PACIFIC SENIOR SECONDARY CERTIFICATE

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BIOLOGY PRESCRIPTION

Effective from January 2002

RATIONALE

Biology is a science that involves the study of the phenomenon of life at levels ranging from the interactions of molecules to the interactions of organisms within the biosphere. This amazing diversity of life forms and biological systems must be understood by successive generations if life on this planet is to be sustainable.

This prescription presents an overview of the structure and function of living things, their interdependence, and their place in the environment. It gives a framework for studying life processes at the molecular level as well as the organisational levels of cells, organisms, and environment. It provides students with an opportunity to develop an understanding of basic biological concepts, to appreciate the relationship between structure and function of different organisms, and the interactions of organisms with each other and the environment.

A study of Biology is applicable to our everyday lives. Human beings are part of the biosphere and interact with it. For example, genetic engineering allows deliberate modification of life-forms, and human beings intervene in most of the planet's ecosystems. The impact of human activities in areas such as these require an increased understanding, care for, and awareness of the biological world to encourage informed discussions and decisions.

Practical work allows for the development of manipulative skills in working with biological equipment. Use of the scientific method in designing and carrying out experiments, making observations, collecting, recording, and analysing data, and evaluating the results is an integral part of this prescription.

It is hoped that by engaging with this prescription the student will develop an appreciation and an understanding of the life of this planet, gain insights into how biologists carry out their work, and be stimulated to undertake further study.

GENERAL AIMS

This prescription is designed to promote interest in and appreciation of Biology by encouraging involvement in the scientific process of inquiry into the living world as well as developing an attitude of curiosity and open-mindedness. The skills and knowledge gained can provide a foundation for further study, leading to a career in Biology or related areas.

The aims of studying this subject are to develop:

- understanding of some of the key ideas of Biology;
- appreciation of the role of scientific method in the accumulation of knowledge about Biology;
- an ability to communicate information and ideas using the language of Biology;
- manipulative and observational skills through practical activities;
- the ability to solve problems, using the knowledge and ideas of Biology;
- the ability to obtain information about Biology, using a variety of resources;

- an appreciation of the relevance of Biology for informed decision making, and a concern for the South Pacific environment;
- an awareness of the social implications of biological knowledge and technological advances in Biology.

COURSE OBJECTIVES

Knowledge of Biology is acquired through a variety of activities and experiences.

Students should be able to:

1. participate in practical activities;
2. design and undertake investigations;
3. obtain information from a variety of sources.

Biological knowledge is made more meaningful if students can explore and understand its application in different contexts.

Students should be able to:

4. critically analyse and evaluate information, procedures, and materials;
5. demonstrate knowledge and understanding of biological concepts;
6. solve a variety of biological problems.

Individuals should use their scientific knowledge and understanding to assume responsibility for themselves, society, and the South Pacific environment, becoming active and confident citizens, and be able to plan their future.

Students should be able to:

7. understand how knowledge of Biology can be used to make informed decisions.

Communication is an important process in learning and development. It allows people to create, exchange, clarify, modify, and transmit knowledge, ideas, feelings, attitudes, and values.

Students should be able to:

8. communicate by using biological terms and conventions correctly;

This prescription is organised around four topics that are arranged as a hierarchy. The prescription also specifies a set of skills that are to be developed through practical and other learning activities.

SKILLS

Practical work is intended to support conceptual development in each section of the prescription. It also emphasises that the concepts of Biology are developed to explain observed experimental results. The concepts of Biology are based on careful observation and measurement, and the analysis and interpretation of results.

The following is a list of experimental, information and communication skills that need to be covered as students engage with this prescription.

1. Experimental Skills

Students should be able to

(a) state a testable hypothesis,

(b) identify the variables in an experiment,

(c) identify any quantities that are deliberately held constant during an experiment,

(d) design and carry out an investigation to test a hypothesis,

(e) follow instructions accurately and safely,

(f) describe and explain the procedure for a given experiment,

(g) draw or interpret diagrams of the apparatus used in an experiment,

(h) describe a pattern or behaviour observed in a practical activity,

(i) record data from an experiment to an appropriate degree of precision,

(j) identify sources of errors in an experiment,

(k) present data in tabular form with appropriate column headings, including symbols and units,

(l) plot a graph of a dependent variable versus an independent variable, with appropriate scales and units. (When graphs are plotted, dependent variables are generally plotted

vertically and independent variables horizontally.),

(m) draw a line or curve of best fit through a series of points on the graph,

(n) replication in an experiment is necessary to reduce the effect of variation,

(o) use data generated from an experiment to draw conclusions about the purpose of the experiment,

(p) evaluate an experiment for strengths and weaknesses, and suggest improvements.

2. Information and Communication Skills

A vast amount of information is accessible on any topic in Biology, and a wide variety of means are available for obtaining this information. It is therefore important to learn and practise the techniques for obtaining and evaluating information.

It is an important aspect o f scientific research that the methods and results are open to scrutiny. This mainly requires the clear and accurate communication of the details of the research to other people.

Students should be able to

(a) state the key ideas relevant to the information required and identify the type of resource that may provide the information when given a topic,

(b) identify key search words and phrases for a given topic,

(c) use an information source (library, text, newspaper, CD-ROM, Internet, etc.) to obtain information about a topic,

(d) evaluate for accuracy and suitability of the information obtained from a source,

(e) list the sources of the information in a standard format,

(f) make well structured, well organised, and clear oral presentations by talking logically and scientifically,

(g) write a practical report on an experiment, describing its purpose, procedure, results, discussion and conclusions,

(h) report in writing on the design of a practical activity,

(i) write an extended response on a selected topic, based on information from a variety of sources.

TOPICS

Molecular Biology

This topic covers the structure and function of organic molecules found in living things.

Cellular Biology

This topic covers the structure and function of processes in cells.

Organism Level Biology

This topic covers the structure and function of a range of organisms to illustrate how different organisms can carry out their life processes.

Environmental Biology

This topic covers diversity, interactions between members of the same species, different species, and the environment.

I. MOLECULAR BIOLOGY

Students should understand that Biology can be studied at different levels of organisation, and be able to give examples of this organisation at the whole organism, body system, organ, tissue, cell, and cell organelle levels.

1. Cell Compounds (Molecules)

Students should be able to

(a) describe the structure and function of chromosomes, DNA and RNA,

(b) describe and illustrate the process of protein synthesis including a brief description of the role of DNA, messenger RNA, transfer RNA, and ribosomes,

(c) describe the processes of transcription and translation,

(d) discuss how human beings can manipulate DNA to produce genetically modified organisms,

(e) draw and recognise simple diagrams using symbols to illustrate structures of each of the following:

- Carbohydrates: monosaccharides (glucose), disaccharides (sucrose), polysaccharides (starch),
- Lipids: fatty acids, glycerol,
- Protein: amino acids, peptide and polypeptides,

(f) state the role of carbohydrates, lipids and proteins in the structure and function of cells,

(g) test foods for the presence of protein, starch, glucose and lipids.

2. Enzymes

Students should be able to

(a) describe how enzymes catalyse biological reactions,

(b) explain how enzymes function in synthesis and breakdown reactions using the induced-fit model,

(c) explain how pH, temperature, and concentration affect the rates of enzyme-controlled reactions.

3. Energy in the Cell

Photosynthesis

Students should be able to

(a) write a balanced chemical equation for photosynthesis,

(b) explain how during the light phase in the grana, photolysis of water occurs producing hydrogen and oxygen and ATP is synthesised,

(c) recognise that the light phase products are needed for the dark phase reactions,

(d) explain how during the dark phase in the stroma, carbon dioxide is fixed and glucose produced,

(e) recognise the grana and stroma of a chloroplast in a diagram or photograph.

Respiration

Students should be able to

(f) write a balanced equation for aerobic respiration of glucose,

(g) explain how during glycolysis glucose is converted to pyruvic acid,

(h) explain how pyruvic acid is broken down in the Krebs Cycle in the matrix of the mitochrondrion and carbon dioxide is released during the process,

(i) explain how during the Respiratory chain most ATP is produced,

(j) state that oxygen is required for respiration inside the mitochondrion,

(k) state that anaerobic respiration in muscle cells produces lactic acid and in yeast cells produces alcohol and carbon dioxide.

II. CELLULAR BIOLOGY

1. Cell Structure

Students should be able to

(a) recognise that the cell is the smallest independent unit of life,

(b) explain how surface area to volume ratio limits substances entering and leaving cells and determines cell size,

(c) identify and state the functions of:
nucleus, chromosomes, mitochondrion, chloroplast, ribosome, Golgi apparatus, vacuole, cell membrane, cell wall, lysosome, rough and smooth endoplasmic reticulum, and centrioles,

(d) recognise that the structures of cells are different depending on their functions and identify the differences between plant and animal cells,

(e) describe the advantages and disadvantages of light and electron microscopes [no detail of the structure of an electron microscope is required],

(f) set up and use a light microscope (low and high power), determine size of a specimen using field of view and be able to prepare a wet mount of a biological specimen.

2. Transport Processes

Students should be able to

(a) define and identify the processes of diffusion and osmosis,

(b) describe the factors which influence the rate of the processes of osmosis and diffusion, and explain how selective exchange occurs at the cell membrane,

(c) define, identify, and compare the processes of active transport and passive transport in terms of energy requirements using relevant examples.

3. Cell Growth and Division

Students should be able to

(a) distinguish between mitosis and meiosis,

(b) discuss the role of mitosis and meiosis in the life cycle of an organism,

(c) recognise the sequence of events in mitosis and meiosis,

(d) describe the role of crossing over, recombination and independent assortment in producing variation in species.

III. ORGANISM LEVEL BIOLOGY

1. Nutrition (Plants)

Students should be able to

(a) describe the differences between the terms autotrophic and heterotrophic nutrition,

(b) identify and describe the functions of; cuticle, epidermis, palisade mesophyll, spongy mesophyll, vascular bundle, stoma, guard cell and air space,

(c) explain how factors such as carbon dioxide, light, intensity, water, temperature and concentration of carbon dioxide may affect the rate of photosynthesis.

2. Nutrition (Animals)

Students should be able to

(a) state the importance of the following classes of food in the human diet; carbohydrate (including fibre), lipid, protein, vitamins (A, B, C, and D) and minerals (such as calcium and iron),

(b) compare the traditional Pacific diet, with more recent diets containing refined processed foods,

(c) discuss feeding in terms of ingestion, digestion, absorption, assimilation and egestion,

(d) identify the structures and state the functions of mouth, oesophagus, stomach, gall bladder, pancreas, small and large intestine and sphincter muscles,

(e) describe the role of peristalsis in the digestive system,

(f) state the site of production and the functions of enzymes in the digestive process,

(g) describe the non-enzymatic functions of saliva, gastric juice and bile,

(h) explain how the structural features of the small intestine assist the process of absorption,

(i) describe the function of the liver in controlling glucose concentration and deamination of nitrogen containing compounds,

(j) state the function of the hepatic portal vein,

(k) state the function of the colon in water reabsorption,

(l) explain how the gut structures of herbivores and carnivores differ.

3. Gas Exchange (Plants)

Students should be able to

(a) identify the gases exchanged during photosynthesis and respiration,

(b) explain how the guard cells regulate the movement of gases,

(c) explain how stomata help to cool the plant by evaporation.

4. Gas Exchange (Animals)

Students should be able to

(a) describe the differences between the processes of breathing (ventilation), gas exchange, and cellular respiration,

(b) compare the terms inhalation and exhalation, and describe the role of the ribs, the intercostal muscles and the diaphragm in breathing,

(c) explain how trachea, mucus, bronchi, alveoli and cilia facilitate gas exchange,

(d) describe how gas exchange occurs in fish gills,

(e) describe the role of the following in the gas exchange system of insects: spiracles, tracheae, tracheoles,

(f) compare gas exchange in mammals, fish and insects.

5. Support & Transport (Plants)

Students should be able to

(a) explain why some plants need a system for support and transport of materials,

(b) describe the importance of and the factors affecting cell turgidity in plant support,

(c) describe the structure and function of the stem tissues: epidermis, cortex, vascular bundles (phloem, cambium, xylem), and lignified fibres,

(d) describe the structure and function of the root hair,

(e) explain how the transpiration rate is influenced by the following environmental factors; humidity, wind, light, temperature and water availability,

(f) describe translocation, and its role in the transport and storage of materials.

6. Support & Transport (Animals)

Students should be able to

(a) explain the advantages and disadvantages of animal endoskeletons, exoskeletons, and hydrostatic skeletons,

(b) explain why animals above a certain size require an internal transport system,

(c) compare and give examples of;
open circulatory system,
closed single circulatory system,
closed double circulatory system,

(d) describe the structure and function of the human heart, including the atria, ventricles, valves, aorta, vena cava, and the pulmo nary artery and vein,

(e) explain how the heart pumps blood by contraction and relaxation,

(f) state the possible effects of smoking, alcohol and obesity in causing coronary heart disease,

(g) describe the structure and function of the red blood cells, platelets and white blood cells,

(h) distinguish between oxygenated and deoxygenated blood and recognise where these occur in the circulatory system,

(i) describe the structure and function of the three main types of blood vessels; arteries, veins and capillaries.

7. Homeostasis

Students should be able to

(a) define homeostasis as the keeping of internal body conditions in a stable state,

(b) explain how a constant internal environment helps cells to function efficiently,

(c) discuss the following examples of homeostasis:
- temperature control in mammals,
- blood sugar levels in humans.

8. Excretion (Animals)

Students should be able to

(a) state and explain the process involved in the production of carbon dioxide, water and nitrogenous wastes,

(b) describe the advantages and disadvantages of excreting nitrogen waste in the form of ammonia (aquatic organisms), uric acid (birds, insects and reptiles) or urea (mammals),

(c) describe the structure and function of the kidney, urethra, ureter and bladder,

(d) explain how the structure of the nephron aids the processes of filtration and reabsorption.

9. Reproduction and Life Cycles (Plants)

Students should be able to

(a) describe the structure and function of sepals (calyx), stamen (filament, anther & pollen), petals (corolla), carpel (stigma, style, ovary and ovule),

(b) explain how the pollen tube is involved in fertilisation,

(c) describe the development of the fertilised ovule into seed and ovary into fruit,

(d) distinguish between sexual and asexual reproduction and discuss the advantages and disadvantages of each process,

(e) compare the sporophyte and gametophyte generations of ferns and angiosperms.

10. Reproduction in Mammals

Students should be able to

(a) describe the structure and function of ovary, oviduct (fallopian tube), uterus (womb), vagina, scrotum, testis, epididymis, sperm duct (vas deferens), prostate gland, seminal vesicle, urethra, and penis,

(b) describe reproductive development from gamete production, fertilisation, implantation to birth,

(c) describe how materials are exchanged between the mother and the foetus via the placenta,

(d) describe the role of the hormones oestrogen and testosterone in the development of secondary sexual characteristics in males and females,

(e) state the role of oestrogen and progesterone in the menstrual cycle.

11. Mendelian Inheritance

Students should be able to

(a) predict the result of a monohybrid, a dihybrid cross and define the phenotype, genotype, dominant and recessive alleles, heterozygous, homozygous, co-dominance and incomplete dominance,

(b) describe the term multiple alleles using human blood groups as an example,

(c) explain how sex is determined in mammals by X and Y chromosomes,

(d) construct Punnet diagrams and apply them to solve examples of monohybrid and dihybrid cross problems.

12. Applications of Genetics

Students should be able to

(a) describe how selective plant and animal breeding can produce different genotypes and different phenotypes,

(b) state examples of selective breeding which may be of regional origin,

(c) explain how the offspring from a test cross may indicate the genotype of an individual,

(d) give examples of how human beings use genetic engineering to produce organisms and substances of benefit to them,

(e) discuss ethical issues associated with the genetic manipulation of organisms.

IV. ENVIRONMENTAL BIOLOGY

Students should be familiar with field work techniques and standard biological data presentation.

1. Introduction

(a) Diversity of Organisms

Students should be able to

(i) describe the diversity of organisms and be able to identify typical examples of the following phyla/divisions and classes

Bacteria
Unicellular organisms

Coelenterates
Annelids
Molluscs
Arthropods
- Crustaceans
- Insects
- Arachnids
- Myriapods

Echinoderms
Chordates
- Fish
- Amphibians
- Reptiles
- Birds
- Mammals

Algae
Fungi
Lichens
Ferns
Gymnosperms
Angiosperms
- monocotyledons
- dicotyledons

(ii) use the binomial system to classify organisms into genus and species and be able to use a dichotomous key to identify an unknown organism,

(b) (i) explain the terms environment and habitat,

(ii) explain why biodiversity is essential for the perpetuation of communities.

2. Adaptive Features

Students should be able to

(a) identify an adaptation as a characteristic that enables an organism to survive better in its habitat,

(b) describe four types of adaptations (structural, physiological, behavioural and life history) and give examples,

(c) describe the concepts implied in the terms: tolerance, acclimation, Gause's Principle, ecological niche and Leibig's Law.

3. Populations

Students should be able to

(a) define the term population and give examples,

(b) define the following characteristics of a population:

- number
- distribution
- density

(c) describe population growth using the terms: natality, mortality and survivorship curve,

(d) describe how mutation may produce variation in a population,

(e) describe the causes of mutation (high temperature, carcinogenic materials, radiation),

(f) describe Natural Selection as the process in which better adapted individuals are more likely to survive and reproduce,

(g) describe speciation resulting from geographical and reproductive isolation,

(h) conduct practical activities using transects, and quadrats to estimate population number and distributions,

(i) determine population number by capture – recapture method,

(j) discuss and recognise competition within a population in terms of:

- space (territory and breeding grounds)
- food (animals)
- reproductive mates
- light and nutrients (plants).

4. Communities

Students should be able to:

(a) distinguish between the terms communities and populations,

(b) discuss and identify the following patterns within communities using local examples,

- zonation
- stratification

- succession,

(c) describe the characteristics and the role of a colonising or pioneer species,

(d) describe a climax community and give examples,

(e) explain how competition for living space, food and nutrients affect relationships in a community,

(f) describe the following relationships and identify an example for each:

- predation
- parasitism
- mutualism
- commensalism.

5. Ecosystems

Students should be able to

(a) identify the living (biotic) and non-living (abiotic) parts of an ecosystem,

(b) assign trophic levels to organisms in a food chain or web,

(c) construct and interpret food chains and food webs in community,

(d) describe how energy flows through an ecosystem and state that the energy available in each trophic level is less than the one before,

(e) draw and interpret ecosystem energy flow diagrams,

(f) construct and interpret pyramids of numbers, biomass and energy,

(g) construct a simple diagram to illustrate the recycling of nutrients using carbon and nitrogen as examples,

(h) discuss the importance of recycling of nutrients,

(i) identify an environmental issue, describe possible causes and effects and suggest possible solutions,

(j) design and carry out an investigation to test an hypothesis about an environmental issue.

ASSESSMENT

The assessment of this prescription is in two parts (internal and external assessment), and is made up of five assessment components:

External Assessment (60%)		
Assessment Component 1: External Examination		60%
Internal Assessment (40%)		
Assessment Component 2: Practical Reports	20%	
Assessment Component 3: Investigative Study		10%
Assessment Component 4: Other Tasks		6%
Assessment Component 5: Practical Test		4%

EXTERNAL ASSESSMENT

Assessment Component 1: External Examination

a) The 3-hour examination assesses most of the course objectives.

b) The four topics and the skill section of the prescription will be examined in approximately the following weightings:

Molecular Biology	10%
Cell Biology	10%
Organism Level Biology	45%
Environmental Biology	25%
Skills	10%

(The questions from the Skills section will be on all the four sections in roughly the same proportion. No detailed Chemistry on Photosynthesis and Respiration in the Molecular Biology Section will be examined.)

Criteria for Judging Performance

The criteria for judging performance are set out below. The relevant course objectives are listed in parentheses, alongside each outcome listed below.

- identify hypotheses, variables, and controls in experiments (2);
- draw valid conclusions from data (4, 5);
- critically evaluate experimental procedures and present logical conclusions (4, 5);
- compare and contrast features of biological materials (4, 5);
- describe and explain biological concepts and processes (5);
- discuss and explain biological theories and definitions (5, 6, 7);
- identify and discuss points of view involved in biological issues (7);
- discuss the impact of human practices and decisions on the biological world (7);
- use biological vocabulary where appropriate (8);

The examination structure is as follows:

Objective type questions.	25%
Short-answer questions (restricted response) covering all the topics.	60%
Extended-response questions	15%

Note: ALL questions are COMPULSORY.

INTERNAL ASSESSMENT

- Practical Reports 20%
- Investigative Study 10%
- Other Tasks 6%
- Practical Test 4%

1. The internal assessment is a continuous process, which should include both formative and summative tasks. **There should be at least eight summative tasks that make up the overall Internal Assessment**. This will be weighted as 40% of the total assessment.

2. The major purpose of a PSSC internal assessment programme is to measure subject-related skills and abilities that cannot easily be measured by pencil-and-paper tests, i.e. practical skills, long-term research and investigative skills.

3. Although certain student attitudes and behaviours may be desirable (e.g. co-operativeness, perseverance, politeness, etc.) they should not be included as skills to be assessed when recorded through the marking schemes in the PSSC Internal Assessment programme submitted by any school. Attempts to quantify and report such qualities should be done as a separate school activity.

4. Schools that intend to enrol students in PSSC Biology must submit a completed "**PSSC Internal Assessment Summary Form"** by March 1 st in the year of enrolment. These forms will be provided by the SPBEA. Several forms may be necessary to document a school's Internal Assessment programme. Further information must also be attached to these forms. This information should include details of procedures, the marking of separate teacher-designed tasks, and descriptions of intra-school moderation of internal assessments if a school has more than one class taking PSSC Biology.

5. Clear records and documentation regarding the school's approved PSSC Internal Assessment programme must be kept. Furthermore, all students' work that has been assessed under this programme (tests, essays, practical reports, projects, etc.) must be available for verification by SPBEA officers during any one school year.

6. Students who will be enrolled in PSSC Biology must be given a copy of the school's PSSC Internal Assessment programme for the subject. Each student must also be informed of when assessment tasks are to be given, and be notified of his or her assessment result for each task as soon as it is marked.

7. Schools must submit a mark for each of the four assessment components:

Practical Reports	(out of 50)
Investigative Study	(out of 25)
Other Tasks	(out of 15)
Practical Test	(out of 10)

Assessment Component 2: Practical Reports

This assessment component is designed to assess Objectives 1, 2, 4 and 8.

About 15 to 20 hours of the 120 hours of programmed school time should be spent on practical work. A suggested list of appropriate practical activities is included on the Advisory Section. **At least 10 practicals must be completed of which 5 are summative and 5 are formative.** Students must also write a report on each of these activities. **At least two practical activities must be based on each of the prescribed topics.**

In at least one summative practical activity, students must formulate a hypothesis, design an experiment to test the hypothesis, carry out the designed experiment, interpret the results, and evaluate the experiment.

Students should be taught, and have the opportunity to practise, the skills necessary for them to meet the assessment criteria in formative practical activities.

The five formative practical activities are essential in developing the skills that will enable students to carry out experiments effectively, using the scientific method. Students are expected to develop manipulative skills in such areas as microscopy, measurement, heating substances, the use of basic apparatus, and conducting chemical tests. Teachers will choose the skills necessary for the required practical activities.

When judging performance in the five summative practical activities, teachers must assess the ability of the students to perform the intended student outcomes given below.

Criteria for Judging Performance

The criteria for judging performance are set out below. The relevant objectives are listed in parentheses.

- follow instructions accurately (1, 2);
- design an investigation to include an aim, a method, a hypothesis, and predictions (2);
- describe and explain the procedure for a given experiment (2);
- select and use appropriate apparatus (1, 2);
- use appropriate units of measurement (1, 2) (only SI units are acceptable);
- make observations and record results in an appropriate form (1, 2);
- identify variables in an experiment (2);
- identify any quantities that are deliberately held constant during an experiment (2);
- replicate treatments to eliminate chance variation (2);
- evaluate the accuracy of the data and identify sources of error (4, 8);

- use data generated from an experiment to draw conclusions about the purpose of the experiment (2, 8).

Assessment Component 3: Investigative Study

This assessment task is designed to assess Objectives 1, 2, 3, 4, 5, 6, 7, and 8.

Students are required to submit a report that is to be between 1,000 – 1,500 words, excluding the diagrams, photographs, maps, graphs, tables, bibliography. Further information on this work is given in the Advisory Section.

The report could take a number of forms but it would be advisable for teachers to suggest a possible structure, both to help the student in meeting the outcomes required, and to make the job of assessment easier.

Criteria for Judging Performance

The criteria for judging performance are set out below. The relevant objectives are listed in parentheses.

- identify the type of resource that may provide the information (8);
- establish the purpose for collecting information and identifying possible sources (4);
- critically analyse information for relevance, bias, and accuracy (4);
- show that they have used a variety of sources by presenting a properly formatted bibliography (3);
- relate biological ideas to the topic being investigated (3);
- design an investigation to include an aim, a method, a hypothesis, and predictions (2);
- select and use appropriate apparatus (1, 2);
- make observations and record results in an appropriate form (1, 2);
- identify variables in an experiment (2);
- identify any quantities that are deliberately held constant during an experiment (2);
- replicate treatments to eliminate chance variation (2);
- evaluate the accuracy of the data and identify sources of error (4, 8);
- use data generated from an experiment to draw conclusions about the purpose of the experiment (2, 8).
- use knowledge and understanding of biological concepts to identify issues and present arguments (5, 7);
- identify problems, and use biological knowledge and understanding to provide reasoned solutions to the problems (6);
- understand the need to modify human practices, and the strategies for achieving such change (7);
- communicate biological ideas and issues using appropriate vocabulary (8);

For the oral presentation of the investigative study, students will be judged by the extent to which they:

- give a structured, well-organised, clear, and logical oral presentation (8);
- give a relevant oral presentation (5, 8);
- identify the purpose, audience, and context for the presentation (8).

Assessment Component 4: Other Tasks

This assessment component is designed to assess Objectives 4, 5, 6, 7, and 8.

These objectives could be met using assessment items such as tests, essays, assignments, field trips or comprehension and interpretation tasks.

Criteria for Judging Performance

The criteria for judging performance are set out below. The relevant objectives are listed in parentheses.

- discuss and explain biological concepts, theories, and definitions (5);
- critically evaluate experimental procedures and present logical conclusions (4);
- are able to compare and contrast the features of biological materials in explaining concepts and processes (5);
- identify, and provide reasoned solutions to, a biological problem (6);
- identify and discuss the points of view involved in biological issues (7);
- discuss the impact of human practices and decisions on the biological world (7);
- understand the need to modify human practices, and the strategies for achieving this change (7);
- identify and express biological ideas in a clear and concise manner (8);
- use appropriately, and spell correctly, biological terms (8);
- use common and scientific names for organisms (8).

Assessment Component 5: Practical Test

This assessment component is designed to assess Objectives 1, 2, 4 and 8.

Teachers are required to design a practical test of at least 1-hour duration which assesses observation, manipulative skills, measurement and following instructions.

The practical test must be completed by 30 June.

Further information on practical tests is given in the Advisory Section.

MODERATION

Moderation is a process designed to place different teachers' assessments of their students' performances in the same subject on the same scale so that valid comparisons between performances can be made. The purpose of moderation is to help to ensure fairness to students and to provide the wider community with reliable information about student performance. Moderation is undertaken to ensure that the IA scores given to students taking the subject are comparable from school to school.

Moderation process is subject to the requirements and procedures of the Board.

a) Assessment component 3 (Investigative Study) is to be sample moderated by country followed by an external moderation.

b) Assessment components 2, 4 & 5 are to be statistically moderated.

ADVISORY SECTION

A. Practical Reports

The suggested practical activities listed below could meet the assessment criteria. **They are not prescriptive and students are not expected to complete all the activities listed**

Molecular Biology

- Modelling of DNA to show understanding of transcription, translation, and replication.
- An investigation of the energy reserves in different organic molecules.
- Enzyme practical activities (e.g. factors that affect the ability of the enzyme catalase to catalyse the breakdown of hydrogen peroxide). Pepsin, amylase, and rennin are also suitable enzymes.
- Extraction and analysis of pigments.
- Calorimetry (energy) of lipids, carbohydrates, and proteins.

Cellular Biology

- Microscopic observation of cells. Possibilities include the use of stains to identify organelles or important macromolecules in cells.
- An investigation of the properties of cell membranes. This might include factors that affect the rate of diffusion or osmosis in cells.
- A study of the process of mitosis, involving the preparation of slides in various stages of the cellular division.
- Motility in organisms.
- Surface area to volume ratio.

Organism Level Biology

- Dissection and modelling of the structure and function of organs such as kidney, lung, intestine.
- Microscopic observation of tissue types.
- Investigations of the action of sensory receptors in detecting external stimuli.
- An investigation of factors that affect photosynthesis.
- An investigation of fermentation of yeast.
- An investigation of respiration in germinating seeds.
- Observations of chromosomes in meiosis in pollen mother cells.

Environmental Biology

- Competitive exclusion in defined environments.
- Investigation of decomposition rates.
- An investigation of the effect of salinity on germination and/or growth of seeds.
- An investigation of the effects of nutrient levels on the growth rate of seedlings.
- Succession studies using transects.
- Simulation games illustrating the principles of natural selection.
- Simulation games modelling population growth.
- Effects of pollution on the growth of plants or animals.
- Estimate of population numbers (e.g. using capture/recapture).

Suggested Mark Scheme for Summative Practical Report (Design Type)

	Mark Scheme	
1.	Formulation of hypothesis	(1)
2.	Procedure	
	• Instructions clearly stated, followed and explained	(2)
	• Design	(2)
	• Controls identified	(2)
	• Variables identified (independent and dependent)	(2)
	• Replication and repetition	(2)
3.	Results	
	• Tabulated	(2)
	• Graphed	(3)
	• Accurate and precise	(2)
	• Errors identified	(2)
4.	Interpretation & Evaluation	
	• Evaluation	(2)
	• Conclusion	(2)
	• Communication	(2)
	TOTAL	**26**

Suggested Mark Scheme for Summative Practical Report (Completion Type)

	Mark Scheme	
1.	Describe and explain procedure	(4)
2.	Procedure	
	• Controls identified	(2)
	• Variables identified (independent and dependent)	(2)
	• Instructions followed	(2)
3.	Results	(10)
	• Tabulated	
	• Graphed	
	• Accurate and precise	
	• Errors identified	
	• Pattern identified	
4.	Interpretation & Evaluation	
	• Evaluation	(2)
	• Communication	(2)
	• Conclusion	(2)
	TOTAL	**26**

B. Investigative Study

Carrying out an investigation in science involves an interaction of many complex skills. These include focussing, planning, information gathering, processing, interpreting, and reporting. Students may be investigating by carrying out a practical investigation of the "real world", by carrying out an investigation of appropriate reference material, or by integrating these approaches.

As part of the requirements of the PSSC Biology course, you are required to do a piece of individual research of your own choice. This is an investigative study and is worth 10% of your overall grade. You will need to decide upon a topic in Biology that you would like to know more about. Once you decide upon an area of Biology that interests you e.g. an environmental issue, then you need to explore the area by reading and collecting resource material, writing to or interviewing experts and having discussions with teachers, parents and your peers. You will need to decide what you want to find out. This means that you need to have a clear, specific question which allows you to design an investigation that will give you answers.

Example 1) for an environmental issue, you will need to:

- identify the problem through observation and critical thinking
- investigate the problems
- some actions and responsibilities to be taken to solve the problems etc.

2) for an ecological issue. There are a large number of ecological issues that can be investigated. Choose an ecological issue that interest you and using the following guidelines;

- why the topic is a conservation issue (what ecological resource is being lost, damaged or threatened)
- what is causing the problem
- opposing points of view
- possible remedies
- practicality and affordability of the remedies

There will be 2 parts to the study:

a) report – 20%
b) oral/interview – 5%

Investigative Study – Mark Scheme

Focusing and Planning			**Marks**
Log Book:	Accurate, complete entries of dates, types of resources identified for the study, episodes of work, planning		2
	Partially accurate and complete entries of dates, types of resources, episodes of work, planning		1
	Largely inaccurate and incomplete.		0
Experimental Design:			
aim	A clear aim for the study is stated.		1
	An aim is stated, but is not clear, or an aim is not stated		0
methodology	A clearly expressed statement describes the methodology to be carried out.	4	
	(collection and processing of data, controls, variables)		
	A statement identifies the methodology to be carried out.		2
	No statement identifying the methodology has been attempted.		0
hypothesis	A relevant hypothesis has been clearly stated.		1
	A hypothesis has been attempted, but is not clear, or a hypothesis has not been stated.		0
			8
Information Gathering			
Apparatus:	Appropriate apparatus selected and used correctly.	2	
	At times, appropriate apparatus selected and used correctly.		1
	Apparatus not selected and used appropriately.		0
Results:			
collecting, accuracy:	Appropriate and accurate method of collecting and recording results (observations, units, tabulation).	5	
	Appropriate but not always accurate method of collecting and recording results.		3
	An attempt has been made to collect and record results.		1
	No attempt, or very unclear attempt to collect and record results.		0
variables, controls:	Variables and controls clearly identified in experiments.		2
	An attempt has been made to identify variables and constants.		1
	No attempt, or very unclear attempt to identify variables and constants		0

replications:	Replications to eliminate chance variation, carefully and clearly carried out.	2	
	A replication attempt has been made.		1
	No replication attempt has been made.		0
			11

Processing and Interpreting

Analysis of information:			
	Information collected has been critically analysed, convincingly, for relevance, bias and accuracy.		3
	Information collected has been critically analysed, for relevance, bias and accuracy	2	
	Information collected has been critically analysed, in part, for relevance, bias and accuracy		1
	No attempt has been made to critically analyse information	0	
Limitations of Results recognized i.e. sources of errors, problems:	Sources of error have been identified and problems recognized and the extent of the effect of these and problems on the results.		3
	Sources of error identified and problems recognized.		2
	A problem or possible error identified.		1
	No mention of the limitations of results.		0
Issues:	Various points of view, focusing on clearly identified issues, are convincingly discussed.		6
	Various points of view, focusing on identified issues, are discussed satisfactorily.		4
	An issue has been identified with a limited discussion of views.		2
	No clear identification of issues or discussion of views are made.		0
Solutions and strategies:			
	Solutions and strategies to clearly identified issues and human practices are described.		2
	Solutions and strategies to identified issues and human practices are stated	1	
	No attempt has been made to provide solutions, or solutions are not clearly recognizable.		0
			14

Reporting

Conclusions:	Sound and reasoned conclusions are identified and described from the data.	4	
	Sound conclusions are identified from the data.		2
	An attempt has been made to draw out one or two conclusions from the data.		1
	No attempt has been made to identify a conclusion from the data.		0
Communicate ideas:	Biological ideas and issues are concisely expressed using appropriate vocabulary, and are clearly related to the topic investigated.		3
	Biological ideas and issues are outlined using appropriate vocabulary		2
	An attempt has been made to identify biological ideas and issues, using some appropriate vocabulary. An attempt has been made to relate these to the topic.		1
	No attempt has been made to identify biological ideas and issues or relate them to the topic.	0	
Bibliography:	A variety of sources are included, using accurate, accepted conventions of formatting.		2
	A number of sources are included, using accepted conventions for the most part.		1
	No real attempt has been made to include an acceptable bibliography.		0
			9

TOTAL MARKS: 42 (20%)

Oral Presentation/Interview

Structure:	Ideas and issues are coherently well organised and clearly structured.		5
	Ideas and issues are organised and there is some structure.	3	
	There is some evidence of organised and structured ideas and issues.		1
	No attempt has been made to organise or structure ideas and issues.		0
Thought/Content:	Excellent relevant and logical development of ideas and issues.		3
	Relevant and mostly logical development of ideas and issues.		2
	An attempt has been made to provide relevant and logical development of ideas and issues.	1	
	No real attempt has been made to provide a relevant and logical development of ideas and issues.		0
Visual aids:	Visual aids have been used effectively.		2
	An attempt has been made to use visual aids.		1
	No attempt has been made to use visual aids.		0

TOTAL MARKS: 10 (5%)

C. Practical Test

Practical tests can be used to find out if a student has really mastered particular skills. The student is given one or more specific tasks that involve the use of scientific equipment or the application of certain skills. The teacher then assesses the student's level of skill either by observing the student carrying out the task or by checking the final result.

There are many tasks that students could be given. For example:

- dissecting an insect, a flower
- testing an unknown solution for starch, glucose and protein
- preparing a microscope slide of some pond slime and setting it up under a microscope
- experiment to test a given hypothesis

Do not include a task in a practical test unless the student has been taught the general principles related to that task. However, it would be possible to give a student an experiment that had not previously been studied if you were assessing the ability to follow instructions or if the student had completed an earlier experiment that was based on the same principles.

Practical tests are excellent for assessing practical skills and students usually find them enjoyable and stimulating. Designing and setting up a good practical test will take some time and careful planning. Marking the test, on the other hand, is usually quite simple.

The easiest practical test to design would be one where all students are given the same practical task (e.g., one from the list above) and have a set time to complete it. In reality, such an approach is often not possible as there may not be sufficient equipment for each student or it could be too easy for students to see what others are doing. Such problems can be overcome by having just a few students doing the task while the rest of the class is working unsupervised in another room, or by taking students aside one at a time and having them carry out a particular task while you watch and assess their performance. In this case, the rest of the class would be continuing with set work in the same room.

Another type of practical test that overcomes the problems of limited equipment and collusion between students but can still be sat by a whole class, is the 'station-type' practical test. In this type of test, several 'stations' are set up around the room. At each station there is an instruction card telling the student exactly what to do and all the equipment that will be required. Each station has instructions for a different task. The number of stations will depend on the time each task will take and the total time depend on the time each task will take and the total time available for the test. e.g., If 5 minutes is given for each task then a 10-station test could take 50 minutes to complete. If there were more than 10 students in the class, it would be necessary to either:

- add more stations and make the test longer,
- add more stations but reduce the time spent at each station so that the test will still take the same time,
- set up an identical test in another room

Station-type practical tests take time to set up but are easily controlled by a single teacher. The following steps should be followed:

- students should be given clear instructions about the test before entering the room,
- ideally, each student should be given an answer sheet designed specifically for the questions in the test, (this will help prevent confusion and will also make marking more easier),
- students enter the room and one student occupies each station,
- each student spends the allotted time on the task at his or her station,
- the teacher signals “time up” and all students move to the next station,
- the test ends when all stations have been visited by each student.

PSSC Internal Assessment Summary Form

BIOLOGY

Country _____ *School*
_____

Topic	Practical Activities *(Indicate with an asterisk (*) the 5 summative practicals and (**) for the design type.)*	Start Date	Completion Date	Task Weight %	
	1.				
	2.				
	3.				
	4. 5.				
	6.				**50%**
	7.				
	8.				
	9.				
	10.				
	Investigative Study Report Oral Practical Test			 **20%** **5%** **10%**	
	Other Task 1				
	Other Task 2				**15%**
	Other Task 3				
				100%	

Note: (i) One of the summative practical activities must be a design type.

(ii) The practical test must be completed before **30 June**.

(iii) At least two practical activities must be based on each prescribed topic.

(iv) Task **outlines and detailed marking schemes for the 5 summative practical activities and 'other tasks' must be submitted together with this completed IA Summary Form**.

Teacher ..... Date: ……

SAMPLE MARK CAPTURE FORM FOR BIOLOGY INTERNAL ASSESSMENT

No.	Code Number	Name	Practical Report		Practical Test		Other Tasks	
			____ Marks	50%	____ Marks	10%	___ Marks	15%
1.								
2.								
3.								
4.								
5.								
6.								
7. 8.								
9.								
10.								
11.								
12.								
13.								
14.								
15.								
16.								
17.								
18.								
19.								
20.								