Biology

Senior High

Grades 11 and 12

Syllabus

Standards-Based

Department of Education

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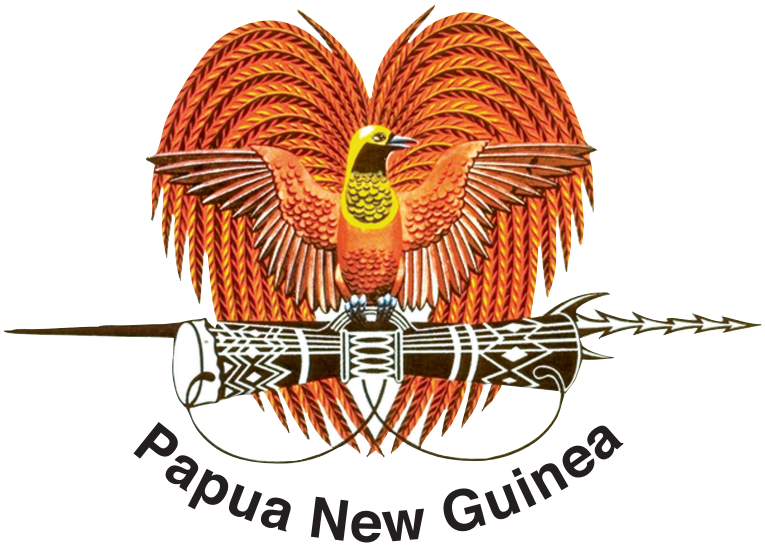

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Contents

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Acronyms

AAL	Assessment As Learning
AFL	Assessment For Learning
AOL	Assessment Of Learning
BOS	Board of Studies
CDD	Curriculum Development Division
CP	Curriculum Panel
IHD	Integral Human Development
NDoE	National Department of Education
OBC	Outcome-Based Curriculum
OBE	Outcome-Based Education
PNG	Papua New Guinea
SAC	Syllabus Advisory Committee
SBC	Standards-Based Curriculum
SBE	Standards-Based Education
SCG	Subject Curriculum Group
STEAM	Science, Technology, Arts, and Mathematics
UNCRC	United Nations Convention on the Rights of the Child

Secretary's Message

The ultimate aim of Standards-Based Education (SBE) in Papua New Guinea (PNG) is to prepare children for careers, higher education, and citizenship. This means that education should focus on developing and equipping children with essential career, higher education, and citizenship readiness knowledge, skills, values, and attitudes that they can use to work, study, and live in the complex, competitive, technology driven, and knowledge-based economy and society of the 21st Century. Rigorous and comparable learning standards have been set at the national and grade-levels to enable all children to acquire essential career, higher education, and citizenship proficiencies before leaving school at the end of grade 12.

Education must also aim to motivate and prepare students to pursue Science, Technology, Engineering, Arts, and Mathematics (STEAM) courses in higher education and pursue careers in STEAM related fields. Essential STEAM principles, concepts, processes, and skills have been embedded in the national content standards and grade-level benchmarks to enable all students to learn and use these to solve problems created by both the natural and physical environments by developing creative and innovative solutions.

The realigned Science curriculum is focused on scientific skills and process, utilizing the analytical and inquiry based approaches where students will be encouraged to predict, explore, question, test ideas, formulate questions and challenge their own ideas and overtime become scientifically literate. Scientific literacy is critically important for Papua New Guinea to participate productively in an increasingly competitive knowledge and technologically based society. By the end of grade 12, all students will acquire the essential scientific proficiencies and develop the ability to be creative, innovative, productive, and competitive in diverse knowledge and technology-based contexts.

It is therefore, important for biology teachers to be creative, innovative and motivated when teaching biology.

Teachers are encouraged to use the syllabus in conjunction with the Teacher Guides and other relevant resources to generate creative teaching and learning activities to deliver the Science content and enable all students to progressively learn and master the essential scientific knowledge, skills, values, and attitudes.

I approve and commend this Grades 11 and 12 Biology Syllabus to be used by teachers in all Senior High Schools throughout Papua New Guinea.

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UKE W KOMBRA, PhD
Secretary for Education

Introduction

The 21st Century is a time of rapid change. New knowledge, tools, and ways of doing and communicating Science continue to emerge and evolve, and impact on our lives in many different ways.

PNG needs to be on par with the rest of the world. The need to understand and use science in everyday life, in schools, and in the workplace has never been greater. Biology knowledge, skills, values, and attitudes are needed in a variety of careers, including STEAM related careers, in the 21st Century. The 21st Century job market is very competitive. Those who do not possess the in-demand proficiencies will find it difficult to get any sort of employment or create and sustain their own career pathways. Thus, it is important that students are encouraged, motivated, and enabled to develop a scientific attitude of the mind to enjoy learning science and, simultaneously, achieve high academic standards and attain the required career, higher education, and citizenship proficiencies before leaving school.

In this century and beyond, those who understand and can-do science will have more opportunities and options to create and sustain a future of their choice. Scientific competence increases career choices and opens doors to productive and rewarding futures. All students should be provided the opportunity and necessary support to learn Biology and achieve the expected Biology standards and proficiencies before leaving school.

The Biology learning standards are comparable to regional and global science standards. This syllabus and the teacher guide will provide the bases for all children to progressively learn and master the essential scientific knowledge, skills, values, and attitudes to effectively prepare them for careers, higher education, and citizenship in the 21st Century and beyond.

Time allocation for grades 11 and 12 Biology is 240 minutes per week.

Teacher can use the time allocated to do their time table or program according to their school needs.

Aims and Goals

The ultimate aim of education in PNG is to prepare students for careers, higher education, and citizenship. To achieve this aim, a number of enabling aims and goals were formulated based on evidence. The ultimate aim and the enabling aims and goals are closely linked. The enabling or operational aims and goals are described below.

Aims and Goals of Standards-Based Education and Curriculum

Curriculum aims and goals articulate the outcomes that will be achieved in the long-term and the medium-to-long term. They embed the development and educational aspirations of PNG and its citizens. These have been influenced by evidence from the analysis of context and research on teaching and learning, and on social, economic, political, technological, and cultural developments. There is a close link between the aims and goals of the curriculum. This is important for ensuring that the chain of learning results is clear.

Aim 1: Students will acquire essential and relevant knowledge, skills, values, and attitudes that will prepare them for careers, higher education, and citizenship.

Goals

Students will be able to;

(a) acquire essential in-demand knowledge and employability skills, and values, and attitudes required for working, studying, and living in the 21st Century.
(b) achieve internationally comparable and high academic standards, and attain essential proficiencies that will enable them to make a smooth transition from secondary to post-secondary institutions, pursue a variety of career pathways, and live purposeful, productive, responsible, and harmonious lives.
(c) acquire and use intellectual, emotional, cultural, physical, creative, vocational, recreational, and spiritual knowledge, skills, values, and attitudes as bases for living fulfilling, purposeful, and productive lives in communities in which they choose to live.

Aim 2: Students will achieve high standards in Language, Mathematics, Science and Technology, Social Science, Civic and Citizenship Education, Character and Social Development, and Skills Education (Creative, Physical, and Vocational skills).

Goals

Students will be able to;

(a) acquire and use intellectual, emotional, cultural, physical, creative, vocational, recreational, and spiritual knowledge, skills, values, and attitudes as a basis for living a fulfilling and a productive life in the communities in which they choose to live.
(b) understand and apply mathematical reasoning, processes, formulas, and concepts to solve mathematical problems.
(c) examine and apply scientific reasoning, processes, and concepts to improve real life situations.
(d) aware of scientific standards and methods and their application across all branches of science.
(e) aware of logical and abstract thinking in the formulation of problems, the importance of mathematics in science reasoning, and recognize the role of science in every aspect of life.
(f) explain the connection between science and technology and recognize the importance of technology in the development of communities, the improvement of peoples' lives, in communication, and industry.
(g) acquire fundamental knowledge and skills to build and market different types of technology.
(h) communicate orally and in writing, use different approaches and modes of communication, identify different purposes of communication, and understand and appreciate PNG's languages and the languages of people from different cultures.
(i) aware of their civic and citizenship responsibilities, the importance of these responsibilities to harmonious living and maintaining social cohesion, and to community and national development and well-being.
(j) acquire knowledge, skills, values and attitudes required for learning and practice of creative arts, and the application of knowledge and skills to express themselves, promote PNG's cultures, and make a living.
(k) recongnise the importance of healthy mind, body, and spirit, the importance of physical exercise and sport, balanced diet, and regular exercise in living a healthy life style.
(l) recognise the importance of healthy mind, body, and spirit, the importance of physical exercise and sport, balanced diet, and regular exercise in living a healthy life style.
(m) attain essential agriculture knowledge, skills, values, and attitudes required for making a living in agriculture related contexts, starting and managing agriculture businesses for personal and family sustainability, and pursing agriculture-oriented livelihoods.

Aim 3: Students will attain both regional and internationally comparable standards in literacy and numeracy.

Goals

Students will be able to;

(a) develop fluency in reading and comprehension to enable them to decode, critique, critically analyse, and synthesize a variety of texts.
(b) acquire essential writing and publication proficiencies to enable them to write and publish a variety of texts.
(c) learn and demonstrate proficiency on the essential mathematics knowledge, skills, values, and attitudes and use these to solve problems in real life situations.
(d) attain the expected levels of literacy in Science, Social Science, Character and Social Development, Citizenship and Christian Values Education, Industrial Arts and Technology, Business and Commerce, Agriculture, Arts, Physical Education.

Aim 4: Students will develop their full potential and empowered to be dynamically involved in the process of freeing themselves from oppressive situations, contribute to promoting the common good and welfare of society, and develop a sense of responsibility for oneself and others.

Goals

Students will be able to;

(a) recognize and critically analyse the situations that oppress and marginalize them and others, and take appropriate individual and collective actions to transform these situations in order to improve their wellbeing.
(b) develop a positive attitude towards community service and responsibility for the well-being of the community while being responsible for their personal behaviour and conduct and hold others to account for their behaviour and attitudes in the interest of public good.
(c) develop effective communication and social skills, and think critically and rationally when solving problems and making decisions at different stages of their personal development.
(d) interpret language and cultural expressions attributed to oppressed and marginalized groups by dominant and powerful groups and challenge these in order to improve their situations.

Aim 5: Students will contribute towards the development of knowledge-based economy and society, and the transformation of Papua New Guinea from a developing to a middle income country by continuously learning and applying knowledge, skills, values, and attitudes to improve the prevailing social, economic, political, cultural, scientific, and technological conditions.

Goals

Students will be able to;

(a) value creativity and innovation; the spirit of autonomy and independence; and foster an attitude to knowledge creation and application to improve working and development conditions.
(b) obtain relevant knowledge, skills, values, and attitudes that will enable them to be multi-skilled, lifelong learners, and knowledge-based workers capable of functioning in a changing world and work environment.

Aim 6: Students will continue to learn throughout their lives and apply the outcomes of learning to improve their personal and collective learning, growth and development, and the quality of life for oneself and others.

Goals

Students will be able to;

(a) think sensibly for themselves and to develop as individual members of a community.
(b) develop and foster an attitude towards continuous learning as a basis for improving one's own knowledge, thinking, practice, value and belief system and hence improve life outcomes.
(c) cultivate a positive attitude towards research, reflection, and critical analysis as bases for lifelong learning.

Aim 7: Students will acquire essential knowledge, skills, values, and attitudes necessary for the building of peaceful and safe communities, living together, upholding the principles of a democratic state and society, building social cohesion, promoting equity and social justice, and ensuring economic prosperity for all.

Goals

Students will be able to;

(a) value justice, responsibility, equality between men and women, mutual respect and cooperation, and actively contribute to the building and fostering of peaceful, safe, and inclusive communities.
(b) use effective communication skills and think creatively in a rational manner and develop better problem solving and decision-making skills at appropriate levels and ages.
(c) examine in-depth problems at hand by collecting and using evidence to make informed decisions about the best strategies to address the problems and achieve results that are satisfactory to all stakeholders.
(d) become happy, healthy, and useful members of society.
(e) analyse the principles of democracy, how a democratic government works, citizen's democratic rights and responsibilities, and the weaknesses and strengths of the democratic ideology.

Aim 8: Students will foster an understanding and an appreciation of PNG's many cultures and languages, their influence on the construction and representation of Papua New Guinean's identities, and the value, knowledge, and belief systems that underlie these diverse cultures and languages; while embracing the cultural and linguistic differences, and take actions to sustain the good and eliminate the bad aspects of cultures.

Goals

Students will be able to;

(a) have pride and responsibility towards their cultures and languages, and preserve and promote one's identity through language and culture while at the same time learning, appreciating, and tolerating other cultures and languages, both local and international.
(b) communicate with other people through written and spoken language, through mathematics and through other ways such as art, music and movement.
(c) investigate the underlying knowledge, value, and belief systems of different cultures and languages, and take appropriate individual and collective actions to eliminate aspects of cultures that hinder the building and fostering of healthy relationships and peaceful and safe environments, that are oppressive and detrimental to human development, and detrimental to the promotion of inclusive development and a hindrance to promoting and safeguarding fundamental human rights.

Aim 9: Students will develop their knowledge and an appreciation and respect for the natural environment and physical and human resources, and the need to develop these in ways that are sustainable for the benefit of current and future generations.

Goals

Students will be able to;

(a) cultivate and maintain an attitude to respect life, care for nature, and contribute to the protection of the environment.
(b) help develop and sustain Papua New Guinea's environment and its physical and human resources, for the benefit of current and future generations.
(c) become wise guardians of Papua New Guinea's resources.
(d) act responsibly and within the spirit of environment sustainability in the use of natural resources with the knowledge that local actions on environment have both local and global consequences.

Aim 10: Students will develop healthy self-concepts; contribute to the establishment and sustainability of healthy communities; the eradication of common diseases; and improvement in the health status of all citizens.

Goals

Students will be able to;

(a) demonstrate an understanding of the different stages of child development from conception to childhood, adolescence to adulthood.
(b) show awareness and understanding of the importance of building and promoting healthy life styles and healthy communities as prerequisites for healthy living and life style.
(c) investigate common diseases in PNG and their causes and symptoms, appreciate the consequences and impact they have on the citizens, look at what is being done to eradicate these diseases, and know how they can contribute to eradicating these diseases.

Aim 11: Students will understand that parenthood is a lifelong responsibility however, in exercising this right they should be aware of the impact of uncontrolled population growth and its consequences on families, communities, the environment, available resources, and the nation.

Goals

Students will be able to;

(a) appreciate the importance of having a family unit and show awareness of parental responsibilities, recognize the consequences of the decisions they make regarding the size of their families, recognizing the fact that the quality of life for their students depend on the decisions they make.
(b) aware of the contributing factors to population growth and demonstrate an understanding of the consequences of uncontrolled population growth.

Aim 12: Students will acquire knowledge, skills, values, and attitudes required for social and economic development, for gainful employment and self-employment, and for transforming individual and collective livelihoods and alleviating poverty.

Goals

Students will be able to;

(a) acquire knowledge, skills, values, and attitudes required for active participation in the formal and informal economy as means for making a sustainable living.
(b) explain and apply the concepts and practices of self-reliance and personal viability to create own employment as an alternative to formal employment.
(c) foster an attitude towards work by acquiring relevant values, knowledge, and skills that will prepare them to pursue vocational skills occupations.

Aim 13: Students will develop required values and respect for oneself, others, and the community, and use these as a basis for developing effective national and global citizenships traits.

Goals

Students will be able to;

(a) learn about and show awareness about past and present outstanding and model citizens whose character, moral standing, ethical standards, and contributions have shaped PNG and the world.
(b) demonstrate awareness and understanding of their civic and citizenship roles and responsibilities, the importance of performing these responsibilities in a transparent and accountable way for the greater good of PNG and their communities, and the consequences of neglecting these roles and responsibilities.
(c) develop and foster values, behaviours, attitudes, and communication competencies required to live together and in harmony with peoples of other cultures and linguistic groupings.
(d) show awareness and concern for the welfare and the rights of others, contribute to the promotion of justice for all and the empowerment of the oppressed and marginalized people, promote gender and social inclusion as the basis for protecting and promoting the rights of all.

Overarching Curriculum Principles

Curriculum principles identify, describe, and focus attention on the important concerns that must be addressed when developing the curriculum at all levels of schooling. They are based on significant social, economic, political, cultural, religious, philosophical, environmental, and educational values and beliefs. Curriculum principles are evidence-based and influenced by best practice. The following principles underpin the design, development, and implementation of SBC in PNG.

Relevance

The national curriculum should target the national, community, and personal social, economic, political, cultural, environmental, and spiritual, development needs and aspirations. Curriculum should aim to prepare students for careers, higher education and citizenship. Students should be equipped with essential, in demand knowledge, skills, values, and attitudes to meet the demands and challenges of working, studying, and living in a complex, knowledge-based, and technology driven economy and society of the 21st Century. This can be achieved through the development of rigorous and comparable learning standards, design, development, implementation, and monitoring of a quality SBC, and embedding of values and critical, creative, decision-making, reasoning, problem-solving, high level, 21st Century, and STEAM skills in the curriculum.

The national curriculum will enable teachers to support students' learning by encouraging teaching and learning in real-life contexts, and providing opportunities for students to address the problems posed by the natural and physical environments by developing creative and innovative solutions. This means students will relate and use the knowledge, skills, values and attitudes learnt in different subjects to real life situations.

Multiculturalism

Papua New Guinea is blessed and fortunate to have so many languages and cultures. The diversity of our cultures is the source of our knowledge, skills, attitudes, and values. As a multicultural society, we must protect, promote, and respect our many cultures and languages. There are many people from our own ethnic groupings and from other countries with their own cultures living and working together in PNG. This is the most multicultural country in the world. We must ensure that we promote and share our cultures with the rest of the world. We must also critically examine and address the problematic aspects of our cultures.

Ethics, Morals, and Values

PNG is striving to create a society in line with democratic liberal traditions. The citizens of PNG should recognise appropriate social relationships based on sound human and religious ethics, morals and values. These are required for interaction with families and people from other provinces and nations. The process of socialisation requires a belief in the ethics, morals and values of the Melanesian extended family, dialogue with and respect for others and a willingness to conserve and promote those aspects of our traditions, which are consistent with studying, working, and living in the 21st Century global society. Socialisation also requires an awareness of the interdependence of individuals, societies, and nations in the postmodern world. It requires involvement with family, school, church, community, and the world beyond.

Integral Human Development

Integral human development focuses on the holistic development of every person. National curriculum should provide opportunities for all students to receive an education that will enable them to;

- be dynamically involved in the process of freeing themselves from every form of domination and oppression so that they will have the opportunity to develop as integrated persons in relationship with others. This means that the national curriculum must integrate and maximise socialisation, participation, liberation, and equality,
- be aware of human potential and the willingness to develop and maximize this potential so that each individual can solve his or her own problems, contribute to the common good of society, and maintain, promote, and improve the learning, working, and living conditions of all, and
- acquire and consistently use Biblical and spiritual values, personal, social and sustainability values, and work, relationship, health, and peace values in their lives.

Papua New Guinea is a rapidly changing society and faces many challenges. To face these effectively, an individual must strive to become an integrated person and to work with others to create a better community.

The process of integral human development calls for a national curriculum, which helps individuals to;

- identify their basic human needs,
- analyse situations in terms of these needs,
- see these needs in the contexts of spiritual and social values of the community, and
- take responsible action in co-operation with others.

The success of a national curriculum requires the integrated involvement of all the agents of education such as the home, church, school, and community.

The Right to Healthy Living

The health status of Papua New Guinea is very low. All citizens have a right to clean water, a nutritious diet, improved sanitation, and appropriate and better local health services. Students need to learn attitudes; skills, and knowledge that will help them become productive, healthy, and contented citizens of PNG. They need to be given a set of skills that will enable them to improve their own and their community's health in order to improve the health status of PNG. The national curriculum will ensure that students have the opportunity to learn about healthy living and lifestyles.

Nation Building and National Unity

Our nation is young and there is still a great deal of nation building to be done. Students need to be given the skills to undertake this task and participate in nationally organised events. The national curriculum should enable them to understand how Papua New Guinean societies work and how they can be a useful part of these societies. Students should learn that they have a place in PNG and that PNG has a place in the world as a whole.

They will be able to help PNG develop a national identity as one nation if they learn to;

- work together with tolerance,
- respect one another, their traditional ways and resolve problems peacefully,
- respect and act in the spirit of the national Constitution,
- recognise their capabilities and develop their own talents,
- participate in the development of the national community, and
- protect and safeguard the national wealth and resources.

Sustainability

The natural environment of PNG is as diverse as its cultures. It is often under threat from uncontrolled exploitation, over logging, abuses associated with mining, over fishing, dynamiting of reefs, and dumping of toxic wastes. Our diverse cultures are also under threat from over exploitation and commercialisation of sacred cultural practices. Our cultural traditions are not being handed down from generation to generation. The national curriculum will guide students to further appreciate, respect, and value their natural environment, cultures, customs, and traditions. It will give them the skills and knowledge to identify problems and issues and to take action to sustain these aspects of life in PNG.

Gender Equity and Social Inclusion

Gender is what it means to be a woman or a man. It refers to those behaviours and attitudes that are culturally accepted as ways of being a woman (femininity) and being a man (masculinity). Addressing gender issues goes well beyond ensuring that females have the same opportunities as males to receive an education. A person's experiences determine the way they understand and make sense of the world. Gender is also culturally determined. In PNG, there is a need for sensitivity to local cultural practices and values, with respect to traditional roles for males and females. The national curriculum will provide students with subjects, resources, activities, and experiences that value the needs of both girls and boys.

Females are generally a disadvantaged group in PNG. PNG does not have in place a good record about gender equity for females. Violence against females is widely acknowledged as a serious problem. A number of health and other indicators of human development show that females have a lower quality of life than males. Females have lower literacy rates and lower income levels than males. Males hold nearly all positions of leadership, authority, and decision making.

Men hold most senior positions in government departments and the community. It is a similar situation in the Department of Education, provincial education divisions, and schools. The national curriculum will provide students with opportunities to consider these problems and ways of addressing gender issues.

Inclusive Curriculum

The national curriculum is inclusive and designed to meet the needs of all students irrespective of their abilities, gender, geographic locations, and cultural language, or socio-economic backgrounds. The national curriculum must be implemented by teachers in ways that are inclusive of all students at all levels of schooling. Much more can be achieved if parents, community leaders, churches, and schools co-operate and communicate with each other.

Students learn in different ways. It is best to use a variety of methods to teach them. No one method is best. It is true that students are very different and even the same students learn best from different methods at different times. By using a range of teaching methods, it is more likely that the needs of all students will be met. In order to be inclusive of all students, teachers need to cater for a range of physical, social, cultural, emotional, spiritual, and intellectual needs of their students. This can be achieved through using appropriately and carefully planned learning activities, a range of teaching methods and strategies, and thoughtful use of the language of communication.

To be inclusive, teachers will need to ensure that all girls and boys have the opportunity to participate. Teaching practices, including classroom organisation and management, should ensure that girls and boys are able to participate fully in all learning activities. Participation requires that individuals are motivated to achieve the goal of socialisation fully where they are encouraged to develop

a sense of obligation for the opportunity to contribute. Through participation, individual creativity can be recognised and encouraged, without losing sight of the principle of communal sharing. Participation is the key to social interaction and can lead to social mobility. It can also help to conserve and generate knowledge and cultural values for future generations.

Student-Centred Learning

Student-centred learning recognises the fact that no two classes are alike and no two children are the same with respect to their needs. A teacher who uses a student-centred approach will endeavour to create a classroom environment that will motivate students to discover new skills and knowledge. In such an environment, the teacher might focus on teaching students how to learn and help them discover relevant information. It is essential to teach students how to learn while at the same time teaching them important content. A student-centred classroom will usually involve students working together in small groups using activity centres set up in the classroom while the teacher works more closely with one or two students. The national curriculum describes what all students are expected to learn in all subjects. A student-centred approach allows teachers to be more flexible in determining the most effective ways to help all students achieve these learning outcomes

Lifelong Learning

School is an important part of a student's education but learning continues throughout life. The initial experience that students have with the school curriculum is critical in encouraging them to continue learning throughout their lives. Going to school should be an enjoyable and satisfying experience for the students and should prepare them for life after school. Students know many things when they come to school. They will learn many things outside of school and continue to learn after they leave school. The national curriculum should build on what students already know. Teachers should make use of this knowledge and skills. When students are learning new, unfamiliar things, teachers should relate the new things to what students already understand. This important learning will continue throughout life as students increasingly take responsibility for their own learning. Increasingly, students who leave school will look for opportunities to continue their education and to return to school or some other educational or training institutions in order to improve their qualifications.

Language Development Across the Curriculum

The national curriculum will provide opportunities for language development across the curriculum. Language development across the curriculum should be encouraged because all subject areas provide meaningful contexts for purposeful learning. Specific subjects have different language requirements such as, the vocabulary and language features of science and the written and oral genres to narrate, explain, persuade, report, and discuss the particular content of various subjects. The conventions and differences must be explicitly taught in relevant contexts across the curriculum.

21st Century Knowledge, Skills, Values, and Attitudes for Careers, Higher Education, and Citizenship.

PNG shapes and is being shaped by the 21st Century social, economic, political, cultural, religious, and environmental discourses and practices. It is important to provide opportunities for students to learn in-depth and master the 21st Century knowledge, skills, values, and attitudes to prepare them for careers, higher education, and citizenship. There is an increasing demand for knowledge-based workers and workers with qualifications in STEAM globally. This cadre of workers is not available in PNG because education is not geared towards preparing this category of workers. PNG children should be equipped with the necessary 21st Century and STEAM proficiencies to ensure that they are marketable globally and can contribute meaningfully to the development of PNG.

Science, Technology, Engineering, Arts, and Mathematics

The majority of careers in the 21st Century is STEAM related. However, demand for STEAM graduates and experienced workers far exceed the supply of this cadre of workers. What is more, although a slow paradigm shift is taking place, careers in STEAM fields are dominated by males. Females are beginning to venture into these careers but at a very slow pace. There is an enormous gender parity gap in this area. Thus, it is critical for STEAM knowledge, skills, values, and attitudes to be taught from prep to post-secondary school level to provide opportunities for all students to attain STEAM related proficiencies before leaving school. The main aim of this education is to shape students' thinking, motivate, and influence them to develop an interest in careers in the STEAM field, and pursue STEAM related academic programs in institutions of higher education.

Standards-Based Curriculum Principles

The principles of the Standards Based Curriculum (SBC) include the following:

- Setting of high academic standards and a careful and continuous assessment and reporting of students' performance against these standards will motivate students to perform at a much higher level.
- Standards allow every student, every parent, and every teacher to share in common expectations of what students should know, understand, and be able to do.
- Students will learn more when more is expected of them in school and at home.
- The setting of clear, measurable, and attainable standards is the key to attaining high academic standards and hence the attainment of the desired quality of education.
- All students are capable of learning and achieving high academic standards, regardless of their backgrounds.
- Students can learn in their own ways and at their own pace.

Protection of Children's Rights

It is paramount that children's rights stipulated in national legal and policy frameworks, and international conventions such as the United Nations Convention on the Rights of the Child (UNCRC) are recognised, promoted, protected, and safeguarded by everyone and every organisation working and dealing with children's welfare and well-being. A child is defined by UNCRC as a human being below the age of 18 years. However, definitions of a child may differ based on the socio-cultural contexts of different countries. Notwithstanding the differences in definitions, biologically, a child is generally anyone between birth and puberty.

The four core principles of UNCRC underpinning children's rights are;

- non-discrimination,
- devotion to the best interests of the child,
- the right to life, survival and development,
- respect for the views of the child,

Children's rights are human rights and therefore they should be promoted and safeguarded by the whole of the education system. They should permeate all education plans, policies, programs, and activities, and firmly embedded in the school curriculum, teaching and learning practices, and the overall management of the education system

Biology Rationale, Aim and Goal, and Guiding Principles

Papua New Guinea (PNG) like any other countries in the world is also making concerted efforts to boost student achievement in literacy, numeracy and Life skills. Science course is no exception since Science is regarded as a key life skill and efforts are aimed at improving science education to develop deep, lasting changes in how students learn this critical yet vital subject.

Across the world, there is an increased demand to pursue careers in science, technology, and engineering that drive the innovation and invention necessary for economic growth and improving the quality of life. To meet this demand, it is increasingly important to prepare significant proportions of students to enter advanced study in these areas.

Their understanding of science should build throughout their schooling so that when, as adults, they are faced with decisions relating to such diverse issues as the treatment of diseases, climate change, and the applications of technology, they are able to act from a sound scientific basis.

Science is organised around four main strands – Science as Inquiry, Physical Science, Life Science, and Earth and Space Science. These strands are comparable with the strands used internationally. Therefore, the learning of key science concepts, ideas, processes and inquiry methods should start at the early stage of a child's education. The scientific method should be re-emphasised at various stages of a child's education until the child masters the methods. This will prepare a student well to take on higher studies in science.

Science has been always the main driver for all creativity, innovation, discoveries, inventions or constructions. Science is also fundamental in life because it has direct application to nearly all aspects of life and society, from sustaining humankind survival through the maintenance and improvement of lifestyles and health to understanding and solving local, regional, and global issues.

Aim of Biology

Biology provides learning experiences which will further develop in students;

- a knowledge and understanding of the living world,
- the capacity to identify, gather, manipulate and process information in the context of scientific endeavours including field investigations,
- the capacity to communicate effectively in various formats on biological issues,
- an appreciation of the complexity and beauty of biological phenomena,
- a recognition that PNG ecosystems have unique characteristics ,
- an appreciation that each type of organism, including Homo sapiens, occupies a unique position in the biosphere,

- a sense of responsibility for the stewardship of the local and global environment,
- an ability to apply biological understanding, skills and reasoning to present-day and emerging issues.

Subject Guiding Principles

The Science curriculum principles identify, describe and focus attention on the important concerns that must be addressed when developing and implementing Science curriculum. There are the underlying guidelines in which both the teacher and the learner should be aware of and be focused on when teaching or learning Science.

Science is for everyone.

This principle recognizes the proactive relationship between science and society. This means putting science into the service of individuals and society. Science education should aim for scientific literacy that is operational in understanding oneself, common human welfare, social, and civic affairs. Science should permeate all levels of society. Whether or not students pursue a university education, they should leave school with a level of understanding and scientific literacy that will prepare them to be informed and participative citizens who are able to make judgments and decisions regarding science applications that may have social, health, or environmental impacts.

Science is both content and process.

Science content and science process are intertwined. The value of science processes is to advance content or the body of knowledge. Without content, students will have difficulty utilising the science process skills. Science processes cannot exist in a vacuum. They are learned in context.

Science should be relevant and useful.

To be relevant and useful, the teaching of science should be organized around situations, problems or projects that engage the students both as an individual and a member of a team.

Science should nurture interest in learning.

Students are generally interested in problems that puzzle them. They have a natural urge to find solutions. Organising the curriculum around problems or phenomena that puzzle students helps motivate them to learn.

Rather than relying solely on textbooks, teachers are encouraged to use hands-on learning activities to develop students' interest and let them become active learners.

School science should recognize that science and technology reflect, influence, and shape our culture. The science curriculum should recognize the place of science and technology in everyday human affairs. It should integrate science and technology in the civic, personal, social, economic, and the values and ethical aspects of life.

Science as Inquiry

Science is a way of thinking about and investigating the world in which we live. This component addresses those skills scientists use to discover and explain physical phenomena. These skills include asking questions about the world, designing and conducting investigations, employing different strategies to obtain information, and communicating results. Activities such as scientific investigations, experiments, project work, field work, group discussion, and debates allow students to be actively engaged in the following processes.

Students of science must become proficient at these practices to develop an understanding of how the scientific enterprise is conducted. These practices include skills from daily life and school studies that students use in a systematic way to conduct scientific inquiry. These include students asking questions, make observations, make predictions and carry out experiments to test their predictions.

The science practices are fundamental to all science disciplines. When students are engaged, they are:

- Asking questions based on observations.
- Generating evidence.
- Working with data.
- Answering the research question.
- Making an argument from evidence.

Five practices that are fundamental to scientific inquiry are represented in detail in the Grades 11 and 12 Teachers Guides. In this syllabus the Science as Inquiry recommended for Grades 11 and 12 are provided in the table below and are also expanded in the teachers' guides.

Grade 11 recommended working scientifically skills	Grade 12 recommended working scientifically skills
• Perform tests, collect data, analyse relationships, and display data. • Identify and communicate • Identify and examine possible and reasons • Formulate explanations by using logical thinking and evidence. • Solve scientific problems • Examine the usefulness of data presented	• The locations, sequences, or time intervals • Recognise and assess the issues of statistical variability and the need for controlled tests. • Analyse situations and solve problems • Combining and applying concepts from more than one area of science. • Researching the literature, analyse data, and communicating the findings • Determine when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent.

Monitoring and Mastering Science Inquiry skills

The table below shows the expectation for students studying Science to master the Science Inquiry Skills from Preparatory to Grade 12. It shows:

- **Emerging** – when the student starts
- **Progressing** – when the student shows evidence of progressing and working towards mastering the skill
- **Mastering** – When the student has mastered the skill and is able to apply in all life situations.

This practice must be on-going and progressively carried out throughout the child's learning in that particular grade.

Schools are encouraged to use this for each student and should be passed on to the next grade so the students mastery level of each skill is monitored rightthroughout their learning from Preparatory to grade 12.

Level of skills	Low				Medium					High			
Inquiry Skills by grades	P	G 1	G 2	G 3	G 4	G 5	G 6	G 7	G 8	G 9	G 10	G 11	G 12
Observing	*	*	**	***	***	***	***	***	***	***	***	***	***
Classifying		*	*	**	***	***	***	***	***	***	***	***	***
Measuring		*	*	**	**	**	***	***	***	***	***	***	***
Inferring				*	**	**	***	***	***	***	***	***	***
Predicting			*	**	***	***	***	***	***	***	***	***	***
Hypothesizing				*	*	**	***	***	***	***	***	***	***
Experimenting				*	**	**	***	***	***	***	***	***	***
Communicating			*	**	**	**	***	***	***	***	***	***	***
Researching				*	*	*	**	***	***	***	***	***	***
Problem-solving				*	*	**	**	***	***	***	***	***	***
Identifying and controlling variables				*	*	*	**	**	**	***	***	***	***
Use/make models			*	*	**	**	***	***	***	***	***	***	***
Use numbers				*	*	**	**	***	***	***	***	***	***
Collect data				*	*	*	**	**	**	***	***	***	***
Analyse relationships						*	*	**	**	***	***	***	***
Use appropriate tools and techniques to make observations and gather data				*	**	***	***	***	***	***	***	***	***
Assess the reliability of data that was generated in the investigation					*	**	***	***	***	***	***	***	***
Formulating questions that can be answered through scientific investigations				*	*	*	**	**	***	***	***	***	***
Formulate explanations by using logical thinking and evidence							*	*	*	**	**	***	***
Proving scientific theories as facts or fraudulent										*	**	***	***
Identifying and explaining mis-conceptions							*	*	*	**	***	***	***
Looking for patterns and meanings								**	**	***	***	***	***
Read, interpret and examine the credibility and validity of scientific claims in different sources of information							*	*	*	**	**	***	***
Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.							*	**	**	***	***	***	***
Explain and distinguish independent and dependent variables including those that are kept constant and those used as controls.							*	**	**	***	***	***	***
Use mathematical operations to analyse and interpret data and present relationships between variables in appropriate forms.							*	**	**	***	***	***	***

Draw conclusions and present plausible explanations based on research data and assess results based on the design of the investigation								*	*	**	**	***	***
Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.					*	*	*	**	**	***	***	***	***
Science as Inquiry/grades	P	G1 G	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12
Level of skills	**Low**				**Medium**					**High**			

The number of asterisks denotes the amount of emphasis given to each process skill in each year level.

* Emergent ** Progressive *** Mastery

Enhancing Science Teaching and Learning Using Instructional Technology

The use of current and emerging technologies is essential to the P–12 Sciences instructional program. Specifically, technology must accomplish the following:

- Assist in improving every student's functional literacy. This includes improved communication through reading/information retrieval (the use of telecommunications), writing (word processing), organization and analysis of data (databases, spreadsheets, and graphics programs), presentation of one's ideas (presentation software), and resource management (project management software).
- Be readily available and regularly used as an integral and ongoing part of the delivery and assessment of instruction.
- Include instrumentation oriented toward the instruction and learning of science concepts, skills, and processes. Technology, however, should not be limited to traditional instruments of science, such as microscopes, lab ware, and data-collecting apparatus, but should also include computers, robotics, interactive-optical laser discs, video-microscopes, graphing calculators, CD-ROMs, probe ware, global positioning systems (GPS), online telecommunication, software and appropriate hardware, as well as other emerging technologies.
- Be reflected in the "instructional strategies" generally developed at the local school division level.

In most cases, the application of technology in science should remain "transparent" unless it is the actual focus of the instruction. One must expect students to "do as a scientist does" and not simply hear about science if they are truly expected to explore, explain, and apply scientific concepts, skills, and processes.

As computer/technology skills are essential components of every student's education, it is important that teaching these skills is a shared responsibility of teachers of all disciplines and grade levels.

Creating and Promoting a Safe Working Environment

During Science lessons, teachers must be certain that students know how to follow safety guidelines, demonstrate appropriate laboratory safety techniques, and use equipment safely while working individually and in groups. Safety must be given the highest priority in implementing the instructional program for science. Correct and safe techniques, as well as wise selection of experiments, resources, materials, and field experiences appropriate to age levels, must be carefully considered with regard to the safety precautions for every instructional activity. Safe science classrooms require thorough planning, careful management, and constant monitoring of student activities. Class enrolment should not exceed the designed capacity of the room.

Teachers must be knowledgeable of the properties, use, and proper disposal of all chemicals that may be judged as hazardous prior to their use in an instructional activity. The identified precautions involving the use of goggles, gloves, aprons, and fume hoods must be followed as prescribed.

While no comprehensive list exists to cover all situations, the following should be reviewed to avoid potential safety problems. Appropriate safety procedures should be used in the following situations:

- observing wildlife; handling living and preserved organisms; and coming in contact with natural hazards, such as poison ivy, ticks, mushrooms, insects, spiders, and snakes;
- engaging in field activities in, near, or over bodies of water;
- handling glass tubing and other glassware, sharp objects, and lab ware;
- handling natural gas burners, Bunsen burners, and other sources of flame/ heat;
- working in or with direct sunlight (sunburn and eye damage);
- using extreme temperatures and cryogenic materials;
- handling hazardous chemicals including toxins, carcinogens, and flammable and explosive materials;
- producing acid/base neutralization reactions/dilutions;
- handling power equipment/motors, and;
- working with high voltage/exposed wiring

STEAM Rationale, Aim and Goals, and Guiding Principles

Rationale

The majority of careers in the 21st Century is STEAM related. However, demand for STEAM graduates and experienced workers far exceed the supply of this cadre of workers. What is more, although a slow paradigm shift is taking place, careers in STEAM fields are dominated by males. Females are beginning to venture into these careers but at a very slow pace.

There is an enormous gender parity gap in this area. Thus, it is critical for STEAM education to be introduced and taught from elementary prep to the higher education level to provide opportunities for students to study in-depth and master the STEAM related knowledge, skills, values, and attitudes, and provide equal opportunity to be engaged in real life experiences to learn and have hands-on experience of applying STEAM concepts, processes, ideas, skill, values, and attitudes to solve real problems and come up with solutions. The main aim of this education is to shape students' thinking, motivate, and influence them to develop an interest in careers in the STEAM field, and to pursue undergraduate and postgraduate programs in institutions of higher education.

Ultimate Aim

The ultimate aim of STEAM education is to develop a STEAM literate society in which all citizens have the expected level of STEAM literacy. STEAM literacy refers to an individual's;

- knowledge, skills, values, and attitudes to identify problems and questions in life situations, explain the natural and design world, and draw evidence-based conclusions about STEAM issues,
- understanding of characteristic features of STEAM disciplines as forms of human knowledge, inquiry, and design,
- awareness of how STEAM disciplines shape our material, intellectual, and cultural environments, and
- willingness to engage in STEAM related issues and with the ideas of STEAM as a constructive, concerned, and reflective citizen.

Goals

The following are the goals of STEAM:

(i) Provide students with STEAM related experiences and opportunities to use STEAM concepts, ideas, and skills to solve problems relating to the natural and physical worlds, and use the evidence to make informed decisions about the interventions.

(ii) Build positive attitudes and embed essential STEAM values in students thereby motivating them to choose STEAM related careers or undertake STEAM related academic programs or courses of study.

(iii) Provide students opportunities to work in collaboration and partnership with people engaged in STEAM related careers or disciplines to learn about how STEAM skills, concepts, processes, and ideas are applied in real life.

(iv) Build a pool of STEAM workers who can contribute to national and global development and progress.

(v) Enable students to achieve high academic standards

Guiding Principles

Integration and application of knowledge and skills in real life situations

Integration of STEAM knowledge and skills and their application to real-life situations inside and outside of the classroom setting will enable students to explain how STEAM disciplines shape our material, intellectual, cultural, economic, social, and environmental contexts.

Emphasis is on the learning and the application of STEAM knowledge and skills to investigate, explain, and solve problems rather than on content

STEAM education emphasizes the learning and the application of knowledge, and skills to investigate, explain, and solving physical and natural problems rather than on in-depth teaching and learning of STEAM content.

STEAM related knowledge and skills are used to investigate, explain, and solve problems relating to the natural and physical environments

STEAM education focuses on providing the learners real life experiences of how STEAM related skills, concepts, processes, ideas, principles, values, and attitudes are applied and used to identify problems and questions in real life situations, explain the natural and physical world, and draw evidence-based conclusions.

Core curriculum

A core set of common learning's (knowledge, skills, values, and attitudes) have been integrated into the curriculum to provide all students an opportunity to acquire and master these before they are career, higher education, and citizenship ready. The core curriculum includes:

- Cognitive skills (critical and creative thinking),
- Reasoning, problem-solving and decision-making skills,
- High level thinking skills (analysis, evaluation and synthesis),
- 21st Century skills,
- STEAM principles and skills;
- Spiritual values and virtues;
- Reading, writing and communication skills, and
- Essential values and attitudes.

The above knowledge, skills, values and attitudes should be taught and assessed by all teachers from prep to grade 12. These are reinforced at each school grade and school level to enable students to become proficient in their application in different careers, higher education and citizenship contexts.

Essential Knowledge, Skills, Values, and Attitudes

Students' level of proficiency and progression towards the attainment of content standards will depend on their mastery and application of essential knowledge, skills, values and attitudes in real life or related situations.

These knowledge, skills, values and attitudes have been integrated into the content standards and benchmarks. They will also be integrated into the performance standards. Teachers are expected to plan and teach these essential knowledge, skills, values and attitudes in their lessons, and assess students' performance, proficiency and progression towards the attainment of content standards.

Provided here are examples of different types of knowledge, processes, skills, values and attitudes that all students are expected to learn and master as they progress through the grades. These are expanded and deepened in scope and the level of difficulty and complexity are increased to enable students to study in - depth the subject content as they progress from one grade to the next.

Types of Knowledge

There are different types of knowledge. These include:	
• Public and private (privileged) knowledge • Specialised knowledge • Good and bad knowledge • Concepts, processes, ideas, skills, values, attitudes • Theory and practice • Fiction and non-fiction • Traditional, modern, and postmodern knowledge	• Subject and discipline-based knowledge • Lived experiences • Evidence and assumptions • Ethics and Morales • Belief systems • Facts and opinions • Wisdom • Research evidence and findings • Solutions to problems

Types of Processes

There are different types of processes. These include:	
• Problem-solving • Logical reasoning • Decision-making • Reflection	• Cyclic processes • Mapping (*e.g*. concept mapping) • Modelling • Simulating

Types of Skills

There are different types of skills. These include:

1. Cognitive (Thinking) Skills

Thinking skills can be categorized into critical thinking and creative thinking skills.

i. Critical Thinking Skills

A person who thinks critically always evaluates an idea in a systematic manner before accepting or rejecting it. Critical thinking skills include:	
Analysis Skills – Analysis skills involve examining in detail and breaking information into parts by identifying motives or causes, underlying assumptions, hidden messages; making inferences and finding evidence to support generalisations, claims, and conclusions.	Evaluation Skills – Evaluation skills involve justifying and presenting and defending opinions by making judgments about information, validity of ideas or quality of work based on set criteria.
Key words	**Key words**
Analyse, compare, contrast, classify, distinguish, infer, explain, separate, select, categorise, connect, differentiate, discriminate, divide, order, point out, prioritise, sub-divide, survey, advertise, appraise, breakdown, calculate, conclude, correlate, criticize, devise, deduce, arrange, discover, establish, examine, organize, outline, investigate, examine, simplify, see, research, recognize, highlight, in-depth, discuss, list, find, group, divide, focus, question, experiment, test, illustrate, identify, deconstruct, simplify,	Evaluate, criticize, order, appraise, judge, support, compare, decide, discriminate, recommend , summarise, assess, choose, convince, defend, estimate, find errors, grade, measure, predict, rank, score, select, test, argue, conclude, consider, monitor, check, debate, determine, justify, explain, give reasons, interpret, opinion, validate, value,

ii. Creative Thinking Skills

A person who thinks creatively has a high level of imagination, able to generate original and innovative ideas, and able to modify ideas and products. Creative thinking skills include;
Synthesis/Creative Skills – Synthesis skills involve changing or creating something new, compiling information together in a different way by combining elements in a new pattern proposing alternative solutions.
Key words
Categorise, combine, compose, create, devise, design, explain, generate, modify, organize, plan, rearranges, construct, deconstruct, reconstruct, relate, reorganize, revise, rewrite, summarise, tell, write, formulate, invent, hypothesise, develop, compile, prepare, produce, arrange, rearrange, assemble, role-play, anticipate, make, predict, act-out, model, build, convert, discuss, elaborate, solve, propose, visualize, imagine, extend, tabulate, transform, integrate, innovate, maximize, minimize,

2. **Reasoning Skills** - Reason is a skill used in making a logical, just, and rational judgment.
3. **Decision-Making Skills** - Decision-making involves selection of the best solution from various alternatives based on specific criteria and evidence to achieve a specific aim.
4. **Problem Solving Skills** – These skills involve finding solutions to challenges or unfamiliar situations or unanticipated difficulties in a systematic manner.

Types of Values

1. Personal Values (importance, worth, usefulness, etc)

Core values	Sustaining values
• Sanctity of life • Truth • Aesthetics • Honesty • Human • Dignity • Rationality • Creativity • Courage • Liberty • Affectivity • Individuality	• Self-esteem • Self-reflection • Self-discipline • Self-cultivation • Principal morality • Self-determination • Openness • Independence • Simplicity • Integrity • Enterprise • Sensitivity • Modesty • Perseverance

2. Social Values

Core values	Sustaining values
• Equality • Kindness • Benevolence • Love • Freedom • Common good • Mutuality • Justice • Trust • Interdependence • Sustainability • Betterment of human kind • Empowerment	• Plurality • Due process of law • Democracy • Freedom and liberty • Common will • Patriotism • Tolerance • Gender equity and social inclusion • Equal opportunities • Culture and civilisation • Heritage • Human rights and responsibilities • Rationality • Sense of belonging • Solidarity • Peace and harmony • Safe and peaceful communities

3. Types of Attitudes

Attitudes - Ways of thinking and behaving, points of view	
• Optimistic • Participatory • Critical • Creative • Appreciative • Empathetic • Caring and concern • Positive • Confident • Cooperative	• Responsible • Adaptable to change • Open-minded • Diligent • With a desire to learn • With respect for self, life, equality and excellence, evidence, fair play, rule of law, different ways of life, beliefs and opinions, and the environment.

Content Standards, Benchmarks, and Evidence Outcomes

Content standards, benchmarks, and evidence outcomes are all curriculum standards. However, they have specific curriculum purposes. Despite this, these curriculum standards are interconnected and enable the intended learning outcomes to be attained.

Content Standards

Content Standards are broadly stated expectations of what students should know, understand, and be able to do in a particular subject, grade, or school level. They embed essential knowledge, skills, values, and attitudes that all students are expected to learn and master in each strand or unit to prepare them for the next grade or level of schooling.

Benchmarks

Benchmarks are specifications of content standards or more detailed descriptions of a specific level of performance expected of students at particular ages, grades, or levels of development. Benchmarks focus on the essential knowledge, skills, values and attitudes that all students are expected to learn, master and demonstrate proficiency.

Evidence Outcomes

Evidence outcomes are indicators that indicate students' progress towards meeting an expectation at the mastery level. They measure students' mastery and application of knowledge, skills, values, and attitudes at each grade, cluster or school level. They indicate that a student is meeting an expectation or achieving a benchmark at the mastery level. They enable teachers to know if a student can do what he/she was expected to know, understand, and do in real life or relevant situations. Evidence outcomes are given for each strand in each grade to describe what all students should do at the end of the different strands of mathematics.

Content Standards and Benchmarks Coding

The following is the coding system used to code the content standards and benchmarks to not only make it easier to interpret and understand the relationship between these two learning standards but also to guide lesson planning, instruction, assessment and reporting of students' performance in relation to a benchmark and content standard.

Grade	: Grade is indicated by the first number (*for example,* **11**.1.1.1)
Strand	: Strand is indicated by the second number (*for example,* 11.**1**.1.1)
Content Standard	: Content Standard is indicated by the third number (*for example*, 11.1.**1**.1)
Benchmark	: Benchmark is indicated by the fourth number (*for example,* (11.1.1.**1**).

Thus, the code will read as **Content Standard 11.1.1**. and **Benchmark** as **11.1.1.1**

Content Overview

The grades 11 and 12 Biology syllabus is organised by strands. Strands are broad content areas that define and describe the subject matter to be taught and learned. They incorporate cross-curriculum learning as well. Each strand has a rationale that justifies its inclusion in the Science curriculum.

Each strand embeds a particular aspect of Science and articulates the subject matter to be learnt. What students are expected to learn and demonstrate proficiency on is described in the strand content standard. Each strand has content standard which is set at the national level. Significant aspects of the content standards (knowledge, skills, values and attitudes) are benchmarked at the grade-level.

Table of Strands and Units

The table below outlines the strands and the units for Senior High School Biology. It shows the progressive development of concepts from grade 11 to grade 12.

	Strand	Grade 11 Units	Grade 12 Units
BIOLOGY	**Science as Inquiry**	1. Scientific skills and Process	1. Scientific skills and Process
	Life	1. Diversity of Living Things 2. Microorganisms 3. Nutrition 4. Respiration and Circulation 5. Support Systems	1. Population Ecology 2. Genetics 3. Evolution

Grades 11 and 12 Strands

Strand 1: Science as Inquiry

Rationale

In Senior High school, students must actively participate in scientific investigations and use their cognitive and manipulative skills to do scientific explanations. They have to formulate testable hypothesis and demonstrate the logical connections between the scientific concepts guiding a hypothesis and the design of the experiment. From Junior High School, they learned that experiments are guided with concepts and are performed to test ideas. The establishment of adequate prior knowledge from these grades is important to help them develop scientific explanations in the senior grades.

Students will also be guided to learn how to gather and analyse evidence or data from their investigation, other students' investigation or databases. The use of new techniques and new tools will provide evidence to guide inquiry and new methods to gather data, thereby contributing to the advance of Science.

Evidence Outcomes

Grade 11	Grade 12
At the end of the grade, all students can; • Identify and formulate questions that can be answered through scientific investigation. • Read, interpret, and examine the credibility and validity of scientific claims in different sources of information. • Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment. • Design and conduct appropriate types of scientific investigations to answer different questions. • Explain and distinguish independent and dependent variables, including those that are kept constant and those used as controls. • Use appropriate tools and techniques to make observations and gather data. • Assess the reliability of the data that was generated in the investigation. • Use mathematical operations to analyse and interpret data, and present relationships between variables in appropriate forms. • Draw conclusions and present plausible explanations based on research data, and assess results based on the design of the investigation. • Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.	At the end of the grade, all students can; • Identify and formulate questions that can be answered through scientific investigation. • Read, interpret, and examine the credibility and validity of scientific claims in different sources of information. • Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment. • Design and conduct appropriate types of scientific investigations to answer different questions. • Explain and distinguish independent and dependent variables, including those that are kept constant and those used as controls. • Use appropriate tools and techniques to make observations and gather data. • Assess the reliability of the data that was generated in the investigation. • Use mathematical operations to analyse and interpret data, and present relationships between variables in appropriate forms. • Draw conclusions and present plausible explanations based on research data, and assess results based on the design of the investigation. • Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

Rationale:

Scientific inquiry may be defined as the activities and processes which scientists and students engage in to study the natural and physical world around us. In its simplest form, scientific inquiry may be seen as consisting of two critical aspects: the what (content) and the how (process) of understanding the world we live in2.

Teaching science as inquiry must therefore go beyond merely presenting the facts and the outcomes of scientific investigations. Students need to be shown how the products of scientific investigations were derived by scientists and be provided with opportunities to: ask questions about knowledge and issues that relate to their daily lives, society and the environment; be actively engaged in the collection and use of evidence; formulate and communicate explanations based on scientific knowledge.

Through inquiry learning, students will be able to acquire knowledge and understanding of their natural and physical world based on their own investigations, apply the skills and processes of inquiry and develop attitudes and values that are essential to the practice of science.

Content Standard : 11.1.1
Explain the nature and the processes of scientific inquiry and use the modes of scientific inquiry and habits of mind to investigate and interpret the world around them

Benchmarks	
11.1.1.1 Identify and formulate questions that can be answered through scientific investigation.	**12.1.1.1** Use appropriate tools and techniques to make observations and gather data.
11.1.1.2 Read, interpret, and examine the credibility and validity of scientific claims in different sources of information.	**12.1.1.2** Assess the reliability of the data that was generated in the investigation.
11.1.1.3 Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.	**12.1.1.3** Use mathematical operations to analyse and interpret data, and present relationships between variables in appropriate forms.
11.1.1.4 Design and conduct appropriate types of scientific investigations to answer different questions.	**12.1.1.4** Draw conclusions and present plausible explanations based on research data, and assess results based on the design of the investigation.
11.1.1.5 Explain and distinguish independent and dependent variables, including those that are kept constant and those used as controls.	**12.1.1.5** Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

[2] Reference: Chiappetta, E. L., Koballa, T., Collette, A. T. (2002). Science instruction in the middle and secondary schools. Upper Saddle River, NJ: Merrill/Prentice Hall

Strand 2: Life

Evidence Outcomes

Grade 11	Grade 12
At the end of the grade, all students can; • Describe the basic characteristics of the types of microbes • Investigate the roles of microbes in world of living things • Explain how pathogens enter the body • Investigate the unity, diversity and interrelationships between organisms, including their relationships to cycles of matter and energy in the environment. • Describe and interpret biogeochemical cycles within ecosystems. • Examine the chemical reactions that occur in photosynthesis and cellular respiration and that result in cycling of energy. • Explain how matter and energy flow through living systems and the physical environment. • Research different cell parts, their functions and how they are specialized into different tissue and organs. • Assess how cells are specialized in different tissues and organs. • Differentiate between the processes of mitosis and meiosis. • Research the components of the human body from cell to system and how they work together. • Investigate how homeostatic balance occurs in cells and organisms. • Examine the components and functions of a variety of macromolecules active in biological systems. • Name and examine the components of the human body from cell to system and how they work together.	At the end of the grade, all students can; • Investigate the unity, diversity and interrelationships between organisms, including their relationships to cycles of matter and energy in the environment. • Describe and interpret biogeochemical cycles within ecosystems. • Examine the chemical reactions that occur in photosynthesis and cellular respiration and that result in cycling of energy. • Explain how matter and energy flow through living systems and the physical environment. • Examine the dynamic equilibrium in organisms, populations, and ecosystems and explain the effect of equilibrium shifts. • Research different cell parts, their functions and how they are specialized into different tissue and organs. • Assess how cells are specialized in different tissues and organs. • Differentiate between the processes of mitosis and meiosis. • Debate the theories of evolution and natural selection and cite evidence that supports these theories. • Investigate the structural properties of DNA and the role of DNA in heredity and protein synthesis. • Discuss how Mendel's laws of heredity can be used to determine the traits of possible offspring. • Research the components of the human body from cell to system and how they work together. • Investigate how homeostatic balance occurs in cells and organisms. • Examine the components and functions of a variety of macromolecules active in biological systems. • Appraise chromosomal mutations, their possible causes and their effects on genetic variation. • Name and examine the components of the human body from cell to system and how they work together.

Grade 11

Unit 1: Diversity of Living Things

In this unit students are introduced to learn about origin and diversity of living things. They will learn the traditional way of classification and the developments of the modern ways of classifying living things. The Linnaean classification system is a popular way to classify living things in which living things are classified into two main groups- kingdoms and domains. This system was later improved and a system of naming organism was also introduced.

Cells are the building blocks of life. The topic on cells is a continuation of what has already been learnt in junior high. Cells have different structures and perform various functions to form tissues, organs and systems.

Content Standard: 11.2.1

Investigate and analyse the principles of scientific classification, diversity of living organisms and the cell

Benchmarks

11.2.1.1 Explain the fundamental principles of taxonomy and phylogeny by defining concepts of taxonomic rank and the relationship such as genus , species and taxon

11.2.1.2 Compare and contrast the structure and function of different types of prokaryotes, eukaryotes and viruses

11.2.1.3 Describe unifying and distinguishing anatomical and physiological characteristics of representative organisms from each of the kingdoms

11.2.1.4 Explain the key structural and functional changes in organisms as they have evolved over time.

11.2.1.5 Explain why diversity is important to maintaining viable ecosystem

11.2.1.6 Describe the cell cycle in animals and explain its importance for the growth and repair of tissues

11.2.1.7 Describe the structure, function and importance of specialised cells and tissues in multi-cellular organisms.

11.2.1.8 Explain cell organization by describing the link between cells, tissues, organs and systems in the body.

Unit 2: Microbiology

Microbiology is the study of all living organisms that are too small to be visible with the naked eye. This includes bacteria, viruses, fungi, protozoa, archea and algae, also known as microbes.
Each type has its own characteristic cellular composition, morphology, mean of locomotion and reproduction. Microorganisms are very important in our lives. Some are responsible for the diseases affecting not only humans, but also plants and animals while others contribute to the maintenance and modification of the environment. Some microsbes also play leading roles in food, beverages and antibiotics industry.

The unit also allows students to study aspects of personal health and community health.

Content Standard 11.2.2

Investigate the diversity of microorganisms, the relationships that exist between them and their effect on personal and community health.

Benchmarks

11.2.2.1 Explain microorganisms and the essential place they occupy in the world of living things

11.2.2.2 Examine the basic characteristics of microbes and explain the roles of microorganisms in ecosystems and biotechnology

11.2.2.3 Investigate the characteristics of pre-life earth and the adaptations that allowed microbial to flourish

11.2.2.4 Investigate the nutritional and physiological characteristics of microorganisms

11.2.2.5 Describe the reproduction and growth of microorganisms

11.2.2.6 Investigate the transmission, symptoms , consequences and treatment of common sexually transmitted diseases in humans

11.2.1.7 Investigate the characteristics and behaviours of prions and viroid

Unit 3: Nutrition

Animals depend on plants for food. This is true for the simple reason that the food materials which animals eat are manufactured by plants. Animals, including human beings feed and can only feed on complex organic matter, however, plants can feed on simple inorganic materials, building these up into complex organic molecules.

Content Standard 11.2.3

Investigate the process plants use to convert simple inorganic materials to build complex molecules that animals use get energy.

Benchmarks

11.2.3.1 Explain the different types of autotrophic nutrition

11.2.3.2 Investigate and analyse the importance, raw materials and the products of photosynthesis

11.2.3.3 Identify and explain the site, chemistry and the conditions required for photosynthesis

11.2.3.4 Explain the different types of heterotrophic nutrition

11.2.3.5 Explore various structures that are involved in the digestion of solid organic material in heterotrophic organisms and how digestive enzymes work

11.2.3.6 Investigate the general principles of feeding and digestion in Humans

Unit 4: Respiration and Circulation

Oxygen is needed by the body to release energy in digested food. In the process, carbon dioxide is produced. Breathing brings oxygen into our body and gets rid of carbon dioxide from our body. Unhealthy lifestyle choices can harm or respiratory system, e.g. smoking is linked to health problems such as bronchitis and lung cancer. The unit introduces the different types of respiration in plants and animals. Students study the respiratory anatomy of animals. They further investigate the characteristics of gas exchange surfaces.

Content Standard 11.2.4

Investigate the conversion process of the food substance to energy forms that allow organisms to live.

Benchmarks

11.2.4.1 Identify and describe ideal gas exchange surfaces in various organisms

11.2.4.2 Explain the organs and structures involved in gas exchange in humans including factors that affect breathing.

11.2.4.3 Compare the different types of respiration and their characteristics

11.2.4.4 Investigate the effects of smoke on the respiratory system and health

11.2.4.5 Examine structures involved in gas exchange in plants

Unit 5 : Support Systems

Sensitivity is one of the characteristics of all living organisms. The effects of sensitivity are easy to observe in animals. There are millions of cells and scores of tissues and organs in the body of an animal such as a mammal. The cells and the organs do not all work independently- their activities are coordinated, which means they work together carrying out various functions at certain times and at certain rates according to the needs of the body.

The unit gives the opportunity for students to investigate plant tropisms and the external factors that cause them. The unit looks at the components and functions of the nervous, defence and endocrine system and how the systems work together.

Content Standard 11.2.5

Investigate the factors that affect the growth and development of plants and animals and how they respond to these factors

Benchmarks

11.2.5.1 Identify the different types of plant tropism and explain the internal and external factors that affect their growth and development

11.2.5.2 Examine the structure, composition and function of the nervous system

11.2.5.3 Explore the structure, composition and function of the endocrine system

11.2.5.4 Explain the development and function of the reproductive system and its related disease

11.2.5.5 Investigate the reproductive patterns, processes and structures of organisms and the continuity of life

11.2.5.6 Explain how the immune systems works to defend against the invasion of microorganisms and other foreign materials.

Grade 12 Units

Evidence Outcomes:

By the end of senior high school, all students can:

- Use appropriate terminology related to genetics.
- Investigate the process of meiosis, using a microscope or computer simulation.
- Identify, and draw biological diagrams of, the phases of meiosis.
- Solve basic problems in genetics that involve monohybrid crosses, using the Punnett square method.
- Compile and analyse qualitative and quantitative data, through laboratory inquiry or computer simulation, on monohybrid crosses, and communicate .
- Investigate the structural properties of DNA and the role of DNA in heredity and protein synthesis.
- Discuss how Mendel's laws of heredity can be used to determine the traits of possible offspring.
- Examine the components and functions of a variety of macromolecules active in biological systems.
- Appraise chromosomal mutations, their possible causes and their effects on genetic variation.
- Debate the theories of evolution and natural selection and cite evidence that supports these theories.
- State the difference between Lamarck's Theory of Evolution and Charles Darwin's Theory of Evolution.

Strand 2: Life

Unit 1: Population Ecology

Organisms interact with each other and their non-living surrounding forming ecosystems. Ecosystems may vary in size and complexity. Energy and matter transfer through ecosystems and can be identified in food chains and webs. Ecosystems respond to external pressures and adjust accordingly. Organisms are adapted to succeed in their surroundings. PNG has a unique environment comprising a variety of valuable ecosystems. Each ecosystem plays a vital role in the overall balance life. Human beings live within the eco systems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability and if not addressed, eco systems will be irreversibly affected.

Content Standard 12.2.1

Investigate the characteristics of population growth and explain the factors that affect the growth of various populations of species

Benchmarks

12.2.1.1 Identify and explain types of habitats, ecosystems, biomes and the interrelationship that exist between them

12.2.1.2 Discuss and describe the biotic and abiotic factors of the major biomes

12.2.1.3 Identify and explain types of behavioural, morphological and physiological adaptations of organisms in terrestrial and aquatic environments

12.2.1.4 Examine the types of interaction that exist between organisms of different species

12.2.1.5 Explain the flow of energy from one organism to another in order to survive

12.2.1.6 Examine the process in which biological communities have changed over time.

12.2.1.7 Explain how matter and energy flow through living systems and the physical environment.

12.2.1.8 Identify methods of sampling population and factors that limit population growth.

12.2.1.9 Use models to represent population dynamics and discuss factors affecting population growth

12.2.1.10 Investigate and describe environmental factors affecting population growth and distribution.

Unit 2: Genetics

In this unit, students will learn about cells and explain the phases in the process of meiosis in terms of cell division, the movement of chromosomes, and crossing over of genetic material. They will explain the concepts of DNA, genes, chromosomes, alleles, mitosis, and meiosis, and how they account for the transmission of hereditary characteristics according to Mendelian laws of inheritance. They will also learn the concepts of genotype, phenotype, dominance, incomplete dominance, codominance, recessiveness and sex linkage according to Mendelian laws of inheritance.

Humans have used biochemicals for over two thousand years. In recent years, the technology for the extraction, purification, analysis and modification of biological molecules has advanced at an enormous rate. When it was understood that nearly all of the genetic information of the cell was contained in DNA, new concepts were rapidly provided in the 1950s and 1960s. In the 1970s, the breakthrough of recombinant DNA technology took biotechnology, or genetic engineering, to new heights. The development of laboratory equipment, availability of biomolecules and refinement of techniques has seen the encompassing of biotechnology in many fields of science, e.g. biochemistry, immunology, food technology, agriculture, microbiology, chemical engineering

Content Standard 12.2.2

Investigate the process of meiosis, laws of heredity and evaluate social, ethical and environmental implications of genetic research and related technologies

Benchmarks

12.2.2.1 Describe the process of meiosis in terms of cell division and the movement of chromosomes

12.2.2.2 Explain how the concepts of DNA, genes, chromosomes, alleles, mitosis, and meiosis account for the transmission of hereditary characteristics from generation to generation

12.2.2.3 Describe the structure and function of DNA, genes and chromosomes and the processes of DNA replication, transcription, and translation in the cell.

12.2.2.4 Explain the concepts of genotype, phenotype, dominance, recessiveness, and sex linkage

12.2.3.5 Investigate newer and commonly practiced methods of gene technology and its applications used today.

Unit 3: Evolution

Evolution in biology refers to all the changes that have occurred to living things over time since life began. Certain characteristics are passed down from the parents to the children or to the offspring. These characteristics include eye, skin, hair colour, height, and hair colour. Every now and then the individual plant or animal is slightly different. These variations are of particular features that are different from the parents. These variations happen very slowly. In fact these differences happen over many generations to produce an offspring that is different from the parent. They will study how living things have inherited in one or more characteristics of a species from one generation to another. They will use different forms to support the theory of evolution.

Content Standard 12.2.3

Investigate evolutionary processes and analyse scientific evidence that support the theory of evolution.

Benchmarks

12.2.3.1 Analyse and evaluate theories and evidence of evolution

12.2.3.2 Identify and explain the mechanism of evolution and its consequences

12.2.3.3 Describe some evolutionary mechanisms and explain how they affect the evolutionary development and extinction of various species

Assessment, Monitoring, and Reporting

The relationship between content standards, benchmarks and performance standards is that they all define students' expected level of proficiency or education quality but at different levels of schooling. Content standards describe the national expectations that all Papua New Guinean students are expected to meet while benchmarks describe the grade-level expectation that all students in a particular grade must meet before proceeding to the next grade. Conversely, performance standards describe students' level of proficiency in a specific knowledge, skill, value or attitude taught in a lesson and measure students' progress towards meeting grade-level expectations and the content standards. Effective instruction and assessment are aligned to performance standards, grade-level expectations, and national content standards.

What is Assessment?

The term "assessment" is generally used to refer to all activities that teachers use to assess students' mastery of what is learned, and to measure and monitor students' progress towards meeting grade-level expectations and the content standards. Assessment is an on-going process of gathering and interpreting information about students' performance and progress towards meeting grade-level expectations as well as the achievement of the content standards described in the subject syllabuses. Data should also be used to help and guide students who are yet to meet grade-level and national expectations to make the required progress towards meeting these expectations.

What is Standards-Based Assessment?

In standards-based curriculum, assessment is used to assess students' level of competency or proficiency of a specific knowledge, skill, value, or attitude taught using a set of performance standards (indicators or descriptors) and measuring, monitoring, evaluating, and reporting their progress towards meeting grade and national-level expectations. Assessment is viewed not only as a measurement activity that is performed after a course or a curriculum topic has been taught (summative), but more importantly, as a continuous process (formative) that provides students' performance data to teachers and students regarding their progress towards achieving the intended standards. Timely and ongoing assessment of student's learning and mastery of what is learned are key to the learning process and the attainment of the desired learning outcomes.
Throughout the year, teachers will be assessing students' performance and progress towards meeting each grade-level benchmark (grade-level expectation) and each content standard (national-level expectation), and using the data to identify areas where a student or a group of students need more attention, and monitor their progress towards meeting the required standards.

Purpose of Assessment

The primary purpose of assessment is to improve students' learning and teachers' teaching. The other purposes of assessment are to;

- improve students' learning, levels of proficiency, and progress towards meeting the expected standards,
- provide data that teachers, schools and Department of Education can use to make informed decisions about how to improve the quality of teaching and learning in the education system,
- inform teachers about the progress of students towards meeting grade-level and national expectations (standards) and enable them to adjust their lesson planning, instruction, and assessment to improve student learning and proficiency levels,
- inform parents and guardians about their students's achievements and status of progress towards meeting national standards; and what needs to be done to close the gaps and enable students to make the progress required to meet these standards, and
- provide information for schools and systems about teaching strategies, resource allocations and curriculum; and other educational institutions, employers and the community about the achievements of students in general or of particular students.

Whatever its purpose, assessment is seen as an integral part of the teaching and learning program rather than a separate process.

Types of Assessment

The following types of assessment have been adopted to assess and monitor students' achievement of the education standards.

- Assessment For Learning
- Assessment Of Learning
- Assessment As Learning

Assessment For and Assessment Of Learning are also known as formative and summative assessments.

Assessment For Learning

Assessment For Learning (AFL), also known as classroom assessment is different. It is an ongoing process that arises out of the interaction between teaching and learning. It is not used to evaluate learning but to help learners learn better. It does so by helping both students and teachers to understand;

- the performance standards, grade-level benchmarks and content standards that students are expected to meet to achieve the desired level of proficiency or quality of education,
- where each learner is in relation to the national curriculum standards,

- where they need to be, and
- what they need to do to make progress towards meeting the expected standards.

Assessment Of Learning

Assessment Of Learning (AOL) is the use of a task or an activity to measure, record,and report on a student's level of achievement in regards to specific learning expectations such as unit tests and end of term or year exams. It is normally referred to as Summative Assessment.

Assessment As Learning

Assessment As Learning (AAL) is the use of an assessment task or an activity by the teacher in his/her everyday teaching. This strategy provides students with opportunities to understand what they have learnt or are having difficulties with. Self and peer assessments allow students to reflect on their own learning and identify areas of strengths and weaknesses. These tasks offer students the chance to set their own personal goals to improve their own learning.

Diagnostic Assessment

Apart from these three main types of assessment, teachers are expected to do the diagnostic test/assessment to identify strengths and weaknesses in students. This can be done before any teaching and learning of a new content and for new entry levels for students.

Diagnostic assessment is a form of pre-assessment that allows a teacher to determine students' individual strengths, weaknesses, knowledge, and skills prior to instruction. It is primarily used to diagnose student difficulties and to guide curriculum and lesson planning.

Assessment Methods

These are some methods that teachers can use to assess students' performance.

- Observing students during the lesson
- Conferencing with students
- Student's Portfolio
- Tests
- Assignments
  - projects/reports/quizzes/presentations/practical work samples

Recording and Reporting

Recording

Teachers must keep accurate records of students' performance and achievements. They must report these achievements in fair and accurate ways to parents, guardians, teachers and students. Examples of recording methods include:

- anecdotal notes in a journal or diary,
- checklists,
- portfolios of students' work,
- progressive records, and
- work samples with comments written by the teacher.

Reporting

Reporting is communicating clearly to students, parents, guardians, teachers and others the information gained from assessing students' learning.

Students' reports should be based on assessment information collected from ongoing assessments. Schools will decide on how best the reports will be presented to suit the needs of their communities. Methods will include interviews and written reports. Written reports should include;

- a written record of progress made towards meeting grade-level expectations and the attainment of content standards by each student since the previous report,
- a written record of each student's learning and mastery problems and what needs to be done to make the required progress towards meeting grade-level benchmarks and national content standards, and
- information about students' attitudes, values and general behaviour.

Monitoring and Evaluation

Assessment information should be used to make judgments about students' achievements and monitor their progress towards meeting grade-level expectations and national content standards.

Monitoring

Data from performance assessment should be used to monitor and report on students' performance towards meeting grade-level and national expectations. Performance standards or indicators should be used to report and keep a tab on each students' progress towards meeting the expected level of proficiency or competency. Teachers should develop a clear and measurable set of performance standards or indicators to monitor and report on students' progress and achievements on a regular basis.

Evaluation

Teachers should use assessment data to evaluate the effectiveness of their teaching and their students' learning, and make improvements to their teaching practices in order to improve student learning outcomes. Evaluation tools such as written records, questionnaires, logs and diaries, submissions or records of meetings and discussion with general staff members, teaching staff, parents and other community members should be used to evaluate students and teachers' competency levels, and make informed decisions about how these could be improved.

Glossary

Terms	Definitions
Assessment	Activities teachers use to help students learn and monitor their progress
Assessment as/in Learning	It is a design to inform students what they will do well and what they need to improve on daily/weekly bases as an integral part of everyday teaching and learning such as exercise, activities or experiments students do or practice
Assessment For Learning	A common form of assessment. It is an ongoing process that arises out of the interaction between teaching and learning. Also referred to as formative assessment
Assessment of Learning	Provides a summary of students learning over a set of period of time and is generally carried out at the end of a course or project. Sometimes it is referred to as summative assessment and is evaluative.
Assessment Strategies	Different styles and ways of assessing students work.
Assessment Tasks	On-going test of knowledge, skills and attitudes/values gained throughout the particular unit or topic.
Benchmark	Benchmarks are specifications of contents or more detailed descriptions of a specific level of performance expected of students at particular ages, grades or levels of development.
Content Standards	Broadly stated expectation of what students need to know, understand and be able to do as intended by the syllabus. They define the breadth and depth of knowledge, skills and processes and attitudes and values that are to be taught in the strand, unit or topic.
Evidence outcomes	Evidence outcomes are indicators that indicate students' progress towards meeting an expectation at the mastery level
National Education Assessment	Is a learning system and is systematic and ongoing process of collecting and interpreting information about students' achievements.
Performance Standard	A descriptive statement of the knowledge and skills that students may display as they work towards the achievement of the content standard.
Standards-based Education	It is a philosophical concept that is centred on the process of planning, developing, delivering, monitoring and improving education programs.
Standards-based Curriculum	It is a cumulative body of knowledge and set of competencies that form the basis for quality education.

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