Pacific Community
Communauté du Pacifique

South Pacific Form Seven Certificate

BIOLOGY

SYLLABUS

2023

EQAP

GENERAL INFORMATION

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SOUTH PACIFIC FORM SEVEN CERTIFICATE

BIOLOGY

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BIOLOGY

1. Preamble and Rationale

This syllabus defines the requirements for the South Pacific Form Seven Certificate Biology course.

Each Major Learning Outcome for the course is to be read in conjunction with the Indicator Notes given for each outcome and the learning outcomes that follow. Students also require knowledge and understanding of outcomes from the national Year 12 or Form 6 qualification or its equivalent, which are related to the specific outcomes of SPFSC Biology.

This syllabus is derived from a revision of the Educational Quality and Assessment Programme (EQAP) 2020 syllabus and the New Zealand National Certificate of Educational Achievement (NCEA) Level 3 Biology Achievement Standards as published by the New Zealand Qualifications Authority (NZQA). The SPFSC Biology course is designed for students who wish to undertake university studies in Biology and other related fields.

2. Aim

Students are expected to develop an understanding of

- the interactions of organisms with their biotic and abiotic environment;
- the process of evolution in producing the diversity of life forms;
- the ways in which genes interact to determine the phenotype;
- the impacts of climate change and global warming in our lives and ways to address them;
- modern biotechnology and its role in our lives as well as issues that they pose;
- practical biological investigations;
- researching and processing information;
- scientific thinking, investigating and reporting.

Students are also expected to develop the attitude and values of problem solving, critical thinking, collaboration, tolerance, self-sufficiency and good judgement.

3. Prerequisites

Students are expected to have completed the national Year 12 Biology course or its equivalent.

4. General Objectives

Students will be expected to demonstrate an understanding of

- aspects of animal behaviour;
- process and patterns of evolution;
- concepts and processes relating to gene expression;

- applications in modern biotechnology;
- aspects of environmental issues and ways to address them;
- planning, carrying out and reporting on practical biological investigations;
- researching and processing data to write a scientific report on a biological issue.

5. Content Components

The content of the SPFSC Biology course is organised under five strands and a number of sub-strands under each strand. These are outlined below together with corresponding learning outcomes.

Strand Number	Strand Title and Major Learning Outcome	Sub strand number	Sub-strand title and Key Learning Outcome
1.	**Animal behaviour** Students are able to *demonstrate knowledge application and critical evaluation* of biological concepts and processes relating animal behaviour to biotic and abiotic environmental factors and how the behaviour contributes to an organism's survival.	1.1	**Ecological Niche** Students are able to *demonstrate knowledge application and critical evaluation* of the ecological niche of an animal species and to investigate and report an aspect of an animal species' ecological niche.
		1.2	**Orientation and Navigation** Students are able to *demonstrate knowledge application and critical evaluation* of animal orientation and navigation processes and how these influence movement and survival.
		1.3	**Timing responses** Students are able to *demonstrate knowledge application and critical evaluation* of timing responses and ways of representing and interpreting timing responses.
		1.4	**Interspecific interactions** Students are able to *demonstrate knowledge application and critical evaluation* of interspecific interactions and ways in which these interactions influence survival in ecological niches.
		1.5	**Intraspecific interactions** Students are able to *demonstrate knowledge application and critical evaluation* of intraspecific interactions and ways in which these interactions influence survival in ecological niches.

Strand Number	Strand Title and Major Learning Outcome	Sub strand number	Sub-strand title and Key Learning Outcome
2.	**Gene Expression** Students are able to *demonstrate knowledge application and critical evaluation* of biological concepts and processes relating to gene expression.	2.1	**DNA structure and replication** Students are able to *demonstrate knowledge application and critical evaluation* of the DNA structure and replication and ways in which these influence DNA functioning.
		2.2	**Protein structure, function and synthesis** Students are able to *demonstrate knowledge application and critical evaluation* of protein structure, functions and synthesis and how these contribute to forms and functions in plants and animals.
		2.3	**Mutations** Students are able to *demonstrate knowledge application and critical evaluation* of mutations and ways in which these influence DNA functioning.
		2.4	**Metabolic pathways, Genetic Linkages and Sex linkages** Students are able to *demonstrate knowledge application and critical evaluation* of metabolic pathways, linkages and sex linkages and ways in which these influence DNA functioning.
		2.5	**Gene-gene interactions and Mendelian inheritance** Students are able to *demonstrate knowledge application and critical evaluation* of gene-gene interactions and Mendelian inheritance and ways in which these influence DNA functioning.
3.	**Biotechnology Applications** Students are able to *demonstrate knowledge*	3.1	**Gene cloning** Students are able to *demonstrate knowledge application and critical evaluation* of gene cloning and the use of bacterial plasmids and PCR.

Strand Number	Strand Title and Major Learning Outcome	Sub strand number	Sub-strand title and Key Learning Outcome
	application and critical evaluation of skills in biotechnology applications.	3.2	**Transgenesis** Students are able to *demonstrate knowledge application and critical evaluation* of trans genesis and using techniques of gene transfer.
		3.3	**DNA profiling** Students are able to *demonstrate knowledge application and critical evaluation* of DNA profiling and the use of PCR and gel electrophoresis.
		3.4	**Contemporary biotechnology issue** Students are able to *demonstrate knowledge application and critical evaluation* of research techniques and process information to write a report on a chosen contemporary issue regarding biotechnology and present their findings in an oral presentation.
4.	**Processes and Patterns of Evolution** Students are able to *demonstrate knowledge application and critical evaluation* of processes and patterns of evolution.	4.1	**Variation** Students are able to *demonstrate knowledge application and critical evaluation* of the different types of variations, the causes of these variations and the circumstances that give rise to variation.
		4.2	**Natural selection** Students are able to *demonstrate knowledge application and critical evaluation* of natural selection and factors that influence this, and things that are impacted by natural selection.
		4.3	**Gene pool and allele frequency** Students are able to *demonstrate knowledge application and critical evaluation* of gene pools and allele frequencies within gene pools of a population and factors that affect allele frequency.

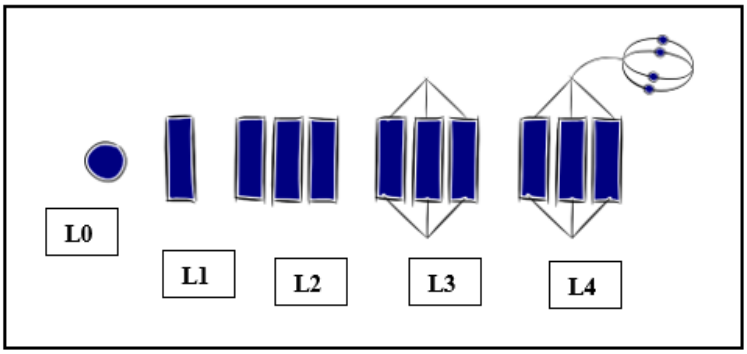
Strand Number	Strand Title and Major Learning Outcome	Sub strand number	Sub-strand title and Key Learning Outcome
		4.4	**Speciation** Students are able to *demonstrate knowledge application and critical evaluation* of the different types of speciation, the different reproductive isolating mechanisms and the impact of speciation on diversity.
		4.5	**Patterns of evolution** Students are able to *demonstrate knowledge application and critical evaluation* of the different patterns of evolution in terms of divergent evolution, convergent evolution and co-evolution.
5.	**Environmental Issues** Students are able to *demonstrate knowledge application and critical evaluation* of biological concepts and processes relating to contemporary environmental.	5.1	**Climate Change** Students are able to *demonstrate knowledge application and critical evaluation* of contemporary environmental issues and impacts of human activities climate change and vice versa.
		5.2	**Conservation** Students are able to *demonstrate knowledge application and critical evaluation* of adaptation and mitigation action for climate change situations.

6. Unpacking of Learning Outcomes

In this syllabus, Learning Outcomes are stated at three levels of generality: Major Learning Outcomes (MLOs) are stated at the strand level, Key Learning Outcomes (KLOs) are stated at the sub-strand level, and Specific Learning Outcomes (SLOs) are unpacked from the Key Learning Outcomes. Each SLO is a combination of a cognitive skill and a specific content component. Each SLO is given a skill level, level 1– 4, and this skill level results from the categorisation of the cognitive skill that is embedded in the SLO using the SOLO taxonomy[1].

[1] Structure of Observed Learning Outcomes by Biggs and Collis (1982)

The SOLO taxonomy provides a simple, reliable and robust model for three levels of understanding – surface, deep and conceptual (Biggs and Collis, 1982).



At the **prestructural** level (L0) of understanding, the task is inappropriately attacked, and the student has missed the point or needs help to start. The next two levels, unistructural and multistructural are associated with bringing in information (surface understanding). At the **unistructural** level (L1), one aspect of the task is picked up, and student understanding is disconnected and limited. The jump to the multistructural level is quantitative.

At the **multistuctural** level (L2), several aspects of the task are known but their relationships to each other and the whole are missed. The progression to relational and extended abstract outcomes is qualitative. At the **relational** level (L3), the aspects are linked and integrated, and contribute to a deeper and more coherent understanding of the whole. At the **extended abstract** level (L4), the new understanding at the relational level is re-thought at another conceptual level, looked at in a new way, and used as the basis for prediction, generalisation, reflection, or creation of new understanding (adapted from Hook and Mills 2011). [http://pamhook.com/solo-taxonomy/..]

The progression from Level 1 to Level 4 is exemplified in the progression from *define* →*describe* → *explain* → *discuss* with each succeeding level indicating a *higher level of understanding*, as follows:

- **Define** – to state a basic definition of a concept [Unistructural or L1]
- **Describe** – to give the characteristics of, or give an account of, or provide annotated diagrams. [Multistructural or L2]
- **Explain** – to provide a reason for a relationship – an event and its impact, a cause and an effect, as to *how* or *why* something occurs. [Relational or L3]
- **Discuss** – this means *linking biological ideas* (descriptions, explanations) to make generalisations or predictions or evaluations. It may involve relating, comparing, analysing, and justifying. [Extended Abstract or L4]

STRAND 1: ANIMAL BEHAVIOUR

Major Learning Outcome

Students are able to *demonstrate knowledge application and critical evaluation* of biological concepts and processes relating animal behaviour to biotic and abiotic environmental factors and how the behaviour contributes to an organism's survival.

Sub-strand 1.1 Ecological Niche (IA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of the ecological niche of an animal species and to investigate and report an aspect of an animal species' ecological niche.

The focus of the sub-strand is summarised as follows:

- ecological niche is defined as the role of an organism in a community in terms of the habitat it occupies, its interactions with other organisms, and its effect on the environment;
- adaptive features refer to structural/physical, behavioural, and physiological features that help a species adapt in its niche;
- environment refers to the surroundings and its conditions, the biotic and abiotic factors;
- an investigation is an activity which includes: a statement of the purpose (hypothesis); testable question or prediction; collecting, recording, and processing data relevant to the hypothesis; and interpreting and reporting the findings in a scientific report.

SLO #	**Specific Learning Outcomes:** Students are able to	Skill Level	SLO code
1	**identify** an ecological niche within a given context.	1	Bio1.1.1.1
2	**describe** the two different types of niches – fundamental niche and realised niche.	2	Bio1.1.2.1
3	**state** a title / aim / hypothesis for an investigation into an ecological niche of a named animal species.	1	Bio1.1.1.2
4	**provide** an independent variable with a minimum of 3 values given (fair test) or repeat samples taken (pattern-seeking).	1	Bio1.1.1.3
5	**structure** (organise) the scientific report correctly (appropriate order) for the aspect being investigated.	1	Bio1.1.1.4
6	**describe** the adaptive features of an animal species in relation to the animal species' habitat and/or niche.	2	Bio1.1.2.2
7	**describe** the ecological niche of a named animal accurately with reference to its physical habitat, the influence of named abiotic and biotic features in the habits and relate it to the aspect being investigated.	2	Bio1.1.2.3
8	**outline** step by step the procedure (method) of an investigation, including the independent variable or repeat samples; dependent variable (with correct units of	2	Bio1.1.2.4

SLO #	Specific Learning Outcomes: Students are able to	Skill Level	SLO code
	measurement), controlled variables, control set-up and trials/replications.		
9	**collect** and record raw data relating to the aspect being investigated in a logbook.	2	Bio1.1.2.5
10	**compile** logbook entries of research, planning, data collection, observations and day to day activities.	2	Bio1.1.2.6
11	**measure** or calculate the average (mean) value of the dependent variable and give unit(s).	3	Bio1.1.3.1
12	**tabulate** and graph results (processed data i.e. average only).	3	Bio1.1.3.2
13	**explain** the findings of the investigation.	3	Bio1.1.3.3
14	**discuss** the results of the investigation in relation to the ecological niche and the biology of the species and how these can be used to make predictions for other communities.	4	Bio1.1.4.1
15	**explain** how problems with the validity of the method were overcome and how the reliability of the data collected is maintained using an appropriate statistical procedure.	3	Bio1.1.3.4
16	**explain** reliability or validity of the research data using an appropriate statistical procedure.	3	Bio1.1.3.5
17	**discuss** the biological significance of results and how they relate to the ecological niche of the species under study.	4	Bio1.1.4.2
18	**draw** valid conclusions supported by the processed data (results) and resources correctly cited.	2	Bio1.1.2.7
19	**make** recommendations on ways to improve the research process.	3	Bio1.1.3.6

Sub-strand 1.2 Orientation and Navigation (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of animal orientation and navigation processes and how these influence movement and survival.

The focus of the sub-strand is summarised as follows:

- innate and learned behaviour;
- taxes (hydro, geo, chemo, photo, thigmo);
- kineses (ortho, klino);
- navigation using solar/sun compass, stellar / star patterns, magnetic field lines, chemical trails/scent, landmarks;
- homing (the regular return of an animal to a nest site);
- migration (long-distance return migration between breeding and feeding/overwintering grounds).

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
1	**identify** innate or learned behaviour in a given context.	1	Bio1.2.1.1
2	**distinguish** between innate and learned behaviour.	3	Bio1.2.3.1
3	**discuss** the consequences of innate and learned behaviour.	4	Bio1.2.4.1
4	**describe** a method used for navigation (solar/sun compass, stellar/star patterns, magnetic field lines, chemical trails/scent, landmarks, ocean currents, communication and signalling among individuals).	2	Bio1.2.2.1
5	**explain** how navigation using solar/sun compass, stellar/star patterns, magnetic field lines, chemical trails/scent, landmarks contribute to migration and survival of a named animal.	3	Bio1.2.3.2
6	**discuss** the effectiveness of navigation using solar/sun compass, stellar/star patterns, magnetic field lines, chemical trails/scent, landmarks for named animals.	4	Bio1.2.4.2
7	**describe** how animals navigate during migration and homing.	2	Bio1.2.2.2
8	**discuss** the impacts of homing on the survival of a named animal.	4	Bio1.2.4.3
9	**explain** the adaptive value of migratory behaviour and homing.	3	Bio1.2.3.3
10	**distinguish** between migration and homing.	3	Bio1.2.3.4
11	**discuss** the impacts of migration (long-distance return migration between breeding and feeding/overwintering grounds) on the survival of a named animal.	4	Bio1.2.4.4
12	**identify** a feature of taxes (hydro, geo, chemo, photo, thigmo) in a given context.	1	Bio1.2.1.2
13	**distinguish** between taxes and kinesis.	3	Bio1.2.3.5
14	**describe** the adaptive value of taxes (hydro, geo, chemo, photo, thigmo).	2	Bio1.2.2.3
15	**discuss** the impacts of taxes (hydro/geo/chemo/photo/thigmo) on the movement and survival of a named animal.	4	Bio1.2.4.5
16	**describe** the adaptive value of kineses (ortho, klino).	2	Bio1.2.2.4
17	**explain** the impacts of kineses (ortho, klino) on the movement and survival of a named animal.	3	Bio1.2.3.6

Sub-strand 1.3 Timing Responses (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of timing responses and ways of representing and interpreting timing responses.

The focus of the sub-strand is summarised as follows:

- timing responses (daily, tidal, lunar, annual) as determined by the movement of earth, sun, moon; diurnal, nocturnal, crepuscular;
- biological rhythms (circadian, circatidal, circalunar, circannual);

- biological clock (in the brain) providing endogenous control (via melatonin) of rhythms and which is set by environmental cues (zeitgebers).

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
1	**identify** a situation in which a biological clock is used.	1	Bio1.3.1.1
2	**describe** the function of a biological clock.	2	Bio1.3.2.1
3	**explain** the adaptive significance of biological timing/biological clocks.	3	Bio1.3.3.1
4	**identify** a diurnal/nocturnal/crepuscular activity within a given context.	1	Bio1.3.1.2
5	**explain** the significance of diurnal/nocturnal/crepuscular activity of organisms in a population.	3	Bio1.3.3.2
6	**distinguish** between endogenous/exogenous biological rhythms.	3	Bio1.3.3.3
7	**identify** actograms/free running period/phase shift/zeitgeber in a given context.	1	Bio1.3.1.3
8	**explain** the activity diagrams (actograms) of an organism using the following terms: free-running period, phase shift, zeitgeber.	3	Bio1.3.3.4
9	**discuss** the implications of environmental destruction on biological clocks and survival of named organisms.	4	Bio1.3.4.1
10	**describe** a rhythmic cycle (daily, tidal, lunar, annual).	2	Bio1.3.2.2
11	**explain** the adaptive value of a biological timing response (daily, tidal, lunar, annual) on the life cycle of an organism.	3	Bio1.3.3.5
12	**identify** circadian/circa tidal/circalunar/circannual biological rhythms within a given context.	1	Bio1.3.1.4
13	**describe** a rhythmic cyle of the circadian / circa tidal / circalunar / circannual.	2	Bio1.3.2.3
14	**explain** how circadian/circa tidal/circalunar/circannual biological rhythms work.	3	Bio1.3.3.6
15	**discuss** important body functions (such as sleep, metabolism, heart rate, blood pressure, body temperature, hormone levels, urine production) that circadian/circa tidal/circalunar/circannual biological rhythms influence.	4	Bio1.3.4.2
16	**contrast** the different biological rhythms (circadian, circatidal, circalunar, circannual) using examples..	3	Bio1.3.3.7
17	**discuss** the significance of different biological rhythms (circadian/circatidal/circalunar/circannual) for a named organism.	4	Bio1.3.4.3

Sub-strand 1.4 Interspecific Interactions (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of interspecific interactions and ways in which these interactions influence survival in ecological niches.

The focus of the sub-strand is summarised as follows:

- competition for resources (named e.g. food, living space, etc.) act to limit numbers and distribution (fundamental niche versus realised / actual niche; zonation) of competing species; out-competition leading to niche differentiation;
- predator-prey relationships and cycles acting to control numbers and distribution (fundamental niche versus realised / actual niche; zonation) of both predator and prey species.

SLO#	**Specific Learning Outcomes:** Students are able to*:*	**Skill level**	**SLO code**
1	**identify** niche differentiation/resource partitioning/out-competition/interspecific competition within a given context.	1	Bio1.4.1.1
2	**identify** the competitive exclusion principle in action within a given situation.	1	Bio1.4.1.2
3	**explain** the biological significance of the competitive exclusion in a population.	3	Bio1.4.3.1
4	**discuss**, using examples, the possible outcomes of competitive exclusion in a population.	4	Bio1.4.4.1
5	**describe** the features of interspecific competition.	2	Bio1.4.2.1
6	**explain** how interspecific competition limits the numbers of a population.	3	Bio1.4.3.2
7	**explain** how interspecific competition leads to niche differentiation/species distribution.	3	Bio1.4.3.3
8	**discuss** how interspecific competition contributes to niche differentiation and population redistribution using named examples.	4	Bio1.4.4.2
9	**identify** predation/parasitism/mutualism/commensalism in a given situation.	1	Bio1.4.1.3
10	**describe** the features of predator-prey relationships.	2	Bio1.4.2.2
11	**explain** how predator-prey relationships contribute to cycles that act to control population numbers and distribution of both predator and prey species.	3	Bio1.4.3.4
12	**discuss** the impacts of predator – prey relationships (within a population) on population numbers, food availability, and species distribution.	4	Bio1.4.4.3
13	**describe** the features of parasitism.	2	Bio1.4.2.3
14	**explain** how parasitism influences host behaviour and fitness.	3	Bio1.4.3.5
15	**describe** how mutualism impacts the size of a population.	2	Bio1.4.2.4
16	**discuss** the ecological significance of mutualism in a population.	4	Bio1.4.4.4
17	**describe** the features of commensalism.	2	Bio1.4.2.5
18	**differentiate** between mutualism and commensalism.	3	Bio1.4.3.6
19	**discuss** the importance of having interspecific interactions between different species in a community.	4	Bio1.4.4.5

SLO#	Specific Learning Outcomes: Students are able to:	Skill level	SLO code
20	**discuss** how interspecific interactions drive distribution patterns that lead to evolutionary changes.	4	Bio1.4.4.6

Sub-strand 1.5 Intraspecific interactions (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of intraspecific interactions and ways in which these interactions influence survival in ecological niches.

The focus of the sub-strand is summarised as follows:

- advantages (eg co-operative behaviour such as hunting/defence / detecting predators; finding food; parental care; mate availability) and disadvantages (eg increased intraspecific competition / aggressive encounters) of group living;
- social organisation; hierarchies (linear and complex); advantages (reduction of serious aggression; controlled access to resources) and disadvantages (uneven access to resources); dominance and submissive behaviours in maintaining hierarchies;
- territory and home range;
- reproductive behaviour: *r* and *k* strategies; monogamous and polygamous mating; courtship, mating, and parental care.

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
1	**identify** *r* or *k* strategies in a given context.	1	Bio1.5.1.1
2	**describe** the features of *r* and *k* strategies.	2	Bio1.5.2.1
3	**differentiate** between *r* and *k* strategies.	3	Bio1.5.3.1
4	**explain** how reproductive behaviour influences survival of species.	3	Bio1.5.3.2
5	**discuss**, using examples, how the different reproductive behaviours (*r* and *k* strategies; monogamous and polygamous mating; courtship and parental care) work together to influence the survival of a named species.	4	Bio1.5.4.1
6	**identify** group living in a given context.	1	Bio1.5.1.2
7	**list** the advantages and disadvantages of group living.	2	Bio1.5.2.2
8	**differentiate** between closed and open groups.	3	Bio1.5.3.3
9	**explain** how group living influences the survival of the group members.	3	Bio1.5.3.4
10	**list** the advantages and disadvantages of different types of parental care.	2	Bio1.5.2.3
11	**describe** the features of different types of social organisations.	2	Bio1.5.2.4
12	**discuss**, using examples, the advantages and disadvantages of social organisation within a population.	4	Bio1.5.4.2

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
13	**discuss** the evolution of group living and evaluate whether group living continues to be an advantage under changing social and environmental conditions.	4	Bio1.5.4.3
14	**describe** the features of social organisation in terms of hierarchies, dominance and submissive behaviours.	2	Bio1.5.2.5
15	**explain** how dominance and submissive behaviours maintain hierarchies within a population.	3	Bio1.5.3.5
16	**analyse** /**sequence** the hierarchal order of social organisations.	3	Bio1.5.3.6
17	**identify** territory and home range within a given context.	1	Bio1.5.1.3
18	**explain** how the establishment of territory and home range increases survival of a species.	3	Bio1.5.3.7
19	**discuss** the social organisations of a number of species living together within an area and how these organisations support survival or threaten extinction, and how members of these species cope.	4	Bio1.5.4.4

STRAND 2: GENE EXPRESSION

Major Learning Outcome 2
Students are able to *demonstrate knowledge application and critical evaluation* of biological concepts and processes relating to gene expression.

Sub-strand 2.1 DNA structure and replication (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of the DNA structure and replication and ways in which these influence DNA functioning.

The focus of the sub-strand is summarised as follows:

- genome;
- structure of the gene;
- replication of DNA – revision and extension of Year 12 to include: semi-conservative replication, enzyme control (helicase, DNA polymerase, ligase), strands, leading and lagging strands, Okazaki fragments and synthesis occurring in the 5 to 3' direction.

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
1	**idenitfy** genome/gene/DNA within a context.	1	Bio2.1.1.1
2	**describe** the structure of a gene/DNA.	2	Bio2.1.2.1
3	**explain** how the genome determines all the characteristics of an organism.	3	Bio2.1.3.1
4	**explain** the roles of DNA.	3	Bio2.1.3.2

5	**define** semi-conservative replication in a given context.	1	Bio2.1.1.2
6	**identify** the leading and lagging strand in a given DNA replication representation.	1	Bio2.1.1.3
7	**explain** the roles of respective enzymes in DNA Replication [Helicase/DNA Polymerase/Ligase].	3	Bio2.1.3.3
8	**explain** the process of DNA Replication in terms of the leading and lagging strands and the Okazaki fragments.	3	Bio2.1.3.4
9	**discuss** the process of DNA Replication of the lagging and leading strand and Okazaki fragments, with the help of enzymes(helicase/polymerase/ligase).	4	Bio2.1.4.1
10	**describe** ways in which DNA Replication problems may arise.	2	Bio2.1.2.2

Sub-strand 2.2 Protein structure, function, and synthesis (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of protein structure, functions and synthesis and how these contribute to forms and functions of plants and animals.

The focus of the sub-strand is summarised as follows:

- protein structure (primary, secondary, tertiary) and function (structural e.g. collagen, keratin, and regulatory e.g. enzymes, hormones);
- protein synthesis; transcription and translation – revision and extension of Year 12 content to include the role of DNA, mRNA (codons), tRNA (anticodons), ribosomes, use of the codon dictionary (Genetic code) to identify amino acids; redundant nature of the genetic code;
- protein structure (primary, secondary, tertiary) and function (structural e.g. collagen, keratin, and regulatory eg enzymes, hormones).

SLO#	**Specific Learning Outcomes:** Students are able to	**Skill level**	**SLO code**
1	**identify** protein synthesis / codons / anticodons in a given context.	1	Bio2.2.1.1
2	**identify** transcription/translation within a protein synthesis process.	1	Bio2.2.1.2
3	**describe** the Dogma Theory of Molecular Biology.	2	Bio2.2.2.1
4	**describe** the roles of mRNA/tRNA/rRNA.	2	Bio2.2.2.2
5	**identify** mRNA / tRNA in a given representation of protein synthesis.	1	Bio2.2.1.3
6	**discuss** the process of protein synthesis [Transcription /Translation/formation of polypeptide chain].	4	Bio2.2.4.1
7	**describe** the use of the Genetic code to identify amino acids.	2	Bio2.2.2.3
8	**describe** the redundant nature of the Genetic code.	2	Bio2.2.2.4
9	**explain** the relationships within transcription and translation including the role of DNA (triplets), mRNA (codons), tRNA	3	Bio2.2.3.1

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
	(anticodons), ribosomes; use of codon dictionary to identify amino acids; redundant nature of the genetic code.		
10	**discuss** the interdependency of the different parts of the process of protein synthesis (transcription and translation including the role of DNA, mRNA (codons), tRNA (anticodons), ribosomes; use of the Genetic code to identify amino acids; redundant nature of the genetic code.	4	Bio2.2.4.2
11	**describe** the features of structural proteins/functional proteins.	2	Bio2.2.2.5
12	**relate** the structure of structural proteins (eg collagen, keratin) to their functions.	3	Bio2.2.3.2
13	**relate** structure of functional proteins (e.g. enzymes, hormones) to their functions.	3	Bio2.2.3.3
14	**explain** the different roles of proteins using examples.	3	Bio2.2.3.4
15	**discuss** the importance of protein structure to different forms and functions in plants and/or animals.	4	Bio2.2.4.3

Sub-strand 2.3 Mutations (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of mutations and ways in which these influence DNA functioning.

The focus of the sub-strand is summarised as follows:

- mutations;
- gene (point) mutations - the substitution of bases producing missense (different amino acid) or nonsense codons (termination); addition or deletion of bases producing a frameshift (as all following amino acids changed leading to early termination);
- chromosome (block) mutations – deletion, inversion, duplication, translocation of genes in and between chromosomes;
- aneuploidy – change in number of chromosomes within a set resulting from nondisjunction during meiosis eg Downs (trisomy 21), Turners, Kleinfelters syndromes;
- polyploidy – change in numbers of (whole) sets of chromosomes resulting from complete non-disjunction during meiosis eg triploid (3n), tetraploid (4n); autopolyploidy, allopolyploidy.

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
1	**identify** mutation within a given context.	1	Bio2.3.1.1
2	**describe** the features of mutation using examples.	2	Bio2.3.2.1
3	**describe** gene (point) mutations (such as substitution of bases producing missense or nonsense codons; addition or deletion of bases producing a frameshift).	2	Bio2.3.2.2
4	**describe** chromosome (block) mutations (deletion, inversion, duplication, translocation of genes in and between chromosomes).	2	Bio2.3.2.3

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
5	**explain** the causes of gene (point) mutations.	3	Bio2.3.3.1
6	**differentiate** between chromosome mutation (block) and gene mutation (point).	3	Bio2.3.3.2
7	**explain** the causes and effects of chromosome (block) mutations.	3	Bio2.3.3.3
8	**discuss**, using named examples, the impact of gene (point) mutations on an affected person.	4	Bio2.3.4.1
9	**discuss**, using named examples, the impact of chromosome (block) mutations on an affected person.	4	Bio2.3.4.2
10	**identify** any of the following mutations, deletion / inversion / duplication / translocation of genes, in a given context.	1	Bio2.3.1.2
11	**differentiate** between missense codons and nonsense codons.	3	Bio2.3.3.4
12	**identify** polyploidy/autopolyploidy/allopolyploidy in a given context.	1	Bio2.3.1.3
13	**describe** the characteristics of polyploidy (presence of whole sets of chromosomes resulting from complete non-disjunction during meiosis eg triploid (3n), tetraploid (4n); autopolyploidy, allopolyploidy).	2	Bio2.3.2.4
14	**compare** and **contrast** autopolyploidy with allopolyploidy.	3	Bio2.3.3.5
15	**explain** the effects of polyploidy on the genome.	3	Bio2.3.3.6
16	**discuss**, using examples the advantages and disadvantages of polyploidy on affected plants and animals.	4	Bio2.3.4.3
17	**define** triploid (3n)/tetraploid (4n).	1	Bio2.3.1.4
18	**compare** and **contrast** the features of triploidy with tetraploidy.	3	Bio2.3.3.7
19	**identify** non-disjunction / aneuploidy in a given context.	1	Bio2.3.1.5
20	**describe** what happens during non-disjunction.	2	Bio2.3.2.5
21	**explain** how non-disjunction results in aneuploidy, using an example.	3	Bio2.3.3.8
22	**explain** the effects of aneuploidy on the genome.	3	Bio2.3.3.9
23	**discuss** the impact of aneuploidy on an affected individual using examples.	4	Bio2.3.4.4
24	**identify** from a given representation or a karyotype an individual suffering from Down's Syndrome/Turner's Syndrome/Klinefelters Syndrome.	1	Bio2.3.1.6
25	**describe** the chromosomal characteristics of a person suffering from Down's Syndrome/Turner's Syndrome/ Klinefelter's Syndrome.	2	Bio2.3.2.6
26	**describe** the common physical characteristics of a person suffering from Down's syndrome/Turner's syndrome/ Kleinfelter's syndrome.	2	Bio2.3.2.7
27	**compare** the features of Down's syndrome, Turner's syndrome and Kleinfelter's syndrome.	3	Bio2.3.3.10

Sub-strand 2.4 Metabolic Pathways, Genetic Linkages and Sex Linkages (IA)

Key Learning Outcome: Students are able to *demonstrate knowledge application and critical evaluation* of mutations and ways in which these influence DNA functioning.

The focus of the sub-strand is summarised as follows:

- metabolic pathways eg. PKU;
- effects of mutation on enzyme control of metabolic pathways;
- linkage and sex linkage;
- inheritance of red-green colour blindness and haemophilia in humans.

SLO#	Specific Learning Outcomes: Students are able to	Skill Level	SLO code
1	**identify** a metabolic pathway within a given context.	1	Bio2.4.1.1
2	**describe** the characteristics of phenylketonuria (PKU).	2	Bio2.4.2.1
3	**explain** the relation between metabolic pathways disorder and PKU.	3	Bio2.4.3.1
4	**represent** diagrammatically the metabolic pathway for PKU.	3	Bio2.4.3.2
5	**explain** the effects of untreated PKU.	3	Bio2.4.3.3
6	**explain** the effects of mutation on enzyme control of metabolic pathways.	3	Bio2.4.3.4
7	**interpret** the effects of mutation on enzyme control of metabolic pathways based on given information.	3	Bio2.4.3.5
8	**identify** genetic linkage /sex linkage in a context.	1	Bio2.4.1.2
9	**identify** a sex-linked condition in a given context.	1	Bio2.4.1.3
10	**describe** the difference between sex linkage and genetic linkage.	2	Bio2.4.2.2
11	**describe** the process of genetic linkage and sex linkage.	2	Bio2.4.2.3
12	**describe** the process of inheritance of red-green colour blindness/haemophilia in humans as an example of sex linkage.	2	Bio2.4.2.4
13	**describe** an example of genetic linkage in humans.	2	Bio2.4.2.5
14	**compare** linked genes to sex linked genes/sex linkage to genetic linkage.	3	Bio2.4.3.6
15	**discuss** linkage and sex linkage as the biological basis of heredity.	4	Bio2.4.4.1
16	**explain** using a punnet square the process of inheritance of sex linkage [haemophilia and colour blindness].	3	Bio2.4.3.7
17	**discuss** using examples of the complications associated with the inheritance of colour blindness/haemophilia.	4	Bio2.4.4.2

Sub-strand 2.5 Gene – Gene Interactions and Mendelian Inheritance (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of gene-gene interactions and Mendelian inheritance and ways in which these influence DNA functioning.

The focus of the sub-strand is summarised as follows:

- gene-gene interactions: collaboration, epistasis (complementary; supplementary genes); polygenes (eg height and skin colour in humans); pleiotrophy (eg sickle cell disease);
- monohybrid and dihybrid crosses with: complete dominance, incomplete dominance, codominance, multiple alleles, test cross (genes, alleles, genotype, phenotype, homozygous, heterozygous) – revision of Year 12 content.

SLO#	**Specific Learning Outcomes:** Students are able to	**Skill level**	**SLO code**
1	**identify** a monohybrid cross / dihybrid cross / test cross in a given context.	1	Bio2.5.1.1
2	**identify** multiple alleles / complete dominance / incomplete dominance / co-dominance.	1	Bio2.5.1.2
3	**idenitfy** homozygous / heterozygous gene pairs in a given context.	1	Bio2.5.1.3
4	**describe** genotypes for monohybrid crosses with complete dominance, incomplete dominance, co-dominance, multiple alleles, test cross (genes, alleles, homozygous, heterozygous).	2	Bio2.5.2.1
5	**explain** the expression of characteristics from monohybrid crosses involving complete dominance, incomplete dominance, codominance, (genes, alleles, genotype, phenotype, homozygous, heterozygous).	3	Bio2.5.3.1
6	**explain** the effect of multiple alleles / complete dominance / incomplete dominance / co-dominance on an individual.	3	Bio2.5.3.2
7	**discuss** the full picture of the inheritance of named characteristics through monohybrid and dihybrid crosses using named plants and or animals.	4	Bio2.5.4.1
8	**identify** epistasis/complementary gene/supplementary gene/pleiotropy / polygene.	1	Bio2.5.1.4
9	**describe** the process of gene – gene interactions seen in epistasis / complementary genes / supplementary genes / polygenes / pleiotropy.	2	Bio2.5.2.2
10	**explain** the significance of gene-gene interactions such as epistasis / complementary genes/supplementary genes/polygenes/pleiotropy, on an individual.	3	Bio2.5.3.3
11	**explain** the difference between complementary gene and supplementary gene using appropriate examples.	3	Bio2.5.3.4
12	**discuss** the types of epistasis and the corresponding phenotypic ratio from a dihybrid cross.	4	Bio2.5.4.2
13	**discuss** the interrelationship between gene – gene interactions in determining various characteristics in humans and the impact of these characteristics on survival.	4	Bio2.5.4.3

STRAND 3: BIOTECHNOLOGY APPLICATIONS

Major Learning Outcome 3

Students are able to *demonstrate knowledge application and critical evaluation* of skills in biotechnology applications.

Sub-strand 3.1 Gene cloning (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of gene cloning and the use of bacterial plasmids and PCR.

The focus of the sub-strand is summarised as follows:

- gene cloning through the formation of recombinant DNA using techniques of restriction enzymes and ligation;
- the use of bacterial plasmids and PCR to produce multiple copies of the desired gene.

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
1	**identify** gene cloning / trans genesis / bacterial plasmids / restriction enzymes / recombinant DNA within a given context.	1	Bio3.1.1.1
2	**describe** the properties of plasmids that allow them to be used in gene cloning.	2	Bio3.1.2.1
3	**explain** the roles of the enzymes restriction endonucleases, reverse transcriptase and ligases; and plasmids in genetic engineering.	3	Bio3.1.3.1
4	**discuss** the steps of producing multiple copies of the desired gene (cloning) using bacterial plasmids.	4	Bio3.1.4.1
5	**discuss**, using relevant examples, the applications of recombinant DNA technology.	4	Bio3.1.4.2

Sub-strand 3.2 Transgenesis (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of trans genesis and using techniques of gene transfer.

The focus of the sub-strand is summarised as follows:

- trans genesis and ways in which genes are transferred;
- using techniques of *Agrobacterium tumefaciens*; ballistic ('gene gun') method; pronuclear ('micro') injection; viral vectors;
- Genetically Modified Organisms (GMOs) – implications and significance.

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
1	**identify** *Agrobacterium tumefaciens* / transgenic organism / GMO in a given context.	1	Bio3.2.1.1

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
2	**describe** trans genesis using the technique of *Agrobacterium tumefaciens*.	2	Bio3.2.2.1
3	**differentiate** between the different methods of gene transfer (*Agrobacterium tumefaciens*, gene gun, pro-nuclear injection and viral vectors).	3	Bio3.2.3.1
4	**explain** the role of *Agrobacterium tumefaciens* in gene transfer.	3	Bio3.2.3.2
5	**explain** why a promoter may have to be transferred into an organism as well as the desired gene.	3	Bio3.2.3.3
6	**explain** the positive and negative impacts of the use of trans genesis on the gene pool for a population.	3	Bio3.2.3.4
7	**discuss** the positive and negative impacts of the use of trans genesis on the human gene pool.	4	Bio3.2.4.1
8	**discuss** how recombinant DNA is formed using restriction enzymes and ligation and its impacts (benefits and dangers) on the transgenic organism.	4	Bio3.2.4.2
9	**discuss** the ethical and social implications of using genetically modified organisms (GMOs) in food production.	4	Bio3.2.4.3

Sub-strand 3.3 DNA Profiling (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of DNA profiling and the use of PCR and gel electrophoresis.

The focus of the sub-strand is summarised as follows:

- DNA profiling and its applications in medical health and forensic science;
- formation of DNA profiles using the techniques of PCR and gel electrophoresis.

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
1	**identify** short tandem repeat (STR) in DNA/DNA profiling/PCR/Gel electrophoresis.	1	Bio3.3.1.1
2	**describe** the use of STRs in DNA profiling.	2	Bio3.3.2.1
3	**explain** the role of PCR in the formation of DNA profiles.	3	Bio3.3.3.1
4	**explain** how gel electrophoresis is used to separate DNA fragments of different lengths.	3	Bio3.3.3.2
5	**explain** the interrelationships of processes in the formation of DNA profiles using the techniques of PCR and gel electrophoresis.	3	Bio3.3.3.3
6	**discuss** the steps involved in PCR to clone and amplify DNA, including the role of Taq polymerase.	4	Bio3.3.4.1
7	**discuss** some applications of the PCR technique (such as COVID-19 RT-PCR Tests, Paternity tests, Criminal forensics).	4	Bio3.3.4.2

8	**explain** the positive and negative impacts of DNA profiling on medical health sciences.	3	Bio3.3.3.4
9	**discuss** how DNA profiling has made the work of criminal justice easier.	4	Bio3.3.4.3
10	**discuss** the impact of the formation of DNA profiles using the techniques of PCR and gel electrophoresis on criminal justice, medicine and other areas.	4	Bio3.3.4.4

Sub-strand 3.4 Contemporary biotechnology issue (IA)

Key Learning Outcome: Students are able to *demonstrate knowledge application and critical evaluation* of research techniques and process information to write a report on a chosen contemporary issue regarding biotechnology and present their findings in an oral presentation.

The focus of the sub-strand is summarised as follows:

- contemporary biotechnology issues;
- human needs or demands that have led to the development of a biotechnological application which is an issue;
- techniques needed to carry out the application;
- any potential biological, social, ethical, economic impacts of the application;
- the differing opinions of named people or groups, including their own justified opinion, on the issue.

SLO#	**Specific Learning Outcomes:** Students are able	**Skill level**	**SLO code**
1	**name/identify** a biotechnology issue within a given context.	1	Bio3.4.1.1
2	**locate** the area in which selected biotechnology issue is commonly encountered.	1	Bio3.4.1.2
3	**list** contemporary biotechnology issues as established through research.	2	Bio3.4.2.1
4	**describe** the human needs or demands that are giving rise to the use of the selected biotechnology application and the related issues.	2	Bio3.4.2.2
5	**describe** the procedures used in the selected biotechnology application.	2	Bio3.4.2.3
6	**provide** elaboration on at least two critical steps in the selected biotechnology application.	3	Bio3.4.3.1
7	**compare** two differing opinions on the selected biotechnology application.	3	Bio3.4.3.2
8	**state** a personal opinion on the use of the selected biotechnology application using supporting evidence.	2	Bio3.4.2.4
9	**organise** ideas in a logical and coherent manner.	2	Bio3.4.2.5
10	**discuss** biological, social, ethical, economic impacts related to the selected biotechnology application.	4	Bio3.4.4.1

11	**produce** a detailed and structured power point presentation with a logical flow of ideas.	4	Bio3.4.4.2
12	**demonstrates** originality and creativity in the presentation of information.	3	Bio3.4.3.3
13	**organise** primary sources of information within a portfolio with correct referencing.	2	Bio3.4.2.6

STRAND 4: PROCESSES AND PATTERNS OF EVOLUTION

Major Learning Outcome 4
Students are able to *demonstrate knowledge application and critical evaluation* of processes and patterns of evolution.

Sub-strand 4.1 Variation (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of the different types of variations, the causes of these variations and the circumstances that give rise to variation.

The focus of the sub-strand is summarised as follows:

- role of mutation as a source of new alleles;
- role of meiosis in producing variation and recombinant genotypes/gametes (independent assortment, segregation, crossing over) – revision and extension of Year 12 content;
- role of fertilisation in sexual reproduction in producing variation;
- importance of variation in evolution.

SLO#	**Specific Learning Outcomes:** Students are able to	**Skill level**	**SLO code**
1	**identify** independent assortment / segregation / crossing over / recombinant genotypes within a context.	1	Bio4.1.1.1
2	**describe** the process of independent assortment/segregation/crossing over during meiosis.	2	Bio4.1.2.1
3	**explain** how independent assortment/segregation/crossing over during meiosis contributes to variation.	3	Bio4.1.3.1
4	**describe** the process of mutation that leads to the formation of new alleles.	2	Bio4.1.2.2
5	**explain** the contribution of mutation to the gene pool of the population.	3	Bio4.1.3.2
6	**discuss** the positive and negative impacts of mutation on a population.	4	Bio4.1.4.1
7	**identify** the processes of meiosis and mitosis from a given context.	1	Bio4.1.1.2
8	**identify/state** a feature or example of meiosis / gametes / fertilisation / mitosis, in a given context.	1	Bio4.1.1.3

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
9	**describe** the process of fertilisation in terms of the combination of chromosomes from gametes.	2	Bio4.1.2.3
10	**explain** how fertilization in sexual reproduction produces variation.	3	Bio4.1.3.3
11	**discuss** the role of fertilization in sexual reproduction in producing variation and enhancing biological success, using named examples.	4	Bio4.1.4.2
12	**identify/state** a feature or example of evolution, in a given context.	1	Bio4.1.1.4
13	**list** the key features of the process of evolution.	2	Bio4.1.2.4
14	**explain** the importance of variation in evolution.	3	Bio4.1.3.4
15	**discuss** the impact of evolution on the survival of species and the critical role of variation in promoting evolution.	4	Bio4.1.4.3

Sub-strand 4.2 Natural Selection (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of natural selection and factors that influence this, and things that are impacted by natural selection.

The focus of the sub-strand is summarised as follows:

- theory of natural selection as proposed by Darwin; selecting agents/selection pressures (eg predators);
- sexual selection as a special case of natural selection – females act as the selecting agent for which males (strongest / biggest / most showy / healthiest) will breed;
- artificial selection (selective breeding) – humans act as the selecting agent for which plants and animals (those with the desirable traits) will breed;
- 'fitness' in terms of the organisms which breed successfully to produce the most offspring, so their alleles increase in frequency in the gene pool.

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
1	**identify** natural selection / selection pressure / sexual selection in a given context.	1	Bio4.2.1.1
2	**define** 'fitness' / Identify 'fitness' within a given context.	1	Bio4.2.1.2
3	**outline** the main points of the Theory of Natural Selection as proposed by Darwin.	2	Bio4.2.2.1
4	**explain** the related ideas in the Theory of Natural Selection as proposed by Darwin.	3	Bio4.2.3.1
5	**evaluate** the Theory of Natural Selection as proposed by Darwin; presenting your own opinion on the relative truth of the theory.	4	Bio4.2.4.1

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
6	**list** the agents for selection pressure [biotic and abiotic factors] that contribute to natural selection.	2	Bio4.2.2.2
7	**explain** the impact of selection pressure on evolution.	3	Bio4.2.3.2
8	**explain** using examples how biotic and abiotic factors act as forces of natural selection.	3	Bio4.2.3.3
9	**differentiate** with examples, between the different types of natural selection: stabilizing, disruptive and directional selection.	3	Bio4.2.3.4
10	**outline** the main features of sexual selection as a special case of natural selection (females act as the selecting agent for which males (strongest /biggest/ most showy/healthiest) will breed).	2	Bio4.2.2.3
11	**distinguish** between intrasexual and intersexual selection.	3	Bio4.2.3.5
12	**discuss** the impact of sexual selection on populations using specific examples [limit your example to a named local species].	4	Bio4.2.4.2
13	**distinguish** between selective breeding and natural selection.	3	Bio4.2.3.6
14	**explain** the role of humans in selective breeding.	3	Bio4.2.3.7
15	**compare** the 'effectiveness' of methods of sexual selection and selective breeding in terms of their contribution to genetic variation in populations.	3	Bio4.2.3.8
16	**discuss** the impact of selective breeding on genetic variation in populations.	4	Bio4.2.4.3
17	**discuss** the significance of fitness and natural selection in the process of evolution.	4	Bio4.2.4.4
18	**evaluate** the contribution of natural selection, sexual selection and selective breeding on a population, providing an opinion on the preferred method.	4	Bio4.2.4.5

Sub-strand 4.3 Gene pool and allele frequency (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of gene pools and allele frequencies within gene pools of a population and factors that affect allele frequency.

The focus of the sub-strand is summarised as follows:

- gene pool as the sum total of genes within a population;
- allele frequency as to how often an allele occurs in a gene pool; factors affecting allele frequency - the size of the population; natural selection, sexual selection, migration (gene flow);
- genetic drift – the changes in allele frequency in a population by chance, related to population size;
- founder effect and bottleneck effect as special cases of genetic drift.

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
1	**define** gene pool / allele frequency.	1	Bio4.3.1.1
2	**describe** how certain factors such as population size, natural selection and gene flow affect allele frequency of a population.	2	Bio4.3.2.1
3	**explain** how 'fitness' affects allele frequency.	3	Bio4.3.3.1
4	**explain** how population size affects allele frequency.	3	Bio4.3.3.2
5	**explain** how natural selection affects allele frequency.	3	Bio4.3.3.3
6	**explain** how migration and gene flow affects allele frequency.	3	Bio4.3.3.4
7	**identify** Genetic Drift/ Founder effect / Bottleneck effect in a given context.	1	Bio4.3.1.2
8	**explain** how genetic drift affects allele frequency in a population.	3	Bio4.3.3.5
9	**explain** how genetic drift is affected by population size.	3	Bio4.3.3.6
10	**explain**, using examples, the causes of genetic drift.	3	Bio4.3.3.7
11	**discuss** the impact of genetic drift on populations and population size.	4	Bio4.3.4.1
12	**describe** the features of the Founder effect / Bottleneck effect as a special case of genetic drift.	2	Bio4.3.2.2
13	**distinguish** between Founder effect and Bottleneck effect.	3	Bio4.3.3.8
14	**explain** the impact of the Founder effect / Bottleneck effect on genetic diversity in a population.	3	Bio4.3.3.9
15	**discuss** the impacts of the Founder effect and Bottleneck effect as special cases of genetic drift.	4	Bio4.3.4.2
16	**discuss** the roles of Genetic Drift, the Founder effect and the Bottleneck effect in evolution.	4	Bio4.3.4.3

Sub-strand 4.4 Speciation (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of the different types of speciation, the different reproductive isolating mechanisms and the impact of speciation on diversity.

The focus of the sub-strand is summarised as follows:

- allopatric, sympatric, instant (polyploidy) speciation;
- reproductive isolating mechanisms:
  - pre-mating (pre-zygotic) – geographical, ecological, behavioural, structural, temporal;
  - post-mating (post-zygotic) – hybrid inviable, hybrid sterile, hybrid breakdown.

SLO#	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
1	**identify** an example of allopatric/sympatric / speciation in a given context.	1	Bio4.4.1.1
2	**list** the pre-zygotic and post-zygotic reproductive isolating mechanisms.	2	Bio4.4.2.1
3	**differentiate** between allopatric and sympatric speciation.	3	Bio4.4.3.1
4	**differentiate** between pre-zygotic and post-zygotic reproductive isolating mechanisms.	3	Bio4.4.3.2
5	**explain** why geographical / ecological / behavioral / structural / temporal isolation leads to reproductive isolation.	3	Bio4.4.3.3
6	**define / identify** hybrid inviability/ hybrid sterile / hybrid breakdown, in a given context.	1	Bio4.4.1.2
7	**describe** how the conditions of hybrid inviability or sterility happen.	2	Bio4.4.2.2
8	**explain** why hybrid inviability , and/or hybrid sterility and/or hybrid breakdown mechanism leads to reproductive isolation.	3	Bio4.4.3.4
9	**discuss** the impact of pre-zygotic reproductive and/or post-zygotic reproductive isolating mechanisms on speciation in populations using specific examples.	4	Bio4.4.4.1

Sub-strand 4.5 Patterns of Evolution (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of the different patterns of evolution in terms of divergent evolution, convergent evolution and co-evolution.

The focus of the sub-strand is summarised as follows:

- divergent evolution from a common ancestor; homologous structures;
- convergent evolution; analogous structures;
- co-evolution.

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
1	**identify** divergent evolution / convergent evolution / co-evolution in a given context.	1	Bio4.5.1.1
2	**identify** homologous structures / analogous structures in a given context.	1	Bio4.5.1.2
3	**describe** how homologous or analogous structures are formed.	2	Bio4.5.2.1
4	**explain** how divergent evolution from a common ancestor relates to homologous structures.	3	Bio4.5.3.1
5	**explain** how convergent evolution relates to analogous structures.	3	Bio4.5.3.2

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
6	**compare** and **contrast** divergent and convergent evolution.	3	Bio4.5.3.3
7	**discuss** the impact of divergent evolution / convergent evolution from a common ancestor to the formation of new species using examples.	4	Bio4.5.4.1
8	**discuss** the significance of co-evolution in shaping biodiversity using a named species.	4	Bio4.5.4.2
9	**discuss** the interplay of divergent, convergent and co-evolution in the establishment of new organisms and new species.	4	Bio4.5.4.3

STRAND 5: ENVIRONMENTAL ISSUES

Major Learning Outcome 5
Students are able to *demonstrate knowledge application and critical evaluation* of biological concepts and processes relating to contemporary environmental.

Sub-strand 5.1 Climate Change (IA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of contemporary environmental issues and impacts of human activities climate change and vice versa.

The focus of the sub-strand is summarised as follows:

- the different challenges of contemporary environmental issues;
- climate change and Global warming;
- human activities contributing to climate change through increased emission of greenhouse gases;
- impacts of climate change on the environment (plants and animals).

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
1	**state** an example of a greenhouse gas (carbon dioxide / methane / nitrous oxide).	1	Bio5.1.1.1
2	**list** the features of climate change (melting of polar ice caps, rising sea levels, heavy rains, death of coral reefs, migration of fishes and insects, stronger cyclones, drought, flooding, extreme temperatures).	2	Bio5.1.2.1
3	**describe** some human activities that increase greenhouse gas emissions.	2	Bio5.1.2.2
4	**differentiate** between global warming and climate change.	3	Bio5.1.3.1
5	**explain** how human activity (such as use of fossil fuels /deforestation) contributes to global warming.	3	Bio5.1.3.2
6	**discuss** how enhanced greenhouse effect contributes to climate change.	4	Bio5.1.4.1

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
7	**explain** the influence of climate change on weather patterns (stronger and more frequent cyclones/flooding/drought).	3	Bio5.1.3.3
8	**discuss** the influence of global warming on coral reefs with emphasis on ocean acidification, coral bleaching and migration of fishes.	~~4~~	Bio5.1.4.2
9	**explain** how changes in temperature impact the lives of animals and plants in a local example (extinction of native species, mass migration of animals).	3	Bio5.1.3.4
10	**discuss** the consequences of climate change on biodiversity (species composition) of a named terrestrial ecosystem (using a forest ecosystem as an example: effect of droughts/cyclones on plants and organisms living within the forest).	4	Bio5.1.4.3
11	**explain** how sea level rise is likely to impact the human population distribution.	3	Bio5.1.3.5
12	**predict** possible types of migration resulting from climate change and/or sea level rise.	4	Bio5.1.4.4
13	**justify** your prediction for types of migration resulting from climate change / sea level rise	4	Bio5.1.4.5
14	**discuss** the consequences of climate change / sea level rise on the livelihoods (water/food/medicine/shelter/clothing/migration) of people living in the Pacific Island countries due to more extreme weather conditions (drought/flooding/stronger cyclones/extreme temperatures) using local examples.	4	Bio5.1.4.6

Sub-strand 5.2 Responses and efforts to address Climate Change (EA)

Key Learning Outcome (KLO): Students are able to *demonstrate knowledge application and critical evaluation* of adaptation and mitigation actions for climate change situations.

The focus of the sub-strand is summarised as follows:

- Adaptation actions – actions that help man adjust or adapt to the effects of global warming and/or climate change;
- Mitigation actions (including conservation practices) – actions that help reduce the emission of greenhouse gases.

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
1	**identify** adaptation or mitigation measures in the context of global warming/climate change.	1	Bio5.2.1.1
2	**identify** a conservation practice (afforestation/reforestation/use of renewable sources of energy) in a given context.	1	Bio5.2.1.2

SLO#	Specific Learning Outcomes: Students are able to	Skill level	SLO code
3	**explain** the significance of conservation in relation to global warming/climate change.	3	Bio5.2.3.1
4	**explain** the roles of frameworks/protocols/conferences in reducing greenhouse gas emissions – the United Nations Framework Convention on Climate Change (UNFCCC)/ the Kyoto Protocol / the Conference of the Parties (COP) / the Cancun amendment / the 2015 Paris summit.	3	Bio5.2.3.2
5	**discuss** the effectiveness of the frameworks/protocols/conferences in reducing greenhouse gas emissions – the United Nations Framework on Climate Change / the Kyoto Protocol / the Conference of the Parties (COP) / the Cancun amendment / the 2015 Paris summit.	4	Bio5.2.4.1
6	**describe** ways of mitigating global warming (adopting renewable energy sources like solar, wind and hydro, geothermal; retrofitting buildings to make them more energy efficient; develop more sustainable transport systems, more sustainable use of land and forests).	2	Bio5.2.2.1
7	**describe** a renewable source of energy (hydro / wind / thermal / solar / biofuel).	2	Bio5.2.2.2
8	**discuss** ways of adapting to climate change/global warming (building seawalls/relocation/planting on higher grounds/proper drainage/building wells).	4	Bio5.2.4.2
9	**explain** how a model of a renewable source of energy (hydro / wind / thermal / solar / biofuel) can be used to generate energy.	3	Bio5.2.3.3
10	**discuss** how a renewable source of energy can be used to address the issue of climate change.	4	Bio5.2.4.3
11	**demonstrate** originality, creativity and participation in producing a video documentary on climate change issues and strategies to address the issues.	3	Bio5.2.3.4

8. Assessment

Assessment in this Biology course is in two parts - external assessment and internal assessment. The respective weightings are

1. **External Assessment (EA) : 60%**
2. **Internal Assessment (IA) : 40%**

The principal, or his/her nominee, will certify that the syllabus requirements have been fulfilled.

8.1 External Assessment

This will be a three-hour written examination and will be out of 60%.

The external written examination will assess learning outcomes from all five strands in the following proportions:

Strand	Strand Title	Weighting
Strand 1:	Animal Behaviour	10%
Strand 2:	Gene Expression	20%
Strand 3:	Biotechnology Applications	5%
Strand 4:	Processes and Patterns of Evolution	20%
Strand 5:	Environmental Issues	5%

Items in the examination paper will require students to demonstrate skills of different levels (Levels 1, 2, 3 and 4). The common skills being assessed include identifying a concept within a context, describing, explaining, discussing and evaluating biological concepts and processes using sentences and paragraphs. They will be expected to interpret resource material supplied (including diagrams, table, and graphs) and to solve genetic problems. **All questions in the written examination paper are COMPULSORY.**

8.2 Internal Assessment

There are four internal assessment tasks, and these include:

Task 1: Investigation into an Ecological Niche (13%)
Task 2: Resource Interpretation on Linkages, and Sex Linkages based on a video (7%)
Task 3: Research and present on a contemporary biotechnology application and issues (13%)
Task 4: Video documentary based on Climate Change and renewable source of energy (7%)

Teacher guidelines, assessment activities, assessment criteria and sample recording templates for the two internal assessment tasks are provided in appendices 1 to 4. These will be used by **all** schools and teachers are *to ensure consistency in practice.* All student reports plus research material and logbooks will be retained on file by the schools after marking. This will assist with ensuring the authenticity of work from year to year and the information contained in them may be referred to by teachers to assist both teachers and students in future assessment activities.

8.3 Assessment Blueprint

The blueprint below is to guide the internal and external assessment allocations for Biology.

The allocation of 10%, 20%, 30% and 40% for levels 1, 2 3 and 4 respectively is common across all subjects at the SPFSC level.

Strand	IA / EA	Level 1	Level 2	Level 3	Level 4	Total (%)	
Strand 1: Animal Behaviour and Ecological Niche	EA					**10**	**23**
	IA	1	1	2	1	**13**	
Strand 2: Gene Expression	EA					**20**	**27**
	IA			1	1	**7**	
Strand 3: Biotechnology Applications	EA					**5**	**18**
	IA	2	2	1	1	**13**	
Strand 4: Process and Patterns of Evolution	EA					**20**	**20**
Strand 5: Environmental Issues	EA					**5**	**12**
	IA			1	1	**7**	
Number of items		**10**	**10**	**10**	**10**	**40**	
TOTAL		**10**	**20**	**30**	**40**	**100**	

8.4 Internal Assessment Tasks and Scoring Rubrics

8.4.1 IA Task 1: Investigating an Ecological Niche

[Weighting: 13%]

There are **two parts** to this task. The first part contains the teacher guidelines. The second part contains the student instructions.

Part 1: Teacher Guidelines

The following guidelines are supplied to enable teachers to carry out a **valid** and **consistent assessment** using this internal assessment resource.

Guideline	Description
1. Context/setting:	This is an activity to investigate *an aspect of the ecological niche* of a named species. The investigation will cover the complete process from planning to reporting and will involve students in the collection of primary data related to the ecological niche of the species. The investigation **will be:** **FAIR TEST** – a type of investigation which involves manipulating a variable (the independent variable or IV) in controlled conditions (e.g. in a laboratory) to observe and record the effect on the organism**.** Tabulated below is a list of organisms and the corresponding aspect to be investigated in the ecological niche of the organism. It is essential that they *develop an understanding* of the ecological niche of the organism

before the investigation is carried out. This can be done through any of the following:

- observation of the organism in its natural habitat,
- observations in the laboratory, within a controlled environment;
- research on the **habitat** of the organism and **factors that influence the behaviour and survival** of the organism in its habitat.

These observations and research will provide the student with the necessary background information on the *relevant* aspect of the ecological niche to investigate. Student understanding can also be developed through classroom teaching, research or practical investigation prior to, and during, the investigation.

Organism (only one)	**Aspect to be investigated (IV) (only one)**	**What is being measured? (DV)**
Tilapia Cockroaches African snails	light intensity humidity temperature soil moisture	Numbers
Slaters/wood lice	Light intensity Levels of humidity Different chemicals	Number of turns Speed of movement
Spider web patterns	Wind or light intensity	
Earthworms	Different types of substrate Amount of soil moisture Temperature Light intensity	Presence and numbers

The investigation includes:
Fair Test (eleven values across a range needed for the IV)
For eg. Tolerance of fiddler crabs to salinity – need a range of salinities, with crabs exposed to different salinities and water loss/gain measured by weight change (need accurate scales and a large number of crabs)

2. Guidance:

The teacher is to *guide* the students in the investigation. This means that the teacher interacts and discusses with the student throughout the investigation. The teacher sets the parameters (such as equipment available) and provides general information such as resource suggestions or possible new directions. Students will keep a **logbook** of their progress and will submit this to their teacher at

	regular intervals (**milestones**) during the investigation for teacher feedback on their progress. All ideas such as rough notes, brainstorming, possible investigations, collection of data and observations, research and planning, failures, successes and tentative conclusions will be kept in the logbook. The logbook is a *working document* - its function is to *record all findings* and shows the student's investigative skills. The students will write their formal report using information in the logbook. The use of milestones also provides opportunities for teachers to verify the authenticity of the students' work and to record progress. The logbooks will be handed in with the final report.
3. Conditions:	Students are expected to carry out an **individual** investigation. Specific conditions must be stated on the student instruction sheet, for example, time in class, expected homework time, equipment and resources available, animal ethics guidelines and specific safety requirements, date(s) for writing the report. Students need sufficient time for: • examining/researching the ecological niche of the organism; for this, students may be divided into groups of similar organisms so they may visit the habitats for observations under supervision; • developing and trialling their method, carrying out their investigation, processing and interpreting their data; • writing the report. The time needed for this practical may include half or one-day field trip to collect or observe their organism in its natural habitat. It is important that students are able to **trial** their method to see if it will be **valid** i.e. the method is able to measure what it intends to measure. The final method used will be developed from the trials. The writing of the report will be done **in class under formal (open book) exam conditions using the student's logbook.** Students *may not* bring a *prepared* (draft) report into the exam room. A time period of 3 hours (maximum) will be allowed for this. If this time period goes over more than one day, then all the work (logbook and incomplete report) *must* be collected in between class sessions for authenticity purposes.
4. Resource requirements:	The resources required for the investigation are:. ❖ container(s) to collect the organisms for observations in the laboratory ❖ large number of organism under investigation

	❖ equipment to measure and record the variables such as temperature, salinity, moisture content of soil, wind velocity ❖ log book and pen to record
5. Additional Information:	Whether this work is completed in a class laboratory or out of school, teachers will need to include strategies to ensure authenticity. For example, regular checking of logbooks; discussion with students about the recordings in their logbooks; digital photographs (students may be helped if the school is able to loan a digital camera so they can record aspects of their work, especially if in the field): signed authenticity statements. The final marked reports and logbooks will **be kept by the teachers/school** after the students have checked their marks. The collected material will be kept on file in the school for future reference by teachers. The data that the students have collected may be made available to students in future years to be included in their investigations too so that for eg. changes in patterns of distribution from year to year may form part of the processed data and discussion.
6. Glossary	
Ecological niche	functional place of an organism within the ecosystem. The result of its structural adaptations, physiological responses and behaviour to its biotic and abiotic environment
Primary data	original data obtained by direct measurement or observations.
Hypothesis	a prediction (based on observations and / or research) which can be tested by experimentation.
Independent variable (IV)	independent variable (IV) refers to the variable that is being manipulated, controlled or changed during the investigation to explore its effects. It is not influenced by other variables.
Dependent variable (DV)	dependent (DV) variable that changes as a result of the manipulation of the independent variable.
Controlled variable	variable(s) that are kept constant (controlled) throughout the experiment to prevent any effect on the dependent variable (therefore the experiment is a 'fair test')
Fair Test	(minimum of three values across a range needed for the IV) A fair test investigation involves taking the organism out of its natural setting/environment and investigating its behaviours within a controlled and artificial environment
Pattern-seeking investigation	involves the investigator going out into the field and observing the behaviour of the animal in its natural environment. It is difficult to control and monitor other factors that might affect the organism's

	behaviour. But, in order to ensure reliability of result, the investigator compares behaviours between different areas
Valid	the design of the experiment (the method) means that the experiment *measures what is intended.*
Reliability	the probability that the same result can be produced again if the experiment is repeated (by same or another experimenter).

Part 2: Student Instructions

The following instructions are provided to enable students to carry out the investigation.

Guideline	Description
1. Conditions	• investigation: you will be allowed to visit and observe the organism you have chosen to study in its natural habitat. The teacher will advise on the schedule for the observation visit and the group to which you belong; • conditions relating to time in class available, expected homework time involved, resources and equipment available, due dates for milestones, date for the writing of the report will be made known to you • the investigation may be carried out as a whole class, in groups or independently **but** the analysis of the data and write up should be done independently • animal ethics (if applicable) • school's authenticity policy (if investigation carried out outside of the classroom) The scientific report will include: • description of the ecological niche of the species with respect to aspect being investigated – research this information to assist you in writing this section of the report • a title, aim and hypothesis • a step by step method which includes the dependent variable (DV); independent variable (IV) and other variables that need controlling • recorded and processed data • explanation of findings • discussion of significance of results • conclusion • evaluation • recommendations • correct referencing and proper citations Read through the glossary of terms to ensure that you understand what each terms means. Seek assistance from the teacher if needed.

2. Logbook	You are required to keep a logbook. • All ideas, rough notes, brainstorming, possible investigations, collection of data and observations, research and planning, failures, successes, tentative conclusions, go into the logbook. • Record all sources of information used eg. **a reference list.** • It is your 'rough' copy and a **working** document. Its neatness is not important, but it must be able to be read and understood by your teacher; its function is to record all findings and show your skills in the investigation. You will hand the logbook into your teacher at set dates (**milestones**). Your teacher will read it, give you feedback, and sign it. If possible, include relevant photographs of your investigation. Your logbook will also be used to establish authenticity. • All entries must be **dated.** • **The information from the logbook will help in writing formal report.**

3. Investigation

This investigation is divided into three activities.

3.1 <u>Activity 1 – From the given list, select and develop an investigation on the named aspect of the ecological niche of the organism.</u>

In this task, you will **gather and process the information on the ecological niche of the selected organism** from background reading and observations. The purpose of this task is to provide information that will enable you to develop *an investigation relating to one aspect in the ecological niche of an organism you have chosen.*

Record the information in your logbook.

3.2 <u>Activity 2 – Carrying out the investigation</u>

a. In this task, you may collect a large number of your selected organism during the visit to its natural habitat, in groups or independently
b. **Follow the method that you have designed to investigate the aspect you have selected.**
c. Analysing the data is done **independently.**

3.3 Activity 3 - Reporting

This task requires the writing of a **scientific report**. The report will be written **in class** under formal exam conditions **using the material recorded in your logbook**. A 3 hour period will be allowed for this.

The report *must* contain the following:

1. **Title** – an appropriate name for the investigation
2. **Aim** and **Hypothesis**.
3. **Introduction** – a *brief* description of the ecological niche of your species focussing on the *aspect* you investigated, explaining why it is important to the way of life of the members of the species.
4. **Method** – the final method used written as a *step by step set of instructions* sufficiently clear enough that another person could carry out the investigation.
5. **Results** – the presentation of results appropriately, including processed data (eg data tables, calculation of averages, graphs *are provided as appropriate*) showing the presence (or absence) of a relationship, trend, or pattern.
6. **Explanation of findings** – a narrative about findings (e.g. patterns in the graph) are described and related ideas are linked so as to give the idea of the totality of findings and their suitability for the purpose of the investigation.
7. D**iscussion** and **Conclusion** – discuss the *biological significance* of the results and how they relate to the ecological niche of the organism.
8. **Recommendations -** make recoomendations of how this process of gathering data and reporting could be improved.
9. **Reference** – ensure that all the resources and texts you have used to obtain information are cited correctly.
10. **Evaluation** - of your investigation in terms of:
    - **either** the **validity** of your method eg how sources of error were eliminated or how limitations were overcome or how the effects of bias were reduced
    - **or** the **reliability** of the data collected using statistical analysis eg Chi-squared test, t-test

Your report, together with your logbook, must be handed to your teacher for marking.

8.4.2 IA Task 1: Scoring Rubric

Item	Level 1	Level 2	Level 3	Level 4
1.1 -1.3 Title, Aim and Hypothesis (Level 1)	States aim accurately			

Bio1.1.1.2				
1.4 Introduction - Ecological Niche (Level 2) Bio1.1.2.1	One correct idea on the ecological niche of the selected organism is provided	Two or more correct descriptions on the ecological niche of the selected organism are provided		
1.5 Method / Procedure (Level 2) Bio1.1.2.4	Description of the procedure is provided but partial only	Description of the procedure is complete		
1.6 Collect and Record Data (Level 2) Bio1.1.2.5	Data are provided in the logbook but partial only	Complete data are provided in the logbook		
1.7 Average of dependent variable (Level 3) Bio1.1.3.1	One relevant idea but far from complete	Two relevant ideas but still not complete	Correct formula for calculating the average is provided in the logbook **and** dependent variable provided in the logbook **and** complete calculation of the average is provided in the logbook with the correct answer and correct unit(s).	
1.8 Results (Level 3) Bio1.1.3.2	Collected results tabulated or graphed with incomplete information	Collected results tabulated and graphed with most details correct	Collected results accurately tabulated and graphed and details are complete	
1.9 Explanation of findings (Level 3) Bio1.1.3.3	One relevant idea but far from complete	Findings are listed but related ideas are not linked	Description of findings, including patterns or trends, is complete and related ideas are linked well	
1.10 Discussion (Level 4) Bio1.1.4.2	One relevant idea but far from complete	Two relevant ideas but still not complete	Related ideas are presented, and the significance of the results are indicated but not well discussed	The biological significance of the results are well discussed and linked to aim and / or hypothesis
1.11 Validity and reliability of the investigation (Level 3) Bio1.1.3.5	One relevant idea but far from complete	Two relevant ideas given, supported with correct statistical analysis but still not complete	Validity and reliability of data well explained supported by correct statistical analysis	

1.11Conclusion with Citations (Level 2) Bio1.1.2.7	One relevant idea but far from complete	Valid conclusion is drawn from the processed data and linked to aim and/or hypothesis		
1.12 Recommendations (Level 3) Bio1.1.3.6	One relevant idea to improve the study but far from complete	Two relevant ideas to improve the study but far from complete	Related ideas presented are complete and are linked well	

Note: the progression from *define* → *describe* → *explain* → *discuss* indicates *higher levels of understanding* as follows:

- **Stating or defining** – statement of one idea or a definition
- **Describe** – means to characterise, or give an account of, or outline features of or provide annotated diagrams.
- **Explain** – means to provide a reason as to *how* or *why* something occurs, to link event and impact, cause and effect, event and a reason etc..
- **Discuss** – this means *linking biological ideas* (descriptions, explanations) to other situations, thus showing extended abstraction.

NOTE: The student's report must be handed in together with the logbook to the teacher for marking. **Reports that are handed in without a logbook receive a zero score.**

Task 1 IA Score Capture Sheet

The electronic version of the IA Score Capture Sheet will be provided by EQAP to all schools. Teachers are to enter student scores into the score sheet using instructions provided by EQAP**.**

8.4.3 IA Task 2: Resource Interpretation on Metabolic Pathways and Sex Linkage

[Weighting: 7%]

Instructions to Teachers

1. This task is based on Strand 2 and is an individual student task based on two short videos which students will view and then answer a worksheet on. Students are encouraged to also bring to the video viewing session other resources such as textbook notes and internet information on metabolic pathways and sex linkage to consult while watching the video and during the discussions that will follow.

2. The videos are based on Sub strand 2.4 Metabolic Pathways, Genetic Linkages and Sex Linkages.

   The videos may be accessed on these links

- Punnett Squares and Sex Linked traits https://www.youtube.com/watch?v=h2xufrHWG3E
- Phenylketonuria: Genetics, signs and symptoms, treatment https://www.youtube.com/watch?v=UZFOdUP4UTY&t=47s

3. After watching the videos, the students will be able to:
    - Describe the process of sex linkage and genetic linkage, and discuss these as the basis of heredity;
    - Describe characteristics of an individual with phenylketonuria (PKU), and the effects of untreated PKU.

4. Teachers may allow students to work in pairs or threes to discuss their ideas around the guiding questions given below:
    - identifying features of sex linked conditions;
    - describing the processes of sex linkage and genetic linkage as a basis for heredity;
    - characteristics of individuals with PKU;
    - effects of untreated PKU.

5. Students may use lesson activities and other information sources to answer the worksheet questions. They are to be given 2-3 lessons to complete this worksheet. The videos may be viewed more than once as needed.

6. The teacher will use the **Task 2 Scoring Rubric** provided to score the task.

Instructions to Students

a. Students are to do some background reading and research on the topic (SLOs) of the given task before viewing the videos.

b. Although the questions may be discussed in groups, individual work is strongly recommended. Plagiarism is a punishable offence. It can results in the student found guilty to lose all his/her scores for the task or even a more serious penalty as per the SPFSC program handbook.

Activity

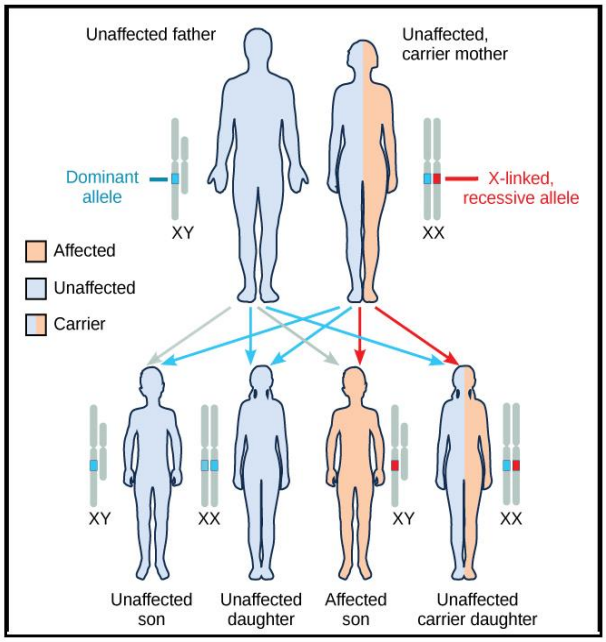
In this task, students will

- View the two videos on sex linkage and PKU;
- Make short notes and important points while watching the videos;
- Answer the questions on the worksheet after viewing the videos.

NAME:_____ DATE:_____

TASK 2: WORKSHEET
STRAND 2: GENE EXPRESSION
SUB STRAND 2.4 METABOLIC PATHWAYS, LINKAGE AND SEX LINKAGE

Study the diagram given below.



Source: https://commons.wikimedia.org/wiki/

1a. With reference to the diagram, identify the type of linkage – whether genetic linkage or sex linkage. (L1)

_____

1b. **Linked genes** (genetic linkage) are those that are found on the same chromosome, while **sex linked genes** are found on the sex chromosomes.
Describe the process of sex linkage and genetic linkage. (L2)

_____

_____

_____

_____

_____

_____

1c. Discuss linkage and sex linkage as the biological basis of heredity. (L4)

Phenylketonuria, also called PKU, is a rare inherited disorder that causes an amino acid called phenylalanine to build up in the body.

2a. Describe the characteristics of PKU. (L2)

2b. Explain the untreated effects of PKU. (L3)

The End

8.4.4 IA Task 2: Scoring Rubric

Item (LO)	LEVEL	Evidence	Level 1	Level 2	Level 3	Level 4
1a. (SLO Bio2.4.1.3) Identifying sex linked condition in the given pedigree diagram	1	• Sex linkage	Correct response given			
1b. (SLO Bio2.4.2.3) Describe the process of sex linkage and genetic linkage.	2	• Sex linkage – applies to genes on the sex chromosomes • Genetic linkage – genes that are closely located on the same chromosome Sex linked genes can be genetically linked	Appropriate feature of sex linked condition is provided; One correct idea is expressed	One correct idea shared **per each phrase**		
1c. (SLO 2.4.4.1) Discuss linkage and sex linkage as the biological basis of heredity.	4	Genetic Linkage • Genes that are sufficiently close together on a chromosome will tend to "stick together," and the versions (alleles) of those genes that are together on a chromosome will tend to be inherited as a pair more often than not. • The members of the autosome pairs are truly homologous; that is, each member of a pair contains a full complement of the same genes (but in different allelic forms), thus	Appropriate feature of sex linked condition is provided; One correct idea is expressed	One correct idea shared **per each phrase**	Two or more ideas provided with linkage between ideas, i.e. how linkage and sex linkage both influence heredity	Two or more ideas provided with linkage between ideas and examples provided.

Item (LO)	LEVEL	Evidence	Level 1	Level 2	Level 3	Level 4
		these alleles tend to be all inherited by offspring) Sex Linkage • The sex chromosomes, do not constitute a homologous pair, as the X chromosome is much larger and carries far more genes than does the Y. • many recessive alleles carried on the X chromosome of a male will be expressed just as if they were dominant, for the Y chromosome carries no genes to counteract them.				
2a. (SLO Bio2.4.2.1) Describe the characteristics of phenylketonuria, PKU	2	• A musty odour in the breath, skin or urine, caused by too much phenylalanine in the body. • Neurological problems that may include seizures. • Skin rashes (eczema) • Fair skin and blue eyes, because phenylalanine can't transform into melanin — the pigment responsible for hair and skin tone	One correct idea is expressed	Two correct ideas expressed		

Item (LO)	LEVEL	Evidence	Level 1	Level 2	Level 3	Level 4
		• Abnormally small head (microcephaly) • Hyperactivity • Intellectual disability • Delayed development • Behavioural, emotional and social problems • Psychiatric disorders.				
2b. (SLO Bio2.4.3.3) Explain the effects of untreated PKU	3	• Untreated infants with PKU tend to have **unusually light eye, skin, and hair colour** due to high phenylalanine levels interfering with production of melanin, a substance that causes pigmentation. They may also have a musty or "mousy" body odour caused by phenyl acetic acid in the urine or sweat • in older children and adults: **Irreversible brain damage and marked intellectual disability beginning within the first few months of life**. Neurological problems such as seizures and tremors. Behavioural, emotional and social problems	One correct idea is expressed	Two correct ideas expressed	Two linked correct ideas expressed	

8.4.5 IA Task 3: Research on Biotechnological Issue

[Weighting: 13%]

There are two parts to this task. The first part contains the teacher guidelines. The second part contains the student instructions.

Part 1: Teacher Guidelines

The following guidelines are supplied to enable teachers to carry out a **valid and consistent assessment** using this internal assessment resource.

Guidelines	Description
1. Context / Setting:	This activity is based on **Sub-strand 3.2: Contemporary Biotechnology Application**. The application to be researched must be considered an **issue**; this means that there is some controversy about the topic with people holding differing opinions. The students select a topic from those listed and then collect **a range of material** covering • the biological **application** • potential **impacts** (positive and negative) of the application • **different opinions** relating to the application It may assist teachers and students in their research and assessment to think of: • **B** for the **B**iotechnological application • **I** for the **I**mpacts • **O** for the **O**pinions There are several biotechnological applications that are listed for students to choose from. Teachers are to organize their students to work in groups (preferably 2 – 3 students maximum). Teachers are reminded that not all student groups are to choose the same topic, but instead that the topics are distributed evenly amongst the groups. Where groups decide on a different topic, the teacher MUST check and approve for relevance before the group can commence the IA task. Teachers are expected to monitor the following group work and participation and facilitate only where totally necessary • Students participation in the research and **processing** of information to identify aspects that will be suitable for use in their written report. • **Report writing** on their chosen topic. Their notes and research material are organised and handed in as part of the authenticity process. The report is written in the student's **own words** with paragraphs flowing in a logical manner rather than jumping from one topic to another. **A traceable reference system** should be used in the report so that the sources of information can be accessed. For example, by using *footnotes* or *endnotes* – this will need to be demonstrated to the students.

	• **Oral presentation** – all members contribute significantly in the presentation.
2. Conditions:	The research and presentation is to be carried out in **groups**. The compilation of the portfolio and the power point presentation will be done in **class under teacher supervision.** Teachers are to provide a schedule for the following components of this IA. • Collection and processing of data. • Processing and organizing of reseach information within a group portfolios. • Preparation of group power-point presentation using collected and processed information. • Group presentations (the duration will also largely depend upon the number of groups in the teachers class). **The teacher will have to indicate the dates for the above in their IA Program proposal.** **Failure to indicate these dates may result in the proposed IA program not being approved.**
3. Milestones:	Student groups need to hand in their researched material to their teachers regularly during the week(s) assigned for collection and processing of data. This is to allow teachers to check and provide feedback on: • the relevance of the material collected • range of material collected • compilation of a reference list • the appropriate and relevant processing
4. Resource requirements:	Students will require access to a range of sources of information on their issue including internet access. All sources used must be *relevant* and *up to date.*
5. Additional information:	The final marked group portfolio and powerpoint slides will **be kept by the teachers/school** after the students have checked their marks. The collected material will be kept on file in the school for future reference by teachers. This will also minimise potential copying of the material by students in future years.
6. Glossary	
Primary data Traceable	original data obtained by direct measurement or observation of the event e.g. data collected field data, interview, lecture
Reference System	a report has all its material/information / data referenced in such a way that a reader *can find the source of that information*.
Secondary data	data from another source eg website, newspaper, DVD
Reference List	a list of the sources collected with titles/author or organisation/date published (eg book) or produced (eg DVD) or accessed (eg website)

Footnotes	the information in the research material has a numbered superscript, then that number is repeated *at the bottom of the page* under the text with the source alongside it eg '200 people were killed in traffic accidents in 2009' [1] (body of text) and at the bottom of the same page eg '[1] ABC Herald page 3 January 18, 2010'. A second reference on the same page would be numbered '2' and so on.
Endnotes	the information in the research material has a numbered superscript then that number is repeated at the *end of the research information* with the source alongside resulting in a list being compiled.

Part 2: Student Instructions

Introduction

This task is about researching, processing and presenting information on a contemporary biotechnological issue. **Students are to work in pairs or groups of three**. Minimizing student numbers per group will ensure that each member participates fully in assigned tasks and avoid total dependency upon others to complete the IA Task.

Conditions

Student groups are expected to complete the following components of this IA within the scheduled time-frame provided by their teacher:

- Collection and processing of data.
- Processing and organizing of reseach information within a group portfolios.
- Preparation of group power-point presentation using collected and processed information.
- Group oral presentations

Activity 1 – Selecting a topic

Select a topic from the following list of biological applications:

- cloning of animals (student groups may choose different animals to specify their research on)
- xenotransplantation
- transgenic plant crops (student groups may carry out their research on specific plants)
- genome analysis
- DNA profiling
- gene therapy
- stem cell technology in medicine
- Use of RT-PCR in covid-19 detection

Activity 2 – Research Portfolio

Students could collect primary and secondary data, information and opinions.

1. Use a wide range of relevant and up to date of (e.g. websites, books, newspaper/journal articles, DVDs, interviews) to collect information on the:
    - **human need(s) or demand(s)** that have led to the development of the biotechnology application
    - **technique(s)** used in the application

- any potential biological, social, ethical, economic **impacts** of the application. Impacts may be positive or negative.
- **differing opinions** relating to the application.

Keep a record of the **sources** of all the researched information so that it can be used to produce a reference list.

2. **Organise** your research notes and copies of research material into a folder or ring binder or clear pockets or similar.

3. **Process** your researched material by highlighting or tagging the key ideas (e.g. colour highlighting, notepad stickies, annotations etc). This will help you in processing your information and organizing them within your portfolio.

4. Produce a **reference list** of all the relevant sources of information – this will be needed for referencing your presentation.

Task:

Student groups are to organize themselves well to ensure that each member in the group contributes to the compilation of the research portfolio and the power-point presentation. The following information are to be collected and **integrated** into the research portfolio:

1. Name the **biotechnology application** to be researched and related issues associated with them.
2. Locate the **area** in which the selected biotechnology issue is **commonly encountered.**
3. Describe the **human need(s) or demand(s)** that have led to the development of the biotechnological application
4. Describe the **technique(s)** used to carry out the application
5. Discuss potential **biological, social, ethical, economic impacts** relating to the use of the application.
6. Give the **differing opinions** named people, groups or organisations hold and the **reasons** for each opinion.
7. Include **your own opinion** on the issue and use supporting evidence from your report
8. Include a **traceable reference system** in your report by using **footnotes** or **endnotes.** This is not needed for your power-point presentation.

All research material, including annotations and notes, will be kept by your teacher at the end of each lesson and will be made available for you to complete your portfolio and prepare your oral presentation only during the assigned lessons.

Activity 3 – Oral Presentation

Student groups will be allowed sufficient time to **prepare their power-point presentation** using their processed research material. This will be carried out in class under teacher supervision..

The presentation must use power-point slides and must be brief but concise with good use of illustrations. It must cover the processed information presented in your portfolio.

Each group is to submit the following to their teacher before their scheduled time for oral presentation:

- Research portfolio
- Power-point presentation (a copy must be saved into your teachers computer/USB Drive).

8.4.6 IA Task 3: Scoring Rubric

Teachers are to use the scoring rubric provided below to score students' reports and presentations. It is recommended that the same scoring rubric is provided to students when they begint to work on their reports so that they are clear from the start about the expectations on their report and how their report will be assessed.

Item	Skill Level	Level 1	Level 2	Level 3	Level 4
1. Name a biotechnology application (Bio3.4.1.1)	1	The relevant biotechnology application is named			
2. Locate area in which selected biotechnology issue is encountered (Bio3.4.1.2)	1	An area in which the biotechnology issue is commonly encountered is identified.			
3. List contemporary issues related to the application (Bio3.4.2.1)	2	One relevant biotechnology issue is stated	More than one relevant biotechnology issue listed		
4. Describe the human need/demand (Bio3.4.2.2)	2	One relevant point only is provided	A number of relevant ideas are provided		
5. Describe the procedures used in the application (Bio3.4.2.3)	2	One relevant point only is provided	A number of relevant ideas are provided		
6. Discuss possible impacts of application (Bio3.4.4.1)	4	Mentions one impact with minimal description	Mentions two or more impacts with descriptions	Relates the impact to the need for the application	Relates the impact areas appropriately with clear examples of each

7. Differing opinions (Bio3.4.3.2)	3	Mentions one differing opinion with minimal description	Mentions two or more differing opinions with details	Compares the *two* differing opinions highlighting the difference/s	
8. Own opinion (Bio3.4.2.4)	2	One opinion matter only is stated	More than one aspect of personal opinion described		
9. Logical flow of ideas (Bio3.4.2.5)	2	Ideas in the write-up seem disparate at a number of points	Ideas in the write-up link up well		
10. Demonstrates originality and creativity in the presentation of information. (Bio3.4.3.3)	3	A portfolio and/or power-point presentation is made without any Originality nor Creativity	A portfolio and power-point presentation is made with either originality OR Creativity	The portfolio and power-point presentation shows both Originality and Creativity.	
11. Sources and referencing (Bio3.4.2.6)	2	Sources of information are organized but without proper referencing OR Sources of information are disorganized but incorrect referencing for the most part.	Sources of information are organized with correct referencing.		

Note: the progression in skills in the rubric above, from *define* → *describe* → *explain* → *discuss* indicating progression towards *higher/deeper levels of understanding* as follows:

- **Stating or defining** – statement of one idea or a definition
- **Describe** – means to characterise, or give an account of, or outline features of or provide annotated diagrams.
- **Explain** – means to provide a reason as to *how* or *why* something occurs, to link event and impact, cause and effect, event and a reason etc..
- **Discuss** – this means *linking or extending biological ideas* (descriptions, explanations) from within the researched topic to other areas of knowledge to show extended abstractions.

NOTE: The group portfolio must be handed in together with the power-point presentation to the teacher for scoring. Portfolios that are handed in without the power-point presentation receive a zero score.

8.4.7 IA Task 4: Video documentary on Climate Change

[Weighting: 7%]

Instructions to teachers:

1.This task is based on Strand 5 and is a **collaborative** student activity on **the production of a video documentary** and should be completed in two weeks. **Students are to work in pairs on this assessment task, and the teacher is to approve and record the pairing of students that work together**. There may be a group of three only if there is an odd number of students in the class.

2. The learning outcomes assessed in this video documentary are based on **Sub strands 5.1 and 5.2. The main theme of the research and video documentary is Climate Change.**

3. Students are to be advised that the four main outcomes of this assessment task are, for students to collaborate, negotiate, share roles, and make decisions in order to:

   a. **Design and produce** a video documentary showcasing their creativity and originality.
   b. Describe the human activities that contribute to climate change.
   c. Explain how these activities are affecting the planet, their country/island and the people within their local community, and
   d. Suggest ways of reducing the effects of climate change.

4. Students are to use video applications either on their mobile phones, tablets or laptops and the teacher is not expected to help! There may be exceptional cases. Self-regulation, independent decision making, role sharing, collaboration and creativity by students is encouraged and valued in this task.

5. Students are to use the information taught by their teachers or had researched about, to create their video documentary. The documentary is to address as best as possible requirements b, c and d above.
6. Group members are to showcase their video documentary to the rest of the class. **The length of the video documentary should be about 8-10 minutes**. Both group members should show evidence of their contribution to the production of the documentary.
7. The teacher scores the student pair's video documentary and their contribution to its production using the **Assessment Criteria** which is provided below.

Instructions to Students:

- Students are to work in pairs on this task.

- Students are to identify TWO features of climate change affecting selected areas within their local community.
    - Examples of features may be: sea level rise, heavy rains, death of coral reefs, migration of fishes/insects, stronger cyclones, drought, flooding, extreme temperatures).
    - Examples of areas may be: coast, coral reef, plantations (crop/livestock production), coastal or inland ecosystems, fishing grounds). Students may seek advise from their teacher on their topic of research before they start.
- Students are required to use their creativity to produce a video documentary based on:
    a. Human activities that contribute to climate change.
    b. How these activities are affecting the planet, their country and with more emphasis on their local community, and
    c. Ways of reducing the effects of climate change.
- Students are to present their completed video to the class. Both group members must show evidence of their contribution in the production of the documentary.

Activity:

- The video documentary must be recorded using any of the following video formats: mp4, mov, wmv, avi, avchd, flv, f4v, swf, mkv, webm or html5.

8.4.8 IA Task 4: Scoring Rubric

Item	Level	Level 1	Level 2	Level 3	Level 4
1. State an example of a greenhouse gas (Bio5.1.1.1)	1	Correctly states an example of a GHG			
3. Lists features of climate change (within a local context). (Bio5.1.2.1)	2	Lists ONE feature or climate change affecting their local community.	Lists TWO features of climate change affecting their local community.		
2 Describe human activities related to climate change (Bio5.1.2.2)	2	Correctly names the human activities	Describes the human activities		

3 Explain effects of human activities on climate change (Bio5.1.3.2)	3	Correctly Names a Human Activity	Two relevant ideas but still not complete	Two or more correct ideas are provided in the documentary and the linking OR reasoning between cause and effect is clear	
4 Discuss consequences of climate change on livelihoods (Bio5.1.4.6)	4	One relevant idea but far from complete	Two relevant ideas but still not complete	Two or more correct ideas are provided and the linking or reasoning between cause and effect is clear	Two or more correct ideas are provided with clear link and reasoning between cause and effect.
5 Describe ways of mitigating global warming (Bio5.2.2.1)	2	One relevant idea is shown in the documentary but far from complete.	Two correct ideas are provided in the documentary.		
6 Explains how a renewable energy source works. (Bio5.2.3.3)	3	A model of a renewable energy source is shown in the video documentary.	A model of a renewable energy source is shown and described.	A model of a renewable energy source is explained in terms of how it works.	
7 Demonstrate originality, creativity and participation (Bio5.2.3.4)	3	A documentary is made but is missing either TWO of the following: Originality, Creativity OR participation.	A documentary is made but is missing either ONE of the following: originality, Creativity or participation.	The documentary shows ALL of the following: Originality, Creativity AND participation.	

Task 4 IA Score Capture Sheet

The electronic version of the IA Score Capture Sheet will be provided by EQAP to all schools. Teachers are to enter student scores into the score sheet using instructions provided by EQAP.

9. IA Summary Form

South Pacific Form Seven Certificate

IA Summary Form 2023

School Logo (optional)

BIOLOGY

COUNTRY					
SCHOOL					
Task	**Brief Description of Tasks**	**Start Date**	**End Date**	**Date to EQAP**	**Weighting**
1. Investigating an ecological niche					13%
2. Resource interpretation on Metabolic pathway: and Sex linkage					7%
3. Research on Biotechnological issue					13%
4. Video Documentary on Climate Change					7%
TOTAL					40%

Note:
1. Be specific about dates, not just Week 3 Term 1, etc.
2. Assessment Schedules/Scoring Rubrics for the tasks will be provided by EQAP. Teachers must use these when scoring students' work.
3. All IA Score Capture Sheets will be provided by EQAP to schools.

Verification and Endorsement of IA Program

Principal's Name	Teachers Name	School Stamp
Signature	Signature	
Date	Date	

A full IA program is to be submitted together with this IA Summary Form.

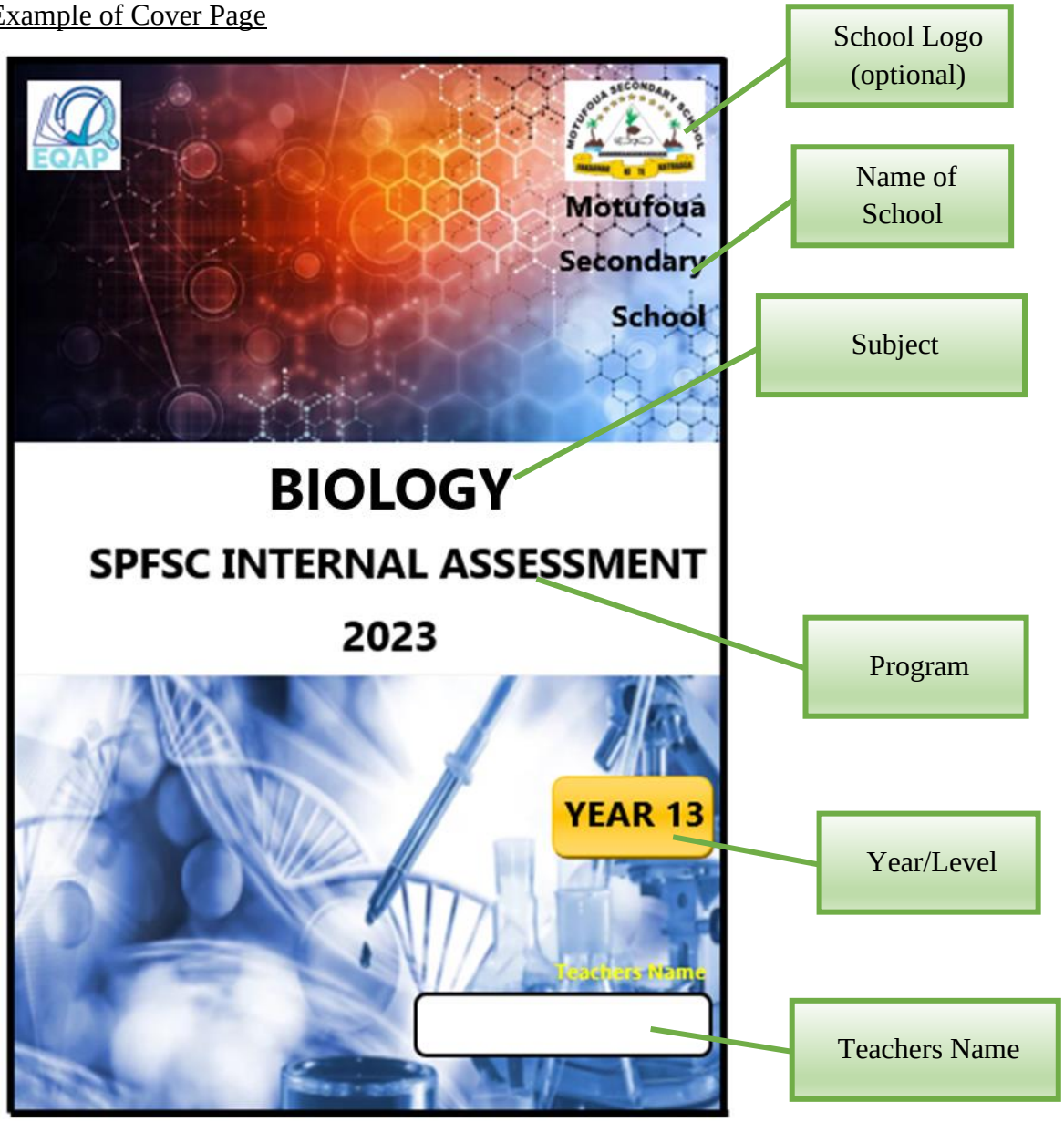
10. IA Program Proposal Template

Page 1: Cover Page

The Cover Page will have the name of the:

- School
- Subject : FULL IA PROGRAM
- Teachers Name:

Example of Cover Page

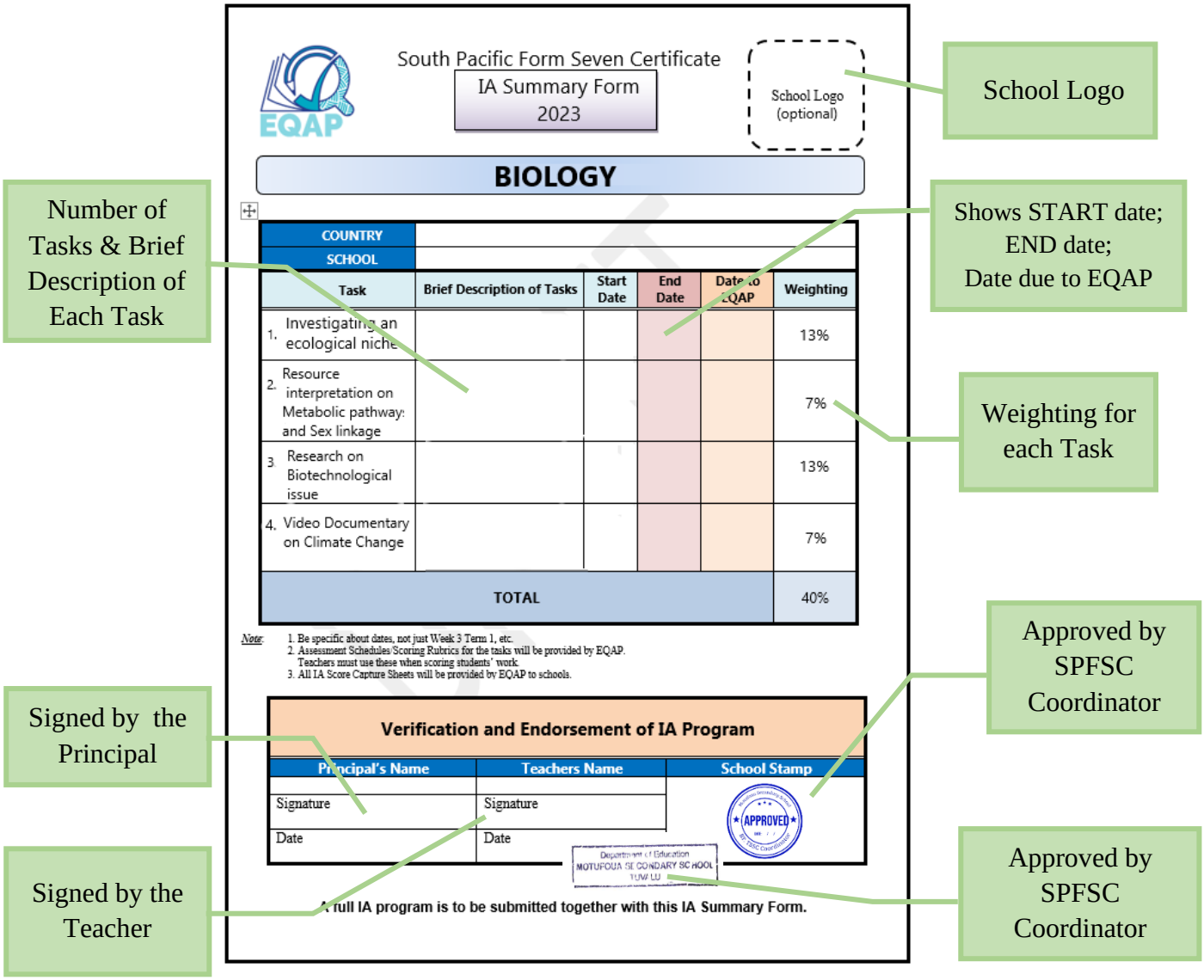


Page 2: Insert IA Summary Form Here

The IA Summary Form must have the following:

- Number of Tasks
- Brief Description of the Tasks
- Start and End Dates
- Signature of Principal and Teacher
- School Stamp/Date
- (To be completed, signed by both the teacher and the School Principal of his/her Nominee/school stamped/scan/insert)

An example of an IA Summary form



Pages 3-12:

a. Task title: Task 1:_____

The title should be brief and include a reference to the particular syllabus topic or skill which is being assessed by the task.

Example: "Research Topic – Investigation of a Social Issue."

b. Learning Outcomes: List the Specific Learning Outcomes (SLOs) to be assessed by the task

These are found in the syllabus and need to be identified before the tasks are constructed.

Example: Describe a feature of ….

(Copy and paste the relevant IA SLOs directly from the Syllabus: show strand, sub strand and SLOs)

c. Assessment/Task:

Describe the task as a form of assessment to measure student achievements of the above learning outcomes at different stages of the lesson/task implementation.

(Think of what are the best types of assessment for the above LOs so that your students can demonstrate they have achieved the learning outcomes. Also include how you will pre-assess their knowledge at the beginning of the lesson and how you will continuously assess them throughout the strand/topic to monitor their learning progress. The summative assessments are the final IA tasks.)

Diagnostic: (can be oral questions/short tests/ surveys/questionnaires to find out what students already know before the lesson)

Formative: 1. This is the formative use of the summative assessment such as the drafts submitted, self-assessment, peer assessment, teacher assessment of the drafts and specific feedback provided to improve the task. 2. For CATs – this can be similar items prepared by teachers using the SLOs and given to students for practice. After scoring, the feedback needs to be given to improve learning. If majority students are not doing well then re-teach using another strategy, assess and monitor learning.

Summative: (these are the final IA tasks or the CATs to measure how much the students have learnt/achieved after the learning period)

d. Resources: List materials required for completing the task (for learning & demonstrating the achievement of the SLOs.

This must specify any material items such as books, documents, maps, stimulus material, equipment required by the task, including use of technology and chemicals.

e. Guidelines for the teacher on advance preparation requirements

i. **time required** by the student for task completion (monitoring progress)
ii. recommended dates/date range for task completion

iii. organization of room/lab and hardware to facilitate task completion.

(After the task has been completed and scored, teachers will need an IAscore capture sheet to record the performance of all students in the class.)

f. Guidelines for the teacher on task completion and task control

This must specify:

- the role of the teacher during the period of task completion
- instructions that are to be given by the teacher to the students
- actions that are required of the teacher during task completion

g. Preparation by the students beforehand

If students are required to prepare in advance of the task date, preparatory notes must indicate the requirements. For example, students may need to collect support materials for a task that is supervised in a classroom.

h. Task outline for the student

This outline is a brief description of the task that the student is to complete. It is a general description without specific detail.

Example: Your task is to focus on an important social issue. After investigating that issue, you need to process information collected and suggest possible courses of action that authorities could take.

i. Task detail for the student

This must provide a detailed description of the task in the sequence that the student would be expected to follow during task completion. This must clearly state:

- what the student is expected to do
- what the student is expected to record and present for assessment.

(NB: Task details can be extracted from the Syllabus)

j. Feedback & Support

Using calendar days, allocate time for:

i. Student's self-assessment and correction
ii. Peer assessment, feedback, and time for improvement
iii. Teacher assessment, feedback, and time for time improvement

(NB: Provide week/dates, and state how the above will be carried out)

k. Final submission & scoring

State when the final task is due and how it will be assessed. State how the school (HOD/SPFSC Coordinator) will monitor the scoring of the tasks.

l. Assessment Schedule/ Scoring Rubric

Copy and paste directly from the aligned Syllabus the relevant scoring rubrics

m. Assessment score capture sheet for the task

Provided by EQAP when the task is due.

(Repeat 1-13 for other tasks)

11. Appendices

Appendix 1 Suggested Teaching Time and Weightings

Strands	Strands/Topics	External/ internal	Suggested Teaching Time	Overall Weighting (%)
1	Animal Behaviour	External	6.5 weeks	23
		Internal		
2	Gene Expression	External	7.5 weeks	27
		Internal		
3	Biotechnology applications	External	5 weeks	18
		Internal		
4	Process and Patterns of Evolution	External	5.5 weeks	20
5	Environmental Issues	External	3.5 weeks	12
		Internal		
	Total number of weeks		**28 weeks**	100%

Appendix 2 Suggested sample Biology Programme Timeline

TERM	WEEKS	TOPIC	ASSESSMENT
ONE	4.5 weeks	Animal Behaviour	Test
	2 weeks	Practical Investigation	Internal Assessment activity
	4 weeks	Genetics : Molecular Genetics	Test
	2 weeks	Genetics : Gene –gene interactions	Internal Assessment activity
TWO	1.5 week	Genetics : Gene – gene interactions	Test
	tbc	MID YEAR EXAM	EXAMINATION
	2.5 weeks	Biotechnology applications	Test
	2.5 weeks	Contemporary biotechnological issue	Internal Assessment activity
	3 weeks	Processes and Patterns of Evolution	Test
THREE	2.2 week	Processes and Patterns of Evolution	Test
	3.5 weeks	Environmental Issues	Internal Assessment activity
	tbc	FINAL EXAM	EXAMINATION

Note that this is a suggested timeline. Teachers may modify the timeline to suit the needs of their school year and students.

Note: The content of SPFSC Biology for both Form 6 and 7 will be found in current (and new) texts designed for NZ years 12 and 13 e.g. ESA publications. No one NZ text will cover either Form 6 PSSC or Form 7 SPFSC courses.

Note – be aware of **copyright** regulations when using any of this material.

TEXTBOOKS

Many publications / publishers offer DVD ROMs; on-line material as well as / together with hard copy texts:

- Campbell Biology 12th edition Reece, Jane B *et al*
  This is probably the most comprehensive text for teacher (and student) reference; one book for staff reference for each school is highly recommended for senior biology at all levels.
- ESA publications (www.esa.co.nz) produce both Study Guides (SG) and Learning workbooks (LWB) for all subjects and updates regularly. Currently, all books are being updated for the introduction of the new curriculum. The year 12 and 13 LWB and SG are good references for both teachers and students (eg class sets). The new line of LWB are in the write-on format and designed for daily use in class
- Biozone course Manuals (www.biozone.co.nz) are available for year 12 and 13 biology and updated annually; new editions will be in production for the new curriculum in 2012 and 2013. Excellent graphics; degree of difficulty of content in current editions varies greatly, hence suitability to students
- Meg Bayley: Designs of Life (year 13) and Patterns of Life (year 12) www.pearsoned.co.nz
  These two have been standard texts for many years and are still valuable resources. They will need to be updated / replaced for the new NZ curriculum.
- Pathfinder Series: Biology Year 13 (Jarvis and Schofield); Year 12 (Relph) www.nelsonsecondary.co.nz. The books in this series have a set format of 2 pages of keynotes for a topic accompanied by 2 pages of questions; can be a very useful resource and class set is recommended.
- Allan, R., (2009). Senior Biology 2: Biozone Student Workbook. Auckland: Biozone International Ltd.
- Bradield, P, Dodds, J., Dodds, J., & Taylor, N., (2001). AS Level Biology. UK: Longman/Pearson Education
- Sinclair, M., (2013). ESA Study Guide: Level 3 Biology. Auckland: ESA Publications
- Roberts, A., (2012). ESA Study Guide: Level 2 Biology. Auckland: ESA Publications

SCIENTIFIC PERIODICALS / MAGAZINES / JOURNALS

Excellent, relevant material may be found in any / all of the following publications, especially New Scientist. A school subscription recommended for these publications in the following priority:

- New Scientist
- National Geographic
- Biological Science Review

- Scientific American
- Time

Newspapers – many of these can still be accessed free on the web, and many regularly have good articles on aspects of biology that can make good resource material in fields such as biotechnology, ecology, genetics, medicine e.g. www.nzherald.co.nz. Internationals such as the New York Times, Guardian are worth browsing.

INTERNET/ONLINE RESOURCES

The easiest and quickest way to find information on any topic is simple to '**google it'.** Teachers need access to computers and the internet as part of their education requirements at this level in order to research information for classwork and assignment work. **Wikipedia** is often the main source provided in a google search (www.wikipedia.org). Youtube (www.youtube.com) can be an excellent source of **video clips** eg animations for DNA replication; transcription and translation. www.istockphoto.com is an excellent source of photos.
Video / DVD material can be accessed and bought from www.vea.com.au (Video Education Australasia)

Resource material provided for NZ teachers and students by the government will have relevance for teachers and students for form 6 PSSC and 7 SPSFC biology –

- www.nzqa. govt.nz (then follow links to **NCEA**) - provides external (exam) AND internal assessment material for all levels of biology; the exam papers and schedules for various topics may provide stimulus material for teaching and learning
- www.tki.govt.nz - provides resource material for internal assessment for all levels; the tasks and schedules for various topics may provide stimulus material for teaching and learning. It can be reached too by a link from NCEA webpage.
- **Strand 1 extra reading on Biological Timing Responses:**
  Science of Biological Timing – NEHC Academy
  Student Online Research sites for IA Task 3 – Contemporary Biotechnological Issues:
  - https://www.nationalgeographic.com/

  Free e-books:
  Notes for Strands 2, 3 & 4:
  - A-Level Biology Notes (Chapters 16, 17 & 19): https://gceguide.com/files/contributions/a2bionotes_biancahimawan.pdf
  - A-Level Notes on Gene Technology: https://alevel-notes.weebly.com/uploads/1/2/2/8/122820312/19_genetic_technology.pdf
  - Revision Notes (A-Level Biology) & Self-tests: https://www.savemyexams.co.uk/a-level/biology/ocr/17/revision-notes/
  - Chapters 17, 18 and 20: A2 Level Biology Notes 2016-2018.pdf

  Excellent online revision sites for students:
  - Strand 1: Animal Behavior, Strand 2: Gene Expression & Strand 4: Variation & Evolution – https://www.nobraintoosmall.co.nz/
  - Notes, Videos & Self-tests (NCEA Level Biology): https://www.passbiology.co.nz/

- https://www.sparknotes.com/biology/

Youtube videos (Excellent student revision on selected topics):

- Orientation Responses: https://youtu.be/RmTX3XjUjaY
- Speciation: https://youtu.be/OylN1_wJexs
- Plant & Animal Responses: https://youtu.be/3Yti68CaVpY
- DNA & Proteins: https://youtu.be/duVohDLd7cE

Video resources for Strand 3

Gene Cloning

1. https://www.youtube.com/watch?v=T1l-StLrDwg
   Steps in Gene Cloning

2. https://www.youtube.com/watch?v=T1l-StLrDwg
   Gel electrophoresis

3. https://www.youtube.com/watch?v=GUXKQBknYQo
   What is Gel electrophoresis

4. https://www.youtube.com/watch?v=c07_5BfIDTw
   What is PCR?

5. https://www.youtube.com/watch?v=a5jmdh9AnS4
   PCR (Polymerase Chain Reaction)

6. https://www.youtube.com/watch?v=7onjVBsQwQ8
   DNA Fingerprinting (DNA profiling)

7. https://www.youtube.com/watch?v=Cr8dJe5uUh8
   DNA profiling

- **ONLINE Books for download and use**. Ensure proper referencing and avoid plagiarism.

1. Essentials of Bioloy (5th Edition) – Sylvia Mader, Michael Windelspchet
   https://book4you.org/book/2930204/fb6172

2. Biotechnology: Applying the Genetic revolution – David Clark, Nanette J. Pazdernik
   https://book4you.org/book/818775/124ab4

3. Essentials of Ecology (Third Edition) – Colin R. Townsend, Michael Begon, John L. Harper https://book4you.org/book/1251891/bc62fa

4. Encyclopedia of Biology – Don Rittner & Timothy L McCabe
   https://book4you.org/book/690888/3c28d2