe the involvement of various systems in maintaining optimal internal environment. 	A simple explanation.	
1.3 Appreciating the uniqueness of the cell	<p>Discuss and predict the cell condition without a particular cellular component.</p> <p>Conduct a role-play activity to show that cells become adapted for different functions.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? predict the state of certain cells without a particular cellular component, ? illustrate that most cells are specialised for the job that they perform. 		uniqueness – <i>keunikan</i>

LEARNING AREA: 2.0 MOVEMENT OF SUBSTANCES ACROSS THE PLASMA MEMBRANE

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
2.1 Analysing the of movement of substances across the plasma membrane	<p>Discuss the following:</p> <ul style="list-style-type: none"> a) substances that are required by cells, b) substances to be eliminated from cells, c) the necessity for movement of substances across the plasma membrane. <p>Discuss the structure of the plasma membrane as comprising the phospholipid bilayer, carrier protein and pores.</p> <p>Conduct an experiment, using starch suspension and glucose solution, to study the movement of substances across egg membrane or Visking tubing.</p> <p>Discuss the properties of the plasma membrane as a semi-permeable membrane.</p> <p>Discuss the movement of soluble substances across the plasma membrane through simple diffusion and facilitated diffusion.</p> <p>Carry out an activity to show osmosis using a simple osmometer.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? state the substances required by living cells, ? state the substances that have to be eliminated from cells, ? explain the necessity for movement of substances across the plasma membrane, ? describe the structure of the plasma membrane, ? describe the permeability of the plasma membrane, ? explain the movement of soluble substances across the plasma membrane through the process of passive transport, ? explain the movement of water molecules across the plasma membrane by osmosis, 	<p>Only a brief account of the structure of the plasma membrane is required.</p>	<p>permeability - <i>ketelapan</i></p> <p>simple diffusion – <i>resapan ringkas</i></p> <p>facilitated diffusion – <i>resapan berbantu</i></p> <p>passive transport – <i>pengangkutan pasif</i></p> <p>active transport - <i>pengangkutan aktif</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Discuss the movement of substances across the plasma membrane through active transport.</p> <p>Conduct a simulation activity to show the movement of substances across the plasma membrane through passive transport and active transport.</p> <p>Use computer simulation to show the movement of substances across the plasma membrane.</p> <p>Discuss the processes of passive transport and active transport in living organisms: a) gaseous exchange in the alveoli and blood capillaries (simple diffusion), b) absorption of digested food in the villus (facilitated diffusion), c) absorption of water by root hairs of a plant (osmosis), d) ion intake by root hairs of a plant (active transport).</p>	<p>? explain the movement of substances across the plasma membrane through the process of active transport,</p> <p>? explain the process of passive transport in living organisms using examples,</p> <p>? explain the process of active transport in living organisms using examples,</p>	<p>Only a basic explanation of the active transport process is required.</p>	

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Construct a concept map on the movement of substances across the plasma membrane.</p> <p>Use a graphic organiser to compare and contrast passive transport and active transport.</p>	? compare and contrast passive transport and active transport.		
2.2 Understanding the movement of substances across the plasma membrane in everyday life	<p>Carry out activities to study the effects of hypotonic and hypertonic solutions on plant and animal cells:</p> <p>a) plasmolysis and deplasmolysis in plant cells,</p> <p>b) haemolysis and crenation in red blood cells.</p> <p>Discuss the following:</p> <p>a) hypotonic, hypertonic and isotonic solutions,</p> <p>b) plasmolysis, deplasmolysis, haemolysis and crenation,</p> <p>c) flaccidity and turgidity of plant cells.</p> <p>Carry out an investigation using various concentrations of salt or sugar solutions to determine the concentration of external solution which is isotonic to the cell sap of plant tissues.</p>	<p>A student is able to:</p> <p>? explain what hypotonic, hypertonic and isotonic solutions are,</p> <p>? explain the effects of hypotonic, hypertonic and isotonic solutions on plant cell and animal cell,</p> <p>? explain plasmolysis, deplasmolysis, haemolysis and crenation,</p> <p>? design an experiment to determine the concentration of external solution which is isotonic to cell sap,</p>	<p>The use of human blood is discouraged.</p> <p>The concentration of the external solution which is isotonic to the cell sap is determined from the plotted graph.</p>	<p>effects - <i>kesan</i></p> <p>turgidity - <i>kesegahan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Discuss and make an inference on the concentration of cell sap in plant tissues which is equivalent to the concentration of isotonic solution.</p> <p>Discuss and correlate the movement of substances across the plasma membrane with the difference in concentration of the external solution and that of the cell sap.</p> <p>Discuss the following:</p> <ul style="list-style-type: none"> a) wilting of plants caused by the excessive use of chemical fertilisers, b) preservation of food using salt or sugar. 	<p>? make an inference on the concentration of cell sap in plant tissues,</p> <p>? relate the movement of substances across plasma membrane with concentration gradient,</p> <p>? explain the phenomenon of wilting in plants using examples,</p> <p>? explain the preservation of food using examples.</p>	<p>Discussion should be based on the concepts of osmosis and plasmolysis.</p>	<p>wilting – <i>layu</i></p> <p>preservation - <i>pengawetan</i></p>
2.3 Appreciating the movement of substances across the plasma membrane	Compose poems to appreciate the movement of substances across the plasma membrane.	<p>A student is able to:</p> <p>? explain the necessity of movement of substances across the plasma membrane which occurs in a continuous and controlled manner for survival of a cell.</p>		

LEARNING AREA: 3.0 CHEMICAL COMPOSITION OF THE CELL

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
3.1 Understanding the chemical composition of the cell	Carry out small group discussion on the following and present the findings: a) elements in the cell, including carbon, hydrogen, oxygen, nitrogen sulphur, phosphorus, calcium, potassium, magnesium, chlorine, sodium and ferum, b) the presence and importance of chemical compounds in the cell.	A student is able to: ? state the elements in the cell, ? list the chemical compounds in the cell, ? explain the importance of organic compounds in the cell, ? explain the importance of water in the cell.	Chemical compounds in the cell are limited to carbohydrates, lipids, proteins, nucleic acids and water only. A brief account on the importance of carbohydrates, lipids, proteins and nucleic acids is required.	organic compounds – <i>sebatian organik</i>
3.2 Understanding carbohydrates	Carry out small group discussion on the following and present the findings: a) elements in carbohydrates, b) types of carbohydrates, i.e. monosaccharides, disaccharides and polysaccharides, using examples, c) the formation and breakdown of disaccharides, such as maltose, sucrose and lactose, d) the formation and breakdown of polysaccharides, such as starch, glycogen and cellulose. Conduct an activity to differentiate between reducing and non-reducing sugars.	A student is able to: ? state the elements in carbohydrates, ? state the types of carbohydrates, ? explain the formation and breakdown of disaccharides and polysaccharides.	A detailed molecular structure is not required. A brief account of condensation and hydrolysis reactions is required.	formation – <i>pembentukan</i> breakdown - <i>penguraian</i> reducing sugar – <i>gula penurun</i> non-reducing sugar – <i>gula bukan penurun</i>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
3.3 Understanding proteins	<p>Carry out small group discussion on the following and present the findings:</p> <ul style="list-style-type: none"> a) elements in protein, such as carbon, hydrogen, oxygen, sulphur, nitrogen and phosphorus, b) dipeptides and polypeptides, c) the formation and breakdown of dipeptides and polypeptides, d) essential amino acids and non-essential amino acids. <p>Use charts to illustrate the various protein structures, i.e. primary, secondary, tertiary and quaternary.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? state the elements in proteins, ? state the various structures of proteins, ? explain the formation and breakdown of dipeptides and polypeptides, ? explain the meaning of essential amino acids and non-essential amino acids. 	<p>A detailed molecular structure is not required.</p> <p>A brief account of condensation and hydrolysis reactions is required.</p>	
3.4 Understanding lipids	<p>List the main types of lipids:</p> <ul style="list-style-type: none"> a) fat, b) oil, c) wax, d) phospholipids, e) steroids, such as cholesterol, testosterone, oestrogen, and progesterone. 	<p>A student is able to:</p> <ul style="list-style-type: none"> ? state the elements in lipids, ? state the main types of lipids, 	<p>A detailed molecular structure is not required.</p>	

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Carry out small group discussion on the following and present the findings:</p> <ol style="list-style-type: none"> elements in lipids, components of fats and oils, formation and breakdown of fats and oils. <p>Use a graphic organiser to compare saturated fats and unsaturated fats.</p>	<p>? state the components of fats and oils.</p> <p>? explain the formation and breakdown of fats and oils,</p> <p>? compare and contrast saturated fats and unsaturated fats.</p>	A brief account of condensation and hydrolysis reactions is required.	<p>saturated fats – <i>lemak tepu</i></p> <p>unsaturated fats – <i>lemak tak tepu</i></p>
3.5 Understanding enzymes	<p>Discuss on the following:</p> <ol style="list-style-type: none"> what enzymes are, enzyme requirement in the living process, general characteristics of enzyme, naming of enzyme based on the substrate, sites of enzyme synthesis, intracellular and extracellular enzymes and examples. <p>Conduct a role-play activity to show the involvement of ribosomes, endoplasmic reticulum, and Golgi body in the production of extracellular enzyme.</p>	<p>A student is able to:</p> <p>? state what enzymes are,</p> <p>? explain why enzymes are needed in life processes,</p> <p>? list the general characteristics of enzymes,</p> <p>? relate the name of enzyme to substrate,</p> <p>? state sites where enzymes are synthesised,</p> <p>? state the meaning of intracellular enzymes and extracellular enzymes,</p> <p>? explain the involvement of specific organelles in the production of extracellular enzymes,</p>		<p>intracellular enzyme – <i>enzim intrasel</i></p> <p>extracellular enzyme – <i>enzim luar sel</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Conduct experiments to study the effects of pH and temperature on the activities of amylase and pepsin.</p> <p>Discuss the effects of enzyme concentration and substrate concentration on enzyme activity.</p> <p>Discuss the mechanism of enzyme action using the 'lock and key' hypothesis.</p> <p>Discuss and correlate pH, temperature, enzyme concentration and substrate concentration on enzyme activity using the 'lock and key' hypothesis.</p> <p>Gather information from the Internet and other sources on the uses of enzymes in:</p> <p>a) daily life, e.g. tenderising meat</p> <p>b) industry e.g. food processing and detergent manufacturing.</p>	<p>? explain the effects of pH, temperature, enzyme concentration, and substrate concentration on enzyme activity,</p> <p>? explain the mechanism of enzyme action,</p> <p>? relate the mechanism of enzyme action with pH, temperature, enzyme concentration and substrate concentration,</p> <p>? explain the uses of enzymes in daily life and industry using examples.</p>		<p>concentration - <i>kepekatan</i></p> <p>substrates – <i>substrat</i></p>
3.6 Realising the importance of the chemical composition in cells	Conduct a role play or story telling session to predict the consequences of deficiency in one of the chemical components in the cell.	? predict the consequences of deficiency in carbohydrates, protein, lipids or enzymes in the cell.		deficiency - <i>kekurangan</i>

LEARNING AREA: 4.0 CELL DIVISION

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
4.1 Understanding mitosis	<p>Conduct a brainstorming session on the following:</p> <ul style="list-style-type: none"> a) the need for production of new cells in organisms, b) the need for production of new cells identical to parent cells. <p>Derive the meaning and significance of mitosis from the brainstorming session.</p> <p>Study charts to identify the various phases of the cell cycle.</p> <p>Make models to demonstrate mitosis and cytokinesis.</p> <p>Prepare and observe a slide of onion root tip to identify different stages of mitosis.</p> <p>Study the process of controlled and uncontrolled mitosis and cytokinesis through simulation, computerised animation or video.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? state the necessity for the production of new cells in organisms, ? explain the necessity for the production of new cells identical to parent cells, ? state the significance of mitosis, ? identify the phases in the cell cycle, ? explain the process of mitosis and cytokinesis, ? arrange the various stages of mitosis in the correct sequence, ? compare and contrast mitosis and cytokinesis in animal cell and plant cell, 		<p>identical - <i>seiras</i></p> <p>significance - <i>kepentingan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Conduct a brainstorming session to come up with examples on mitosis as a controlled process for the perpetuity of living things such as regeneration of lizard tail, certain plant parts and the healing of skin.</p> <p>Gather information on diseases, including cancer or tumour, caused by uncontrolled mitosis in living things.</p> <p>Make a trip to a research institute to study tissue culture technique.</p> <p>Conduct a debate or forum on cloning issues.</p>	<p>? explain the importance of controlled mitosis,</p> <p>? explain the effects of uncontrolled mitosis in living things,</p> <p>? describe the application of knowledge on mitosis in cloning,</p> <p>? explain the advantages and disadvantages of cloning.</p>	Techniques of cloning include tissue culture.	<p>controlled mitosis – <i>mitosis terkawal</i></p> <p>regeneration – <i>pertumbuhan / penjanaan semula</i></p> <p>uncontrolled mitosis – <i>mitosis luar kawal</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
4.2 Understanding meiosis	<p>Discuss the following:</p> <ul style="list-style-type: none"> a) trait inheritance in offsprings, b) the need to maintain diploid chromosomal number from one generation to another, c) the need to produce gametes with haploid number of chromosomes, d) the uniqueness of diploid number of chromosomes in organisms, e) the significance of meiosis, f) the type of cell that undergoes meiosis in human, animals and plants. <p>Observe the process of meiosis through computerised animation, photomicrograph, prepared slides, or video.</p> <p>Use simulation activities to show changes in chromosome behaviour during meiosis I and meiosis II</p> <p>Use graphic organisers to compare and contrast:</p> <ul style="list-style-type: none"> a) Meiosis I and meiosis II, b) Meiosis and mitosis. 	<p>A student is able to:</p> <ul style="list-style-type: none"> ? state the necessity of trait inheritance in offspring for continuation of life, ? state the necessity to maintain diploid chromosomal number from generation to generation, ? state the necessity for production of haploid gametes in sexual reproduction, ? state the significance of meiosis, ? identify the type of cell that undergoes meiosis, <ul style="list-style-type: none"> ? explain the process of meiosis, ? arrange the various stages of meiosis in the correct order, <ul style="list-style-type: none"> ? compare and contrast meiosis I and meiosis II, ? compare and contrast meiosis and mitosis. 	<p>A detailed explanation of Prophase 1 is not required.</p>	<p>trait inheritance – <i>pewarisan ciri</i> offspring – <i>anak</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>4.3 Appreciating the movement of chromosomes during mitosis and meiosis.</p>	<p>a) conduct a role-play, b) avoid radioactive and carcinogenic substances.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? describe what will happen when the movement of chromosomes during mitosis and meiosis do not occur in an orderly manner, ? know and avoid things that maybe harmful. 		

THEME: INVESTIGATING THE PHYSIOLOGY OF LIVING THINGS

LEARNING AREA: 1.0 NUTRITION

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.1 Understanding types of nutrition	<p>Observe and identify types of nutrition in various organisms.</p> <p>Discuss autotrophic and heterotrophic nutrition with reference to chemosynthesis, photosynthesis, holozoic nutrition, saprophytism, and parasitism.</p> <p>Use a graphic organiser to show the types of nutrition.</p> <p>Conduct an activity to classify various organisms according to types of nutrition.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? state the types of nutrition, ? explain autotrophic nutrition, ? explain heterotrophic nutrition, ? classify organisms according to the types of nutrition. 		
1.2 Applying the concept of balanced diet	<p>Carry out small group discussion on the following and present the findings:</p> <p>a) requirements of a balanced diet,</p> <p>b) factors affecting the daily energy requirement such as age, sex, body weight and occupation.</p> <p>Conduct an activity to determine the energy value in food samples.</p> <p>Design activities to test for the presence of starch, reducing sugar, non-reducing sugar, protein and lipid in food samples.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? explain the necessity for a balanced diet, ? explain the factors affecting the daily energy requirement of the human body, ? determine the energy value in food samples, ? determine the nutrient content in different food samples, 	<p><i>The unit for energy used is Joule.</i></p>	<p>balanced diet – <i>gizi seimbang</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Conduct an experiment to determine the Vitamin C content in various fruit juices.</p> <p>Match the vitamins with their sources, functions and effects of deficiency.</p> <p>Match the minerals with their sources, functions and effects of deficiency.</p> <p>Discuss the sources, functions and deficiency of roughage.</p> <p>Discuss the sources and functions of water in the body.</p> <p>Carry out a group discussion to formulate and justify an appropriate diet menu based on a nutrient chart for the following target groups:</p> <ol style="list-style-type: none"> pregnant mothers, infants, children, teenagers, athletes, people with specific diseases, the aged, vegetarians. 	<p>? explain the functions and sources of vitamins in a diet to maintain health,</p> <p>? explain the functions and sources of minerals in a diet to maintain health,</p> <p>? explain the functions and sources of roughage / dietary fibre in a diet,</p> <p>? explain the functions of water in the body,</p> <p>? justify the selection of an appropriate balanced diet for a target group.</p>		<p>roughage / dietary fibre – <i>pelawas</i></p> <p>target group – <i>kumpulan sasaran</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.3 Understanding malnutrition	<p>Carry out small group discussion on the following and present the findings:</p> <ul style="list-style-type: none"> a) meaning of malnutrition, b) effects of deficiency in proteins, vitamins, minerals, on health, c) effects of excessive intake of carbohydrates, lipids, vitamins and minerals on health, d) a diet low in saturated fats help reduce the chance of contracting cardiovascular disease, e) ways to reduce the risk of high blood pressure, diabetes mellitus and osteoporosis. 	<p>A student is able to:</p> <ul style="list-style-type: none"> ? explain what malnutrition is, ? explain the effects of malnutrition using examples, ? describe ways to reduce the chance of contracting certain health problems due to one's diet, ? describe ways to reduce the effects of certain health problems. 		
1.4 Analysing food digestion	<p>Discuss the following:</p> <ul style="list-style-type: none"> a) glucose, amino acids and lipids are always required by the cell to carry out metabolic processes, b) complex substances like carbohydrates, proteins and lipids need to be digested. <p>Draw and label parts of the human digestive system.</p> <ul style="list-style-type: none"> a) 	<p>A student is able to:</p> <ul style="list-style-type: none"> ? state the substances required by the cell to carry out metabolic processes, ? list the complex substances that need to be digested, ? explain the necessity for digestion of complex substances, ? draw and label the human digestive system, ? 		metabolic processes – <i>proses metabolik</i>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Discuss the functions of digestive juices, including saliva, gastric juice, pancreatic juice, intestinal juice and other substances, i.e. hydrochloric acid and bile that aid the process of digestion.</p> <p>Discuss the digestion of carbohydrates, proteins and fats on the following aspects:</p> <ol style="list-style-type: none"> specific location of each digestive process, chewing of food, movement of food, glands involved, digestive enzymes, suitable pH for each enzyme action, substrates and products. <p>Identify the parts of digestive system in ruminants and rodents.</p> <p>Discuss the digestion of cellulose in ruminants (eg. cow) and rodents (rabbit).</p> <p>Use graphic organiser to compare and contrast the process of cellulose digestion in humans, ruminants and rodents.</p>	<p>? state the digestive juices and substances that aid in the process of digestion in human,</p> <p>? describe the functions of the digestive juices and substances,</p> <p>? explain the digestion of carbohydrates, proteins and lipids in the human body,</p> <p>? identify parts of digestive system in ruminants and rodents involved in the digestion of cellulose,</p> <p>? describe the digestion of cellulose in ruminants and rodents,</p> <p>? compare and contrast the digestive process in humans, ruminants and rodents,</p>		<p>digestive juices – <i>jus pencernaan</i></p> <p>bile - <i>hempedu</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Plan and conduct experiments to study the enzyme actions on starch and protein food samples.</p> <p>Collect information and discuss problems related to food digestion: b) incomplete digestion of food, c) bile stones preventing the flow of bile, reduced production of specific digestive enzyme.</p>	<p>? design experiments to study the digestion of starch and proteins in food samples,</p> <p>? describe problems related to food digestion.</p>		
1.5 Understanding the processes of absorption and assimilation of digested food	<p>Examine models or diagrams of the digestive system and cross-section of the small intestine. With reference to the models or diagrams discuss the following: a) adaptation of the small intestine, b) absorption process of amino acids, glucose, fatty acids, glycerol, vitamins and minerals in the villus.</p> <p>Carry out an activity to study the movement of substances through the Visking tubing.</p>	<p>A student is able to:</p> <p>? identify the parts of the digestive system involved in absorption of digested food, ? explain the adaptive characteristic of the digestive system related to absorption, ? draw and label the structure of a villus, ? explain the process of absorption in the villus,</p> <p>?</p>		<p>adaptive characteristic – <i>ciri-ciri penyesuaian</i></p> <p>absorption - <i>penyerapan</i></p> <p>small intestine – <i>usus kecil</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Based on the above activity correlate the movement of food substances through the Visking tubing with nutrient absorption in the small intestine.</p> <p>Discuss the absorption of water and minerals in the colon.</p> <p>Using diagrams, charts or computerised animation discuss:</p> <p>a) the transport of amino acids, glucose, water soluble vitamins and minerals by the circulatory system</p> <p>i) from the small intestine to the liver through the hepatic portal vein,</p> <p>ii) from the liver to the body cells,</p> <p>b) transport of lipids and fat soluble vitamins.</p> <p>Make a schematic diagram to show the transport of nutrients from the intestine to the body cells.</p>	<p>? make an analogy on the process of absorption in the small intestine,</p> <p>? explain the absorption of water and minerals in the colon,</p> <p>? describe the transport of nutrients by the circulatory system for assimilation,</p>		<p>transport – <i>pengangkutan</i></p> <p>circulatory system – <i>sistem peredaran</i></p> <p>liver – <i>hati</i></p> <p>assimilation - <i>assimilasi</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.7 Evaluating eating habits	<p>Carry out small group discussion on the following and present the findings:</p> <p>a) relationship between eating habits and health problems such as:</p> <ul style="list-style-type: none"> (i) gastritis, (ii) obesity, (iii) anorexia nervosa, (iv) bulimia, <p>b) evaluate the nutrient contents of food based on food labels or advertisements,</p> <p>c) evaluate the eating habits of classmates.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? relate eating habits with health problems, ? evaluate critically whether a particular eating habit is good or bad. 	Eating habits involve the frequency and time of eating and the type of food consumed.	<p>eating habits – <i>tabiat makan</i></p> <p>health problems – <i>masalah kesihatan</i></p>
1.8 Realising the importance of a healthy digestive system	<p>Conduct an activity to predict the effects of a defective digestive system.</p> <p>Conduct a discussion on ways to take care of the digestive system, such as good eating habits, avoid junk food, try to cut down on sweet and fatty foods.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? predict the effects of a defective digestive system on health, ? take care of the digestive system for one's well-being. 		<p>defective digestive system – <i>sistem pencernaan yang tidak berfungsi dengan baik</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.9 Understanding the importance of macronutrients and micronutrients in plants	<p>Carry out small group discussion on the following and present the findings:</p> <p>a) the elements required by plants,</p> <p>b) classify the elements required by plants based on the amount needed:</p> <p>(i) macronutrients consisting of carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulphur,</p> <p>(ii) micronutrients consisting of boron, molybdenum, zinc, manganese, copper and ferum.</p> <p>Plan and conduct an experiment on plants to study the effects of macronutrient deficiency i.e. nitrogen, phosphorus, potassium, calcium, magnesium and sulphur. Discuss and correlate the effects of macronutrient deficiency with the function of the macronutrients based on the results of the experiment.</p>	<p>A student is able to:</p> <p>? list elements required by plants,</p> <p>? classify elements required by plants based on the amount needed,</p> <p>? design an experiment to study the effects of macronutrient deficiency in plants,</p> <p>? relate the effects of macronutrient deficiency with the function of macronutrients,</p>	<p>Maize seedlings may be used for this experiment.</p>	<p>elements – <i>unsur-unsur</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Collect and interpret data from various sources such as the Internet on the function of each macronutrient in plants.</p> <p>Discuss the function of micronutrients and effects of micronutrient deficiency in plants.</p>	<p>? explain the function of each macronutrient in plants,</p> <p>? state the function of micronutrients in plants,</p> <p>? state the effects of micronutrient deficiency in plants.</p>		
1.10 Understanding photosynthesis	<p>Students read about the discovery of photosynthesis and extract important facts from it.</p> <p>Study a cross-sectional model of a leaf. Draw and label it.</p> <p>Discuss the following:</p> <p>a) functions of the parts of a leaf,</p> <p>b) adaptation of the leaf for optimal photosynthesis.</p> <p>Carry out an activity to investigate the adaptation of plants such as hibiscus, water lily, <i>Hydrilla</i> and cactus with respect to:</p> <p>a) distribution of stomata,</p> <p>b) distribution of chloroplasts.</p>	<p>A student is able to:</p> <p>? describe the development that leads to the discovery of photosynthesis,</p> <p>? state the substances required for photosynthesis,</p> <p>? state the substances produced from photosynthesis,</p> <p>? draw and label the cross-section of a leaf,</p> <p>? state the function of each part of the leaf with respect to photosynthesis,</p> <p>? explain leaf adaptation to optimise photosynthesis,</p> <p>? explain how plants from different habitats are adapted to carry out photosynthesis.</p>		adaptation - <i>penyesuaian</i>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.11 Understanding the mechanism of photosynthesis	<p>With reference to the structure of chloroplast discuss the light and dark reactions of photosynthesis with respect to:</p> <ol style="list-style-type: none"> substances required. location of reaction. products of reaction. <p>Draw a simple schematic diagram of the light and dark reactions in photosynthesis.</p> <p>Discuss the following:</p> <ol style="list-style-type: none"> compare and contrast the light reaction and dark reaction in photosynthesis, correlate light reaction with dark reaction in photosynthesis. <p>Write an equation to represent the overall process of photosynthesis.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? identify the parts of chloroplast related to photosynthesis, ? explain the light reaction of photosynthesis, ? explain the dark reaction of photosynthesis, ? compare and contrast light reaction and dark reaction in photosynthesis, ? relate light reaction with dark reaction in photosynthesis, ? write an equation to represent the process of photosynthesis. 	<p>Detailed structure of chloroplast is not required.</p> <p>Detailed pathways for light and dark reactions are not required.</p>	<p>light reaction – <i>tindakbalas cahaya</i></p> <p>dark reaction – <i>tindakbalas gelap</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.12 Synthesising factors affecting photosynthesis	<p>Conduct a brainstorming session to identify the factors affecting the rate of photosynthesis i.e. concentration of carbon dioxide, light intensity and temperature. Plan and carry out an experiment to study the effect of light intensity on the rate of photosynthesis.</p> <p>Carry out small group discussion on the effects of light intensity, temperature and concentration of carbon dioxide on the rate of photosynthesis.</p> <p>Plan a strategy based on factors affecting the rate of photosynthesis to ensure crop production throughout the year in countries with four seasons.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? identify the factors affecting the rate of photosynthesis, ? design an experiment to investigate the effect of light intensity on the rate of photosynthesis, ? identify the factor that limits the rate of photosynthesis at different light intensity, ? explain the effects of temperature and concentration of carbon dioxide on the rate of photosynthesis, ? explain the difference in the rate of photosynthesis in plants throughout the day based on the changes in light intensity and temperature, ? identify some ways to meet the need of increasing the productivity of crops based on factors affecting the rate of photosynthesis. 		<p>light intensity – <i>keamatan cahaya</i></p> <p>limiting factor- <i>faktor penghad</i></p> <p>crops - <i>tanaman</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.13 Practising a caring attitude towards plants	<p>Compose a poem or lyric of a song to show appreciation of the role of photosynthesis in ensuring the perpetuation of life.</p> <p>Conduct a planting project in the science resource garden or school compound.</p>	<p>A student is able to:</p> <p>? tell why we need to take good care of plants,</p> <p>? identify cases of mishandling or destruction of plants.</p>		
1.14 Understanding the technology used in food production	<p>Carry out small group discussion on the following and present the findings:</p> <p>a) the quantity of food needed for the present and future population of the country,</p> <p>b) the need for improving the quality and quantity of food for the country in line with the national food production policy,</p> <p>c) effort by various agencies to diversify food production,</p> <p>d) methods used to improve the quality and quantity of food production through the following:</p> <p>(i) direct seeding for rice,</p> <p>(ii) hydroponics and aeroponics,</p> <p>(iii) breeding,</p> <p>(iv) tissue culture,</p> <p>(v) genetic engineering</p> <p>(vi) soil management,</p> <p>(vii) biological control.</p>	<p>A student is able to:</p> <p>? explain the need for improving the quality and quantity of food,</p> <p>? explain the effort to diversify food production,</p> <p>? explain ways to improve the quality and quantity of food production in the country.</p>		<p>improving - <i>menambahbaikkan</i></p> <p>diversify - <i>mempelbagaikan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Conduct a field trip to relevant agencies such as the Institute of Agricultural Research and Development of Malaysia (MARDI), Agriculture Department and Fishery Department.</p> <p>Carry out a vegetable planting project.</p>			
1.15 Evaluating the technological development in food processing	<p>Discuss the need for food processing based on the following:</p> <ul style="list-style-type: none"> a) overcoming the factors causing spoilage of food such as the action of microorganisms and oxidation, b) extending the lifespan of food, c) avoiding food wastage, d) diversifying the uses of food like milk and dairy products, e) ensuring sufficient food supply. <p>Prepare a portfolio on the technological development of food processing from the early days till the present.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? explain the necessity for food processing, ? describe the development of food processing technology, 		<p>food processing – <i>pemprosesan makanan</i></p> <p>development - <i>perkembangan</i></p> <p>food spoilage – <i>kerosakan makanan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Correlate the following food processing methods with factors causing food spoilage:</p> <ul style="list-style-type: none"> i. cooking, ii. using salt, sugar and vinegar, iii. fermentation process, iv. drying, v. pasteurization, vi. canning, vii. refrigeration. <p>Conduct a forum entitled “The effects of processed food on health.”</p>	<p>? relate food processing methods with factors causing food spoilage,</p> <p>? assess the methods of food processing to justify the choice of consuming certain processed food.</p>		

LEARNING AREA: 2.0 RESPIRATION

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
2.1 Understanding the respiratory process in energy production	<p>Discuss the following:</p> <ul style="list-style-type: none"> a) living processes require energy, b) the main substrate for respiration, that is glucose, is obtained from the following: <ul style="list-style-type: none"> (i) the digestion of carbohydrates in human and animals, (ii) the process of photosynthesis in plants. <p>Carry out a discussion on the types of respiration.</p> <p>Carry out an activity to show aerobic respiration.</p> <p>Discuss the energy production in aerobic respiration.</p> <p>Conduct an experiment to investigate anaerobic respiration in yeast.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? state that all living processes require energy, ? identify the main substrate for producing energy, ? state the two types of respiration, ? explain what cell respiration is, ? explain the energy production from glucose during the process of aerobic respiration, ? state the conditions leading to anaerobic respiration in cells, ? explain the process of anaerobic respiration in yeast, 		<p>living processes – <i>proses-proses kehidupan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Discuss the following:</p> <p>a) condition leading to anaerobic respiration in cells,</p> <p>b) the process of anaerobic respiration in human muscles.</p> <p>Use a graphic organiser to compare and contrast aerobic respiration with anaerobic respiration.</p>	<p>? explain the process of anaerobic respiration in human muscles,</p> <p>? write the chemical equations for aerobic and anaerobic respiration,</p> <p>? compare and contrast aerobic respiration with anaerobic respiration.</p>		
<p>2.2</p> <p>Analysing the respiratory structures and Breathing mechanisms in human and animal</p>	<p>Observe graphics and live specimens and discuss the respiratory structures in human and other organisms including protozoa, insects, fish and amphibians.</p> <p>Conduct an activity to compare the total surface area of a flat card with a corrugated card, and correlate the increase in total surface area with the modified surface structure.</p> <p>Discuss the relationship between the total surface area of the respiratory structures and the efficiency of gaseous exchange in various organisms.</p>	<p>A student is able to:</p> <p>? state the respiratory structures in human and some animals,</p> <p>? make an inference on the various adaptations of the respiratory structures,</p>		<p>respiratory structures – <i>struktur pernafasan</i></p> <p>corrugated card – <i>kad lipatan beralun</i></p> <p>adaptations - <i>penyesuaian</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Observe the respiratory structures to generalise the characteristics of the respiratory surfaces in human and other organisms such as protozoa, insects, fish and amphibians.</p> <p>Construct or use a model that can be manipulated to explain the breathing mechanism in human.</p> <p>Discuss the breathing mechanism of other organisms such as protozoa, insects, fish and amphibians.</p> <p>Use graphic organiser to compare and contrast the human respiratory system with that of other organisms.</p>	<p>? describe the characteristics of respiratory surfaces in human and other organisms,</p> <p>? describe the breathing mechanism in human and other organisms,</p> <p>? compare and contrast the human respiratory system with that of other organisms.</p>		<p>respiratory surfaces – <i>permukaan respirasi</i></p> <p>breathing mechanism – <i>mekanisme pernafasan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
2.3 Understanding the concept of gaseous exchange across the respiratory surfaces and transport of gases in human	<p>Using a diagram, discuss the process of gaseous exchange across the surface of the alveolus and blood capillaries in the lungs in relation to:</p> <p>a) the difference in partial pressure of respiratory gases in the air of the alveolus and blood capillaries in the lungs, i.e:</p> <p>(i) partial pressure of oxygen is higher in the air of the alveolus compared to the partial pressure of oxygen in the blood capillaries,</p> <p>(ii) partial pressure of carbon dioxide is lower in the air of the alveolus compared to the partial pressure of carbon dioxide in the blood capillaries.</p> <p>b) the difference in partial pressure of oxygen and carbon dioxide in the blood entering the alveolus with the blood leaving the alveolus i.e.:</p> <p>(i) partial pressure of oxygen is lower in the blood entering the alveolus compared to the partial pressure of oxygen in the blood leaving the alveolus.</p>	<p>A student is able to:</p> <p>? describe the process of gaseous exchange across the surface of the alveolus and blood capillaries in the lungs,</p>		<p>gaseous exchange – <i>pertukaran gas</i></p> <p>blood capillaries – <i>kapilari darah</i></p> <p>partial pressure – <i>tekanan separa</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>(ii) partial pressure of carbon dioxide is higher in the blood entering the alveolus compared to the partial pressure of carbon dioxide in the blood leaving the alveolus.</p> <p>Discuss the following:</p> <p>a) the transport of respiratory gases in human,</p> <p>b) the exchange of respiratory gases between the blood and body cells.</p> <p>Use schematic diagram to explain the exchange and transport of respiratory gases in human.</p> <p>Conduct an experiment to investigate the differences between inhaled and exhaled air in terms of oxygen, carbon dioxide and heat content.</p> <p>Study the process of respiratory gas exchange and transport using simulations and computerised animations.</p>	<p>? explain the transport of respiratory gases,</p> <p>? explain the process of gaseous exchange between the blood and body cells,</p> <p>? distinguish the composition of inhaled and exhaled air.</p>	<p>Caution: Handle the following solutions with care: Alkaline pyrogallate and concentrated potassium hydroxide.</p>	<p>inhaled air – <i>udara sedutan</i></p> <p>exhaled air – <i>udara hembusan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
2.4 Understanding the regulatory mechanism in respiration	<p>Conduct an experiment to study the effects of a vigorous exercise on the rate of respiration and rate of heart beat.</p> <p>Conduct a discussion on the following:</p> <p>a) correlate the rate of respiration with the oxygen and carbon dioxide contents in the body,</p> <p>b) regulatory mechanism of oxygen and carbon dioxide contents in the body.</p> <p>Conduct a discussion on human respiratory response, rate of respiration and rate of heart beat in different situations:</p> <p>a) vigorous activities such as swimming, running, aerobic exercise, mountain climbing and playing badminton,</p> <p>b) relaxing,</p> <p>c) fear.</p>	<p>A student is able to:</p> <p>? describe the change in rate of respiration after completing a vigorous exercise,</p> <p>? correlate the rate of respiration with the oxygen and carbon dioxide content in the body,</p> <p>? explain the regulatory mechanism of oxygen and carbon dioxide content in the body,</p> <p>? explain the human respiratory response and rate of respiration in different situations,</p> <p>? correlate the rate of respiration with the rate of heart beat.</p>		<p>vigorous exercise – <i>senaman cergas</i></p> <p>regulatory mechanism – <i>mekanisme kawalatur</i></p> <p>response – <i>gerak balas</i></p> <p>rate of heart beat – <i>kadar denyutan jantung</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
2.5 Realising the importance of maintaining a healthy respiratory system	<p>Discuss the habits to be cultivated or avoided to ensure the efficient function of the respiratory organs.</p> <p>Conduct an experiment to show the effects of cigarette smoke on white cotton wool and draw an analogy between the lungs and the white cotton wool.</p> <p>Show photographs of damaged lungs (cancer) due to smoking.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? care and maintain efficient function of the respiratory organs. 		efficient – <i>berkesan</i>
2.6 Understanding respiration in plants	<p>Discuss the following:</p> <ul style="list-style-type: none"> a) the lower energy requirement of plants compared to animals for living processes, b) the intake of oxygen by plants for respiration. <p>Draw a diagram to show the intake of oxygen in plants.</p> <p>Discuss the anaerobic respiration carried out by rice plants in a paddy field or other plants in certain situations like flooding.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? describe the energy requirement in plants, ? explain the intake of oxygen for respiration, ? explain aerobic respiration in plants, ? explain anaerobic respiration in plants under certain conditions, 	<p>A diagram of the cross-section of a leaf is required.</p>	energy requirement – <i>keperluan tenaga</i>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Use a graphic organiser to compare the process of respiration with the process of photosynthesis in plants.</p> <p>Discuss the following:</p> <ul style="list-style-type: none"> a) meaning of compensation point, b) correlate light intensity with compensation point from graph. <p>Visualise and describe the effect on living things when the rate of photosynthesis and rate of respiration remains at compensation point.</p>	<ul style="list-style-type: none"> ? compare and contrast the process of photosynthesis and respiration, ? explain what compensation point is, ? relate light intensity with the attainment of compensation point, ? predict the situation when the rate of photosynthesis and rate of respiration remains at compensation point. 		<p>compensation point – <i>titik pampasan</i></p> <p>light intensity – <i>keamatan cahaya</i></p>

THEME: INVESTIGATING THE RELATIONSHIP BETWEEN LIVING THINGS AND THE ENVIRONMENT
LEARNING AREA: 1.0 DYNAMIC ECOSYSTEM

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.1 Understanding the abiotic and biotic components of the environment	Conduct a field study to: a) identify the abiotic components including pH, temperature, light intensity, humidity, topography, and the microclimate of an ecosystem, b) identify the biotic components of an ecosystem, c) investigate the feeding relationships of the biotic components to construct the food chains and food webs, and classify the biotic components into trophic levels, d) investigate the interaction between biotic components as follows: (i) symbiosis among plants and animals encompassing the following: - commensalism, - parasitism, - mutualism, (ii) saprophytism, (iii) predator - prey interaction.	A student is able to: ? identify the abiotic components of an ecosystem, ? identify the biotic components of an ecosystem, ? classify biotic components into trophic levels, ? explain the interactions between biotic components in relation to feeding, using examples, ? explain the interaction between biotic components in relation to competition, using examples.	Emphasis is on field study for the students to reinforce their understanding in this area.	abiotic components – <i>komponen abiotik</i> biotic components – <i>komponen biotik</i> trophic levels – <i>aras trof</i>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>(e) investigate the interaction between biotic components in relation to competition, which are:</p> <p>(i) intraspecific competition,</p> <p>(ii) interspecific competition.</p> <p>Conduct an experiment to study the intraspecific competition and interspecific competition of plants, e.g. maize and rice.</p> <p>Collect and interpret data to study intraspecific competition and interspecific competition involving <i>Paramecium</i>, for example <i>Paramecium aurelia</i> and <i>Paramecium caudatum</i>.</p>			<p>predator – <i>pemangsa</i></p> <p>prey - <i>mangsa</i></p> <p>competition - <i>persaingan</i></p>
1.2 Understanding the processes of colonisation and succession in an ecosystem	<p>Conduct a field study on an ecosystem i.e. a mangrove swamp or a pond to:</p> <p>a) identify the niche, habitat, community and population,</p> <p>b) investigate the process of colonisation,</p> <p>c) investigate the process of succession,</p> <p>d) identify pioneer species, successor species, dominant species and climax community,</p>	<p>A student is able to:</p> <p>? state what an ecosystem is,</p> <p>? identify the niche, habitat, community and population of an ecosystem,</p> <p>? explain the process of colonisation,</p> <p>? explain the process of succession,</p> <p>? identify the pioneer species in an ecosystem,</p> <p>? identify the successors in an ecosystem,</p>		<p>mangrove swamp – <i>paya bakau</i></p> <p>colonisation– <i>pengkolonian</i></p> <p>succession – <i>sesaran</i></p> <p>successors – <i>spesies penyesar</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>e) identify the adaptive characteristics of pioneer species and subsequent species in the habitat for the processes of colonisation and succession.</p> <p>Students present their findings or make a folio.</p> <p>Study the processes of colonisation and succession through video, computer software and printed material.</p> <p>Discuss and correlate the abiotic component and biotic component during the processes of colonisation and succession in an ecosystem.</p>	<p>? identify the dominant species in an ecosystem,</p> <p>? identify the adaptive characteristics of pioneer species,</p> <p>? identify the adaptive characteristics of successors,</p> <p>? explain the changes in habitat caused by pioneer species,</p> <p>? explain the changes in habitat caused by successors at every level of succession until a climax community is reached,</p> <p>? relate the abiotic components with the biotic components in an ecosystem during the processes of colonisation and succession.</p>		<p>adaptive characteristics – <i>ciri penyesuaian</i></p> <p>pioneer – <i>spesies perintis</i></p> <p>climax community- <i>komuniti klimaks</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.3 Synthesising ideas on population ecology	<p>Discuss the appropriate sampling techniques to study the population size of an organism.</p> <p>Conduct a field study or use an appropriate analogy to:</p> <ol style="list-style-type: none"> estimate the population size of animals such as garden snails and wood lice, investigate the distribution of plants using the quadrat sampling technique. <p>Based on the above study discuss the distribution of an organism in a habitat.</p> <p>Discuss and correlate the change in population distribution of an organism with the changes in each of the abiotic factors.</p> <p>Plan and conduct an experiment to study the relationship of population distribution of an organism with changes in any one of the abiotic factors such as pH, temperature, light intensity and humidity. Suggested organisms: <i>Pleurococcus</i>, <i>Lemna</i></p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? identify the appropriate sampling technique to study the population size of an organism, ? estimate the population size of an organism in a habitat, ? determine the distribution of organisms in a habitat based on the density, frequency and percentage coverage of the species, ? correlate the change in population distribution of an organism with the changes in each of the abiotic factors, ? design an experiment to investigate the effect of a change in any <u>one</u> of the abiotic factors on the population growth rate of an organism. 		<p>sampling technique – <i>teknik persampelan</i></p> <p>distribution – <i>taburan</i></p> <p>density – <i>kepadatan</i></p> <p>frequency – <i>kekerapan</i></p> <p>percentage coverage – <i>peratus litupan</i></p> <p>growth rate – <i>kadar pertumbuhan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.4 Understanding the concept of biodiversity	<p>Discuss the following:</p> <ul style="list-style-type: none"> a) meaning of biodiversity, b) need for the classification system of organisms. <p>Gather information on the following:</p> <ul style="list-style-type: none"> a) the five kingdoms in the classification of organisms, which are Monera, Protista, Fungi, Plantae and Animalia, b) main characteristics of organisms in each kingdom, c) examples of organisms in each kingdom, <p>Discuss the following:</p> <ul style="list-style-type: none"> a) the hierarchy in the classification of organisms from kingdom to species, b) the method of naming a number of vertebrates and local flowering plants, using the Linnaeus binomial system, c) the importance of biodiversity. <p>Conduct a field trip to create awareness of biodiversity of an ecosystem.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> ? explain the meaning of biodiversity, ? explain the need for classification of organisms, ? state the five kingdoms used in the classification of organisms, ? identify the main characteristics of organisms in each kingdom, ? list examples of organisms in each kingdom, ? state the hierarchy in the classification of organisms, using examples, ? explain through examples, the method of naming organisms using the Linnaeus binomial system, ? explain the importance of biodiversity. 		<p>biodiversity – <i>biokepelbagaian</i></p> <p>classification – <i>pengelasan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.5 Understanding the impact of microorganisms on life	<p>Using charts, slides and photomicrographs, identify and list various types of microorganisms i.e. protozoa, algae, fungi, bacteria and virus.</p> <p>Conduct an experiment to study the effects of temperature, pH, light and nutrients on the activity of microorganisms e.g. <i>Bacillus subtilis</i> or yeast.</p> <p>Gather information and discuss the role of useful microorganisms in the following:</p> <ol style="list-style-type: none"> decomposition, nitrogen cycle, alimentary canal of termite, digestive system in human. <p>Gather information and discuss the effects of harmful micro-organisms:</p> <ol style="list-style-type: none"> causing diseases, spoilage of food and substances. 	<p>A student is able to:</p> <ul style="list-style-type: none"> ? classify various types of microorganisms based on their basic characteristics, ? state the abiotic components affecting the activity of microorganisms, ? explain the effect of a change in each abiotic component on the activity of microorganisms, ? explain the role of useful microorganisms, ? explain the effect of harmful micro-organisms, 	<p>A brief account of the basic characteristics of each type of microorganisms is required.</p>	<p>decomposition - <i>pereputan</i></p> <p>alimentary canal – <i>salur alimentari</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Gather information and present the findings on the following:</p> <p>a) pathogens, vectors, symptoms, and methods in transmission of diseases such as malaria, dengue fever, cholera, ringworm, food poisoning, AIDS, hepatitis, and SARS,</p> <p>b) methods to control pathogens including the use of antibiotics, vaccines, antiseptics and disinfectants.</p> <p>Gather information and present the uses of microorganisms in biotechnology, such as:</p> <p>a) production of antibiotics and vaccines,</p> <p>b) cleaning of oil spills,</p> <p>c) waste treatment,</p> <p>d) food processing,</p> <p>e) production of bioplastic,</p> <p>f) production of energy from biomass.</p>	<p>? explain the meaning of pathogen,</p> <p>? identify the pathogen, vector and symptoms of <u>one</u> particular disease,</p> <p>? explain how the disease spreads,</p> <p>? describe the methods for controlling pathogen,</p> <p>? explain the use of microorganisms in biotechnology, using examples.</p>	<p>The scientific names of pathogens and life cycle of vectors are not required.</p>	<p>pathogen - <i>patogen</i></p> <p>transmission - <i>pemindahan</i></p> <p>food poisoning – <i>keracunan makanan</i></p> <p>oil spills – <i>tumpahan minyak</i></p> <p>waste treatment – <i>rawatan kumbahan</i></p>
1.6 Appreciating biodiversity	<p>Conduct a forum to discuss the importance of preservation and conservation of biodiversity.</p> <p>Conduct an activity to preserve and conserve various living things around us.</p>	<p>A student is able to:</p> <p>? justify the importance of preservation and conservation of biodiversity.</p> <p>? preserve and conserve various living things around him/her.</p>		<p>preservation - <i>pemeliharaan</i></p> <p>conservation – <i>pemuliharaan</i></p>

LEARNING AREA: 2.0 ENDANGERED ECOSYSTEM

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
2.1 Evaluating human activities that endanger an ecosystem	<p>Carry out small group discussion on the following and present the findings:</p> <p>a) human activities that threaten the ecosystem,</p> <p>b) the impact of human activities on the ecosystem,</p> <p>c) the effects of unplanned development and mismanagement of the ecosystem, such as:</p> <ol style="list-style-type: none"> soil erosion, flash flood, landslide, eutrofication, water, air, thermal and noise pollution, global warming, ozone depletion, climatic change, extinction of living things, deforestation, <p>d) types of pollution and sources of pollution,</p>	<p>A student is able to:</p> <p>? identify human activities that threaten the ecosystem,</p> <p>? explain the impact of human activities on the ecosystem,</p> <p>? evaluate critically the effects of unplanned development and mismanagement of the ecosystem,</p> <p>? describe types of pollution and sources of pollution,</p>		<p>impact – <i>impak/kesan</i></p> <p>threaten - <i>mengancam</i></p> <p>critically – <i>secara kritis</i></p> <p>unplanned – <i>tidak terancang</i></p> <p>mismanagement – <i>salah pengurusan</i></p> <p>development - <i>pembangunan</i></p> <p>ecosystem – <i>ekosistem</i></p> <p>flash food – <i>banjir kilat</i></p> <p>landslide – <i>tanah runtuh</i></p> <p>global warming – <i>pemanasan global</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>e) effects of pollution on the following:</p> <ul style="list-style-type: none"> i. human health (diseases affecting the respiratory system, skin problems, conjunctivitis, cancer and cholera), ii. animal and plant habitats, iii. buildings, iv. agriculture, v. climate. <p>Conduct an experiment to compare solid pollutants in the air of different environments and make an inference on the sources of pollution.</p> <p>Conduct an activity to analyse data on air pollution index of some cities within and outside the country, and make an inference on the sources of pollution.</p> <p>Conduct an activity to analyse data on water pollution, such as Biochemical Oxygen Demand (BOD) value and content of heavy metals in some rivers, and make an inference on the sources of pollution.</p>	<p>? explain the effects of pollution on living things and the environment,</p> <p>? compare and contrast pollutants in the air from different environments,</p> <p>? state the sources of air pollution,</p> <p>? interpret data on the level of air pollution in some cities,</p> <p>? make an inference on the sources of air pollution in some cities,</p> <p>? interpret data on the level of water pollution in some rivers,</p> <p>? make an inference on the sources of water pollution in some rivers,</p>		<p>ozone depletion – <i>penipisan ozon</i></p> <p>extinction – <i>kepunusan</i></p> <p>deforestation - <i>penyahutanan</i></p> <p>pollution -<i>pencemaran</i></p> <p>Biochemical Oxygen Demand – <i>keperluan oksigen biokimia</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Conduct activities to formulate a strategy to reduce the level of air and water pollution in a particular location by:</p> <ul style="list-style-type: none"> a) analysing information on the population, such as the size of population, socio-economic activities, and level of air and water pollution, b) conducting an activity to predict the level of air and water pollution at a particular location within the next ten years, c) preparing an action plan consisting of a strategy to reduce the level of air and water pollution at that particular location within the next ten years. 	<ul style="list-style-type: none"> ? predict the level of air and water pollution in a particular location within the next ten years, ? suggest strategies to solve problems related to air and water pollution in a particular location within the next ten years. 		

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
2.2 Understanding the greenhouse effect and thinning of the ozone layer.	<p>Carry out small group discussion on the following and present the findings:</p> <ul style="list-style-type: none"> a) greenhouse effect, including its cause and effect, b) concentration of carbon dioxide in the atmosphere and correlate it with global warming, c) ozone depletion, including its cause and effect, d) impact of ozone depletion and global warming on the ecosystem. 	<p>A student is able to:</p> <ul style="list-style-type: none"> ? explain what greenhouse effect is, ? correlate the concentration of carbon dioxide in the atmosphere with global warming, ? explain the thinning of the ozone layer, ? explain the impact of thinning of the ozone layer and global warming on the ecosystem. 	<p>The molecular structure of chlorofluorocarbon and equations for chemical reactions are not required.</p>	<p>greenhouse effect – <i>kesan rumah hijau</i></p> <p>global warming – <i>pemanasan global</i></p>
2.3 Realising the importance of proper management of development activities and the ecosystem	<p>Conduct a debate on the need for development to improve the quality of life and to meet the requirements of an increasing population.</p> <p>Discuss the effects of an increase in population on the ecosystem.</p> <p>Carry out small group discussion on the following and present the findings:</p> <ul style="list-style-type: none"> a) implementation of laws, b) use of technology, c) education on the management of resources, including the reduce, reuse, and recycle of resources, 	<p>A student is able to:</p> <ul style="list-style-type: none"> ? justify the need for development, ? explain the effects of increase in population on the ecosystem, ? explain measures taken in the management of development activities and the ecosystem to ensure a balance of nature is maintained. 		<p>balance of nature – <i>keseimbangan alam</i></p> <p>maintain – <i>mengekalkan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>d) preservation and conservation of soil, water, flora and fauna of forests and mangrove swamps,</p> <p>e) practice of biological control,</p> <p>f) use of renewable energy,</p> <p>g) efficient use of energy.</p> <p>Conduct activities to care for the following ecosystems in school and at home:</p> <p>a) fish ponds,</p> <p>b) gardens.</p> <p>Plan and conduct a programme related to the management of the ecosystem, for example, "Environment Day".</p>	<p>? care for the ecosystem,</p> <p>? participate in activities related to the management of the ecosystem.</p>		<p>biological control – <i>kawalan biologi</i></p> <p>renewable energy – <i>tenaga diperbaharui</i></p>

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Advisors

Mahzan bin Bakar	SMP, AMP	Director Curriculum Development Centre
Zulkifly bin Mohd Wazir		Deputy Director Curriculum Development Centre

Editorial Advisors

Cheah Eng Joo		Principal Assistant Director (Head of Science and Mathematics Sector) Curriculum Development Centre
Zaidi Yazid		Assistant Director (Head of Elective Sciences Unit) Curriculum Development Centre

Editor

Ho Heng Ling		Assistant Director (Head of Core Sciences Unit) Curriculum Development Centre
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PANEL OF WRITERS

Cheah Eng Joo	Curriculum Development Centre.	Ratna Devi a/p Kana Nagaraju	SMK Victoria, Kuala Lumpur.
Zaidi Yazid	Curriculum Development Centre.	Azuyah bt. Hassan	SMK Ayer Putih Dalam, Kedah.
Ho Heng Ling	Curriculum Development Centre.	Salmah bt. Mohd. Tahar	SMK Sultan Omar, Trengganu.
Zainusham Yusof	Curriculum Development Centre.	Roslah Awang	SMK Landas, Trengganu.
Salina Hanum Osman Mohamed	Curriculum Development Centre.	Meli bin Hussin	SM Sains Kuala Trengganu, Trengganu.
Aizatul Adzwa Mohd Basri	Curriculum Development Centre.	Norisa bte Mohamed Nor	Sek. Men Sains Seremban, Negeri Sembilan
Zulkifli Baharudin	Curriculum Development Centre.	Chan Suan Khin (Jacinta)	SM Muara Tuang, Sarawak.
Yusof Ismail	Curriculum Development Centre.	Alice Tan	SM Sains Selangor, Kuala Lumpur.
Salbiah Mohd. Som	Curriculum Development Centre.	Lim Boon Hock	SMK Methodist (ACS), Melaka
Zainon Abdul Majid	Curriculum Development Centre.	Roslina bt. Zakaria	SMK Bukit Jana, Perak.
Zaidah Md. Yusof	Curriculum Development Centre.	Ruslinah bt. Mohamad Zaman	SMK Seri Tanjong, Kuala Lumpur.
Ahmad Salihin Mat Saat	Curriculum Development Centre.	Pn.Mazinah bte. Muda	SM Sains Tengku Mohamad Faris Petra, Kelantan.
Wahida Abdullah	SMK Tunku Abdul Rahman Putra, Selangor.	Hasimah bt. Azit	Sek. Seri Puteri, Wilayah Persekutuan.
Noraini Samin	Sek. Men. Sains Muar, Johor.	Chin Mee Ying	SMK Menjalara, Kuala Lumpur.



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