Secondary Education Curriculum
2076
Biology

Grades: 11 and 12 **Subject code:** Bio. 301 **(Grade 11),**
Bio. 302 **(Grade 12)**

Credit hrs: 5 **Working hrs: 160**

1. Introduction

This curriculum presumes that the students joining grade 11 and 12 science stream come with diverse aspirations, some may continue to higher level studies in specific areas of science, others may join technical and vocational areas or even other streams. The curriculum is designed to provide students with general understanding of the fundamental scientific laws and principles that govern the scientific phenomena in the world. It focuses to develop scientific knowledge, skill competences and attitudes required at secondary level (grade 11 and 12) irrespective of what they do beyond this level, as envisioned by national goals. Understanding of scientific concepts and their application, in day to day context as well as the process of obtaining new knowledge through holistic approach of learning in the spirit of national qualification framework is emphasized in the curriculum.

In particular, the curriculum aims to provide sufficient knowledge and understanding of science for all learners to recognize the usefulness, and limitations, of laws and principles of biology, and use them in daily lives providing a sound foundation for students who wish to study biology or related professional or vocational courses in higher education. It helps to strengthen science process skills that are relevant to the study and application of biological science in daily life. It also provides opportunity for the learners who have deeper interest in the subject to delve into the more advanced contents so that the study of biology becomes enjoyable and satisfying to all. Moreover, it helps the students to build up capacity to identify, gather, manipulate and process information in the context of scientific endeavors including field investigations in various formats on biological issues.

The curriculum prepared in accordance with National Curriculum Framework is structured for two academic years in such a way that it incorporates the level-wise competencies, grade-wise leaning outcomes, scope and sequence of contents, suggested practical/project activities, learning facilitation process and assessment strategies so as to enhance the learning on the subject systematically.

2. Level-wise competencies

In completion of this course, students are expected to demonstrate the following competencies:

1. relate natural and biological phenomena in the scientific manner of knowledge, understanding and investigating problems pertaining to the living world
2. use scientific instruments, apparatus and methods to collect, evaluate and communicate information accurately and precisely with biological reasoning

3. use their practical and problem-solving skills in different disciplines of biology, including those in medical, veterinary, food, agriculture, biotechnology, biosecurity, quarantine, conservation and eco-tourism and so on
4. carryout simple experiment, simple scientific research on issues related to biological phenomena
5. apply biological concepts as well as general science knowledge and skills for the wise use of the available natural resources to promote care for the environment, indigenous knowledge, social values and ethics and overall development
6. develop new biotechnological concepts and use of technology in living world.

3. Grade-wise learning outcomes

Grade 11	Grade 12
Part A : Botany	
1. Biomolecules & Cell Biology (15) 1.1 Describe the structure and functions of biomolecules. 1.2 Differentiate between prokaryotic and eukaryotic cell. 1.3 Explain structure and functions of cell organelles 1.4 Analyze the cell cycle and types of cell division with significances. 1.5 Demonstrate an understanding of the basic processes of cellular biology.	**1. Plant Anatomy (8)** 1.1 Explain about the concept of tissues 1.2 Classify types of plant tissues 1.3 Expalin about anatomical structure of root, stem and leaf of monocot and dicot plants. 1.4 Define meaning and mechanism about secondary growth of dicot stem. 1.5 Investigate the structures and functions of plant tissues, and factors affecting plant growth; 1.6 Demonstrate an understanding of the diversity of vascular plants, including their structures, internal transport systems, and their role in maintaining biodiversity.
2. Floral Diversity (30) 2.1 Demonstrate an understanding of the diversity of living organisms in terms of the principles of taxonomy and phylogeny. 2.2 Investigate, through laboratory and/or field activities or through simulations, the principles of scientific classification using appropriate sampling and classification techniques; 2.3 Explain three domains of life, system of classification and status of flora of Nepal. 2.4 Classify fungi upto different classes. 2.5 Explain the structure and reproduction of Mucor and yeast. 2.6 Distinguish between poisonous and nonpoisonous mushroom 2.7 Describe the economic importance of fungi. 2.8 Explain characteristic features and	**2. Plant Physiology (20)** 2.1 Describe the terms diffusion, osmosis, and plasmolysis, ascent of sap, transpiration and guttation with significances 2.2 Define photosynthesis and explain about pigments, mechanism of photosynthesis, C_3 and C_4 plant as well as factors affecting photosynthesis. 2.3 Explain about respiration, types of respiration and mechanism as well as factors affecting respiration. 2.4 Define phytohormone and physiological role of auxins, gibberellins and Cytokinins. 2.5 Describe the terms seed germination, dormancy, photoperiodism, vernalization, senescence; plant movements. 2.6 Analyse the role of metabolic processes in the functioning of biotic and abiotic systems, and evaluate the importance

economic importance of lichen. 2.9 Classify algae into different groups with basic characters 2.10 Explain the structure and reproduction of Spirogyra. 2.11 Describe economic importance of algae. 2.12 Classify bryophytes into different groups with basic characters 2.13 Explain the structure and reproduction of Marchantia. 2.14 Describe economic importance of bryophytes. 2.15 Explain introduction and characteristics features of pteridophytes. 2.16 Explain the structure and reproduction of Dryopteris. 2.17 Describe economic importance of pteridophytes. 2.18 Explain introduction and characteristics features of Gymnosperms 2.19 Explain the structure and reproduction of Pinus. 2.20 Describe economic importance of gymnosperm. 2.21 Describe the morphology of root, stem, leaves, inflorescences, flowers and fruit 2.22 Define taxonomy and classification system 2.23 Describe the families -Brassicaceae, Fabaceae, Solanaceae, and Liliaceae in taxonomic term with economic importance. 2.24 Analyze the effects of various human activities on the diversity of plants.	of an understanding of these processes and related technologies to personal choices made in everyday life; 2.7 Investigate the products of metabolic processes such as cellular respiration and photosynthesis; 2.8 Demonstrate an understanding of the chemical changes and energy conversions that occur in metabolic processes.
3. Introductory Microbiology (5) 3.1 Explain structure, mode of nutrition and growth of bacteria as well as cyanobacteria (blue green algae). 3.2 Explain introduction, structure and importance of virus.	**3. Genetics (21)** 3.1 Define genetics, genetic material and their composition. 3.2 Draw the structure of DNA and RNA 3.3 Describe the mechanism of DNA replication

3.3 Demonstrate an understanding of the diversity of microorganisms (Bacteria and Virus) and the relationships that exist between them. 3.4 Assess the effects of microorganisms (Bacteria and Virus) in the environment, and analyze ethical issues related to their use in biotechnology;	3.4 Define genetic code 3.5 Describe the terminology of genetics, Mendel experiment as well as complete and incomplete dominance. 3.6 Explain about linkage, distinguish between complete and incomplete linkage, sex linked inheritance with reference of Drosophila, crossing over and its significances. 3.7 Describe about mutation, its importance as well as the concept of polyploidy. 3.8 Evaluate the importance of some recent contributions to our knowledge of genetic processes, and analyse social and ethical implications of genetic and genomic research; 3.9 Investigate genetic processes, including those that occur during meiosis, and analyse data to solve basic genetics problems involving monohybrid and dihybrid crosses; 3.10 Demonstrate an understanding of concepts, processes, and technologies related to the transmission of hereditary characteristics.
4. Ecology (11) 4.1 Define ecology, ecological factors and structural and functional concept of ecosystem. 4.2 Explain the concept of food chain, food web and ecological pyramid. 4.3 Explain the term trophic level, productivity. 4.4 Explain the process of bio-geochemical cycle and succession. 4.5 Define adaptation, hydrophytes and xerophytes. 4.6 Define greenhouse effect, ozone layer, acid rain and biological invasion 4.7 Explain and illustrate with examples how living systems interact with the biotic and	**4. Embryology (8)** 4.1 Explain about sexual and asexual reproduction of angiosperms, pollination and fertilization process. 4.2 Describe the developmental process of male and female gametophyte 4.3 Demonstrate developmental process of dicot and monocot embryos. 4.4 Describe an endosperm and importance.

abiotic environment 4.8 Analyse and investigate the roles of plants in ecosystems, and assess the impact of human activities on the balance of nature within those ecosystems;	
5. Vegetation (3) 5.1 Describe the vegetation types of Nepal 5.2 Illustrate the concept of In-situ (protected areas) and Ex-situ (botanical garden, seed bank) conservation with examples 5.3 Demonstrate an understanding of the structure and physiology of plants and their role in the natural environment.	**5. Biotechnology (7)** 5.1 Define biotechnology, tissue culture, plant breeding, disease resistance plant, green manure and bio-fertilizer. 5.2 Analyse some of the social, ethical, and legal issues associated with genetic research and biotechnology; 5.3 Investigate, through laboratory activities, the structures of cell components and their roles in processes that occur within the cell; 5.4 Demonstrate an understanding of concepts related to molecular genetics, and how genetic modification is applied in industry and agriculture.
Part B : Zoology	
6. Introduction to Biology (2) 6.1 Describe the importance and scope of biology 6.2 Analyze biology and its relation with other sciences	**6. Animal Tissues (8)** 6.1 Describe the types of animal tissues: epithelial, connective, muscular and nervous and their functions and how is that function associated with the features of the tissue. 6.2 Describe structure, functions & location of different sub-types of four main animal tissues. 6.3 Describe the nervous tissue with their structures and functions. 6.4 Explain what type of tissue composes cartilage and bones. 6.5 Explain the structure of a striated muscle. 6.6 Discuss the structure of a neuron.
7. Evolutionary Biology (15) 7.1 Explain different theories for origin of life.	**7. Developmental Biology (6)** 7.1 Define and explain the process of

7.2 State and explain evolution as the process of biological change over time with biological evidences and theories of evolution. 7.3 Describe and explain the evolution of modern man from anthropoid ancestor. 7.4 Investigate evolutionary processes, and analyze scientific evidence that supports the theory of evolution; 7.5 Demonstrate an understanding of the theory of evolution, the evidence that supports it, and some of the mechanisms by which it occurs.	spermatogenesis & oogenesis. 7.2 State the biochemical changes taking place during fertilization of frog. 7.3 Describe the development of frog up to formation of three germ layers. 7.4 Discuss the importance of gastrulation in frog's egg. 7.5 Explain the effects of yolk on gastrulation in the development of frog. 7.6 Explain the formation of notochord, nerve cord and coelom in the development of frog.
8. Faunal Diversity (34) 8.1 Understand protista and classify Protozoa upto class with examples and characteristic features. 8.2 Explain the habits and habitat, structure, reproduction, life-cycle and economic importance of Paramecium caudatum, Plasmodium vivax and P. falciparum. 8.3 Explain level of organization, body plan, body symmetry, body cavity and segmentation in animals. 8.4 Give the diagnostic features and classify different phyla (up to class) with examples. 8.5 Describe the morphology, different systems and physiological processes of earthworm and frog. 8.6 Investigate, through laboratory and/or field activities or through simulations, the principles of scientific classification, using appropriate sampling and classification techniques;	**8. Human Biology (28)** 8.1 Describe alimentary canal and digestive glands of human and discuss physiology of digestion. 8.2 Explain how digestion is completed in small intestine. 8.3 Discuss the role of salivary glands, liver and pancreas in digestion of food. 8.4 Explain respiratory organs and respiratory mechanism in human. 8.5 Explain the exchange of gases, transport of gases and regulation of respiration. 8.6 Explain how CO2 is transported from tissues to lungs. 8.7 Describe the exchange of gases that take place between the alveolus and blood capillary. 8.8 Explain how hemoglobin is associated with respiration. 8.9 Define double circulation and describe the structure of human heart. 8.10 Explain origin and conduction of heart beat, cardiac cycle, cardiac output 8.11 Describe the arterial and venous systems (major arteries and veins) in human.

	8.12 State blood grouping and blood pressure. 8.13 Mention briefly the modes of excretion. 8.14 Describe the excretory organs and discuss the process of urine formation in human. 8.15 Mention the types of nervous system 8.16 Give the structure and function of human brain 8.17 Discuss how nerve impulse travels in and across an axon. 8.18 Describe the structure and functions of various parts of human eye and ear. 8.19 Differentiate between exocrine and endocrine glands. 8.20 Differentiate between hormones and enzymes. 8.21 Describe the various endocrine glands, their location, structure, hormones secreted and their functions. 8.22 Mention the disorders/diseases caused by deficiency or over-secretion of various hormones. 8.23 Describe male and female reproductive organs. 8.24 Explain various stages of the ovarian cycle. 8.25 Explain that the ovarian cycle governs the preparation of endocrine tissues and release of eggs, while the menstrual cycle governs the preparation and maintenance of the uterine lining. These cycles occur concurrently and are coordinated over a 22–32 day cycle, with an average length of 28 days. 8.26 Analyse the social or economic impact of a technology used to treat systems in the human body, and the impact of lifestyle choices on human

	health; 8.27 Investigate, through laboratory inquiry or computer simulation, the anatomy, physiology, and response mechanisms of mammals; 8.28 Demonstrate an understanding of the structure, function, and interactions of the circulatory, digestive, and respiratory systems of mammals. 8.29 Evaluate the impact on the human body of selected chemical substances and of environmental factors related to human activity; 8.30 Investigate the feedback mechanisms that maintain homeostasis in living organisms; 8.31 Demonstrate an understanding of the anatomy and physiology of human body systems, and explain the mechanisms that enable the body to maintain homeostasis. 8.32 Analyse the relationships between changing societal needs, technological advances, and our understanding of internal systems of humans; 8.33 Investigate, through laboratory inquiry or computer simulation, the functional responses of the respiratory and circulatory systems of animals, and the relationships between their respiratory, circulatory, and digestive systems; 8.34 Demonstrate an understanding of animal anatomy and physiology, and describe disorders of the respiratory, circulatory, and digestive systems.
9. Biota and Environment (10) 9.1 Define and explain different types of adaptations in animals 9.2 Identify different types of animal behavior and explain reflex action, taxes, dominance and leadership.	**9. Human Population and Health Disorders (6)** 9.1 List various reasons for human population growth and how can it be controlled. 9.2 Explain human population growth curve

9.3 State and explain migration in fish and birds 9.4 Analyze air, water and soil pollution, its causes, effects and find out the ways out to protect oneself and the environment from the adverse effects of these pollution 9.5 Analyze the pesticides & their effects on environment.	9.3 Describe in brief demographic cycle. 9.4 Explain in brief cardiovascular, respiratory & renal disorders common in Nepal. 9.5 Explain substance abuse: drug, alcohol and smoking abuse. 9.6 Analyse the relationships between population growth, personal consumption, technological development, and our ecological footprint, and assess the effectiveness of some Canadian initiatives intended to assist expanding populations; 9.7 Investigate the characteristics of population growth, and use models to calculate the growth of populations within an ecosystem; 9.8 Demonstrate an understanding of concepts related to population growth, and explain the factors that affect the growth of various populations of species.
10. Conservation Biology (3) 10.1 State the concept and importance of biodiversity to maintain viable ecosystems and identify its causes of extinction and its effect for human beings. 10.2 Find out the ways of biodiversity conservation focusing on wildlife, national parks, conservation areas, biodiversity hotspots, wetland and Ramsar sites 10.3 Explain IUCN Red list categories and discuss endangered species in Nepal.	**10. Applied Biology (16)** 10.1 Explain tissue and organs transplantation. Organs that have been successfully transplanted are the heart, kidneys, brain, liver, lungs, pancreas, intestine, and thymus. Tissues include bones, tendons (both referred to as musculoskeletal grafts), corneae, skin, heart valves, nerves and veins. 10.2 Explain in-vitro fertilization (IVF), which is an assisted reproductive technology (ART). 10.3 Explain amniocentesis, (also referred to as amniotic fluid test or AFT) which is a medical procedure used in prenatal diagnosis of chromosomal abnormalities and fetal infections, and also for sex determination. 10.4 Describe genetically modified organisms (transgenic animals). These animals (most commonly mice) that have had a foreign gene

		deliberately inserted into their genome.
	10.5	Describe poultry farming and fish farming and their prospects in Nepal.
	10.6	Enumerate risk and hazard group of microorganisms.
	10.7	
	10.8	Write introduction, causative agents, symptoms, prevention and control measures of selected human diseases: typhoid, tuberculosis and HIV infection, cholera, influenza, hepatitis, candidiasis.
	10.9	Explain basic concepts of immunology–vaccines.
	10.10	Enumerate the application of microorganisms in dairy and beverage industries, microbial contamination of water, sewage and drinking water treatment, bio-control agents and bio-fertilizers.
	10.11	Analyse technological applications of enzymes in some industrial processes, and evaluate technological advances in the field of cellular biology;
	10.12	Investigate the chemical structures, functions, and chemical properties of biological molecules involved in some common cellular processes and biochemical reactions;
	10.13	Demonstrate an understanding of the structures and functions of biological molecules, and the biochemical reactions required to maintain normal cellular function.
	10.14	Evaluate some social, ethical, and environmental implications of genetic research and related technologies;
	10.15	Investigate the process of meiosis, and analyse data related to the laws of heredity;
	10.16	Demonstrate an understanding of the

	process of meiosis, and explain the role of genes in the transmission of hereditary characteristics

4. Scope and Sequence of Contents

Grade 11		Grade 12	
Contents	**T H**	**Contents**	**T H**
Part A: Botany			
1. Biomolecules & Cell Biology 1.1 **Biomolecules:** Introduction and functions of: carbohydrates, proteins, lipids, nucleic acids, minerals, enzymes and water. **1.2 Cell:** Introduction of cell, concepts of prokaryotic and eukaryotic cells, detail structure of eukaryotic cells (composition, structure and functions of cell wall, cell membrane, mitochondria, plastids, endoplasmic reticulum, golgi bodies, lysosomes, ribosomes, nucleus, chromosomes, cilia, flagella and cell inclusions. **1.3 Cell division :** Concept of cell cycle, types of cell division (amitosis, mitosis and meiosis) and significances	**4** **8** **3**	**1. Plant Anatomy** **1.1 Plant anatomy:** Concept of tissues, types of plant tissues (meristems and permanent tissues), Anatomy of dicot and monocot root, stem and leaf Secondary growth of dicot stem.	**8**
2. Floral Diversity **2.1 Introduction:** Three domains of life, binomial nomenclature, five kingdom classification system (Monera, Protista, Fungi, Plantae and Animalia); status of flora in Nepal and world representation **2.2 Fungi:** General introduction and characteristic features of phycomycetes, ascomycetes, basidiomycetes and deuteromycetes; structure and Reproduction of *Mucor* and Yeast, introduction of Mushrooms, poisonous and non-poisonous mushrooms, economic importance of fungi. **2.3 Lichen:** General introduction, characteristic features and economic importance of lichen **2.4 Algae:** General introduction and characteristic feature of green, brown and	1 3 1 2	**2. Plant Physiology** **2.1 Water relation**: Introduction and significance of - diffusion, osmosis, and plasmolysis, ascent of sap, transpiration and guttation. **2.2 Photosynthesis:** Introduction and significance of photosynthesis, photosynthetic pigments, mechanism of photosynthesis (photochemical phase and Calvin-Benson cycle), C_3 and C_4 plants, photorespiration, factors	**4** 5 5 3

red algae; structure and reproduction of *Spirogyra*. Economic importance of algae **2.5 Bryophyta:** General introduction and characteristic features of liverworts, hornworts and moss; morphological structure and reproduction of *Marchantia*. Economic importance of bryophytes **2.6 Pteridophyta:** General introduction and characteristic features of pteridophytes; morphological structure and reproduction of *Dryopteris*. Economic importance of pteridophytes **2.7 Gymnosperm:** General introduction and characteristic features of Gymnosperms; morphology and reproduction of *Pinus*. Economic importance of gymnosperm **2.8 Angiosperm:** Morphology (root, stem, leaves, inflorescences, flowers and fruit); Taxonomic study: Definition, taxonomic hierarchy, classification systems (artificial, natural and phylogenetic) of angiosperms, taxonomic description of the families – Brassicaceae, Fabaceae, Solanaceae, and Liliaceae with economic importance	2 2 3 16	affecting photosynthesis. **2.3 Respiration:** Introduction and significance of respiration, types of respiration, mechanism of respiration (glycolysis, Kreb cycle, electron transport system), factors affecting respiration. **2.4 Plant hormones:** Introduction, physiological effects of auxins, gibberellins and Cytokinins. **2.5 Plant growth and movement:** Concept on seed germination, dormancy, photoperiodism, vernalization, senescence; plant movements (tropic and nastic).	3
3. Introductory Microbiology **3.1 Monera:** General introduction, structure of bacterial cell, mode of nutrition, bacterial growth; cyanobacteria (blue green algae). **3.2 Virus:** General introduction, structure and importance of virus, bacteriophage **3**.3 Impacts of biotechnology in the field of microbiology.	3 1 1	**3. Genetics** **3.1 Genetic Materials:** Introduction to genetics and genetic materials, composition, structure and function of DNA and RNA, DNA replication, introduction of genetic code. **3.2 Mendelian genetics:** General terminology, Mendel's experiment and laws of inheritance, gene interactions (incomplete dominance, co-dominance). **3.3 Linkage and crossing over:** Concept and types of linkage (complete and incomplete), sex-linked inheritance (colour	5 6 5 5

		blindness in man and eye colour of *Drosophila*), concept and significances of crossing over. **3.4 Mutation and polyploidy:** Concept, type (gene and chromosomal mutation), importance of mutation (positive and negative), polyploidy (origin and significance).	
4. Ecology **4.1 Ecosystem ecology: C**oncept of ecology, biotic and abiotic factors, species interactions; concept of ecosystem, structural and functional aspects of pond and forest ecosystem, food chain, food web, trophic level, ecological pyramids, productivity, biogeochemical cycle - carbon and nitrogen cycles, concept of succession. **4.2 Ecological Adaptation:** Concept of adaptation, hydrophytes and xerophytes. **4.3 Ecological Imbalances:** Green house effects and climate change, depletion of ozone layer, acid rain and biological invasion.	7 2 2	**4. Embryology:** Asexual and sexual reproductions in angiosperms, pollination, fertilization, development of male and female gametophytes, development of dicot and monocot embryos, concept of endosperm	8
5. Vegetation a. Vegetation: Introduction, types of vegetation in Nepal, concept of *In-situ* (protected areas) and *Ex-situ* (botanical garden, seed bank) conservation. Natural environment-vegetation and human activities	2 1	**5. Biotechnology:** Introduction, tissue culture, plant breeding, disease resistance plants, green manure and bio-fertilizer, bio-pesticide, genetic engineering and GMOs (genetically modified organisms) and application, bio-engineering, food safety and food security.	7
Part B: Zoology			
6. Introduction to Biology **6.1 Introduction to Biology:** Scope and fields	1	**6. Animal Tissues** **6.1 Animal Tissues:**	8

of biology. Relation with other science.		Introduction; Types of animal tissues: epithelial, connective, muscular and nervous (structure, functions & location of different sub-types).	
7. Evolutionary Biology	2	**7. Developmental Biology**	
7.1 Life and its Origin: Oparin-Haldane theory, Miller and Urey's experiment.		**7.1 Gametogenesis:** Spermatogenesis & Oogenesis.	2
7.2 Evidences of evolution: Morphological, Anatomical, Paleontological, Embryological and Biochemical.	5		4
7.3 Theories of evolution: Lamarckism, Darwinism & concept of Neo Darwinism.	3	**7.2 Development of frog:** Fertilization & its effects, cleavage, morulation, blastulation, gastrulation, organogenesis – formation of notochord, nerve cord & coelom.	
7.4 Human evolution: Position of man in animal kingdom. Differences between new world monkeys & old world monkeys, apes & man. Evolution of modern man starting from anthropoid ancestor.	5		
8. Faunal Diversity		**8. Human Biology**	
8.1 Protista: Outline classification. Protozoa: diagnostic features and classification up to class with examples; *Paramecium caudatum, Plasmodium vivax* - habits and habitat, structure, reproduction, life-cycle and economic importance of *P. falciparum*.	4	**8.1 Digestive system:** Alimentary canal and digestive glands, physiology of digestion.	**2**
8.2 Animalia: Level of organization, body plan, body symmetry, body cavity and segmentation in animals. Diagnostic features and classification of the following phyla (up to class) with examples:Porifera, Coelenterata (Cnidaria), Platyhelminthes, Aschelminthes (Nemathelminthes), Annelida, Arthropoda, Mollusca, Echinodermata and Chordata.	10	**8.2 Respiratory System:** Respiratory organs, respiratory mechanism - exchange of gases, transport of gases and regulation of respiration.	**2** **4**
Earthworm (*Pheretima posthuma*): Habit and habitat, External features; Digestive system (alimentary canal & physiology of digestion), Excretory system (types of nephridia, structure and arrangement of septal nephridia), Nervous system (central & peripheral nervous system, working mechanism) & Reproductive systems (male & female reproductive organs), Copulation,	10	**8.3 Circulatory System:** Double circulation (concept), heart (structure and working mechanism), origin and conduction of heart beat, cardiac cycle, cardiac output, arterial and venous systems (major arteries and veins), blood grouping, blood pressure.	**3** **3**
		8.4 Excretory System: Concept of modes of excretion (ammonotelism,	**2**

Cocoon formation and Economic importance. **Frog** (*Rana tigrina*): Habit and habitat, External features, Digestive system (alimentary canal, digestive glands & physiology of digestion), Blood vascular system (structure & working mechanism of heart), Respiratory system (respiratory organs & physiology of respiration) and Reproductive system (male & female reproductive organs).		ureotelism, uricotelism), Excretory organs, mechanism of urine formation. **8.5 Nervous system:** Types of nervous system (central, peripheral & autonomous), structure and function of brain, Origin and conduction of nerve impulse. **8.6 Sense organs:** Structure and functions of eye and ear. **8.7 Endocrinology:** Endocrine glands and hormones – structure & functions of hypothalamus, pituitary, pineal, thyroid, parathyroid, adrenal, pancreas, gonads; hypo- and hyper-activity and related disorders. **8.8 Reproductive System:** Male and female reproductive organs, ovarian & menstrual cycle.	**9** **3**
9. Biota and Environment **9.1 Animal adaptation:** Aquatic (Primary & Secondary), Terrestrial (Cursorial, Fossorial & Arboreal) and Volant adaptation. **9.2 Animal behavior:** Reflex action, taxes, dominance and leadership. Fish and bird Migration. **9.3 Environmental Pollution:** Sources, effects and control measures of air, water and soil pollution. Pesticides & their effects.	3 4 3	**9. Human Population and Health Disorders** **9.1 Human Population:** Growth problem and control strategies, Concept of demographic cycle. **9.2 Health disorders:** Concept of cardiovascular, respiratory & renal disorders; Substance abuse: Drug, alcohol and smoking abuse.	2 4
10. Conservation Biology **10.1 Conservation Biology:** Concept of biodiversity, biodiversity conservation, national parks, wildlife reserves,	2 2	**10. Applied Biology** **10.1 Application of Zoology:** Tissue and organs transplantation, in-vitro	6

conservation areas, biodiversity hotspots, wetland & Ramsar sites. **Wildlife**-Importance, causes of extinction and conservation strategies. IUCN categories of threatened species- meaning of extinct, endangered, vulnerable, rare, and threatened species. Endangered species in Nepal.		fertilization (IVF), amniocentesis, concept of genetically modified organisms (transgenic animals). Poultry farming and fish farming. **10.2 Microbial diseases and application of microbiology:** Risk and hazard group of microorganisms. Introduction, causative agents, symptoms, prevention and control measures of selected human diseases: Typhoid, Tuberculosis and HIV infection, cholera, influenza, hepatitis, candidiasis. Basic concepts of immunology–vaccines. Application of microorganisms in dairy and beverage industries, microbial contamination of water, sewage and drinking water treatment, bio-control agents and bio-fertilizers.	10

5. Practical Courses [32 Hours]

The practical work that students do during their course is aimed at providing them learning opportunities to accomplish competency of the curriculum as well as reinforcing their learning of the theoretical subject content. This part of the curriculum focuses more on skill development than knowledge building. Students must spend lots of time for working with biological materials. Observations and investigations can enhance student learning. Project work may consist of activities designed to demonstrate the concepts and ideas through collecting, processing, analyzing and communicating data.

Students should learn to,

- collect and identify
- preserve
- dissect
- draw figure, chart, preparing models, slides etc
- handle the equipment, instruments and laboratory handling with experimentation
- draw conclusion

Students should perform at least 10 experiments, either listed below or designed by teacher, so that no more than three experiments come from the same unit and students should perform at least 5 experiments from botany and 5 experiments from zoology part of this curriculum.

a) Practical Activities for Grade 11

The following are the list of practical activities for Grade 11 in Biology

Botany

Unit 1: Biomolecules and Cell Biology

1. Study of tissues and diversity in shapes and sizes of plant cells (e.g. palisade cells, guard cells, parenchyma, collenchyma, sclerenchyma, xylem, phloem,) through temporary/permanent slides.
2. Study of mitosis in onion root tips cells by preparing temporary slides and permanent slides.

Unit 2: Floral Diversity

3. Collect, identify different types of plants from your nearby locality and preserve them with appropriate method.
4. Collect, preserve and identify some available mushrooms. Distinguish poisonous and edible mushrooms.
5. Study and describe three locally available common flowering plants from each of the following families (Solanaceae, Fabaceae and Liliaceae) including dissection and display of floral whorls and anther and ovary to show number of chambers. Types of root (Tap and Adventitious); Stem (Herbaceous and woody); Leaf (arrangement, shape, venation, simple and compound).
6. Study and identification of different types of inflorescence.

Unit 3: Introductory Microbiology

7. Culture the given sample of soil and study the microorganisms present in it.

Unit 4: Ecology

8. Study the biotic and abiotic factors of a pond as an ecosystem.
9. Determine the population density of plants of given area by quadrate method.
10. Collect and study soil from at least two different sites and study them for texture, moisture content, pH and water holding capacity of soil. Correlate with the kinds of plants found in them.
11. Study of plant population density by quadrate method.

Unit 5: Vegetation

12. Study of the specimens and identification with reasons- Bacteria, Oscillatoria, Spirogyra, Rhizopus, mushroom, yeast, liverwort, moss, fern, pine, one monocotyledonous plant and one dicotyledonous plant and one lichen.

Zoology

Unit 6: Introduction to Biology

13. Study parts of a compound microscope.

Unit 7: Evolutionary Biology

14. Study of the evidences of evolution through fossils (for example *saligram*).

Unit 8: Faunal Diversity

15. Study of specimens and identification with reasons- Amoeba, Hydra, Liverfluke, Ascaris, leech, earthworm, prawn, silkworm, honeybee, snail, starfish, shark, rohu, frog, lizard, pigeon and rabbit.
16. Dissect and study the alimentary canal of the earthworm, frog and rabbit.

Unit 9: Biota and Environment

17. To study the biotic and abiotic components of pond or any other ecosystems nearby you

Unit 10: Conservation Biology

18. . Find out the new strategies for conserving biodiversity in the context of Nepalese development.

b) Sample project work for grade 11 in Biology

1. Collect the sample of cryptogams (Algae, Bryophytes, Pteridophytes) and study their characteristics.
2. Observe and compare the morphological adaptation of hydrophytes, xerophytes and xerophytes.
3. Prepare a report on local varieties and improved varieties of crops and vegetables in your area.
4. Visit the forest or vegetation types in your nearby area and prepare a report on it.
5. Prepare a report on the role of botanical garden in conservation of plants in Nepal
6. Survey any locality regarding any topics related to theory course of Biology (visit to zoological museum/zoo/protected areas/natural habits- forest/lake or river) and writing a report of it.

7. Prepare a report on causes and consequences of environmental pollution in your locality.
8. Observe different cultivation methods of Mushroom and prepare a report on it.
9. Look for resources like library, journals, web surfing, field observations etc and study present status and scope of Biotechnology in Nepal.

c) Practical activities for grade 12 in Biology

Botany

Unit 1: Plant Anatomy

1. Preparation and study of T.S. of dicot and monocot roots and stems (primary).
2. Prepare a temporary mount of onion root tip to study mitosis.

Unit 2: Plant Physiology

3. Study of osmosis by potato osmometer.
4. Study of plasmolysis in epidermal peels (e.g. Rhoeo leaves)
5. Study of distribution of stomata in the upper and lower surface of leaves.
6. Comparative study of the rates of transpiration in the upper and lower surface of leaves.
7. Study the rate of respiration in flower buds/leaf tissue and germinating seeds.
8. Observation and comments on the experimental set up for showing:
   a. Anaerobic respiration
   b. Phototropism
   c. Apical bud removal
   d. Suction due to transpiration

Unit 3: Genetics

9. Study, Observe and Comments upon the Mendelian Inheritance suing seeds of different colours/sizes of any plants.

Unit 4: Embryology

10. Study of imbibition in seeds/raisins.

Unit 5: Biotechnology

11. Preparation of bio-fertilizer and analyze the significances.

Zoology

Unit 6: Animal Tissues

12. Study of tissues and diversity in shapes and sizes of animal cells (e.g. squamous epithelium, muscle fibers and mammalian blood smear) through temporary/permanent slides.
13. Study of mitosis in animal's cells (grasshopper) from permanent slides.

Unit 7: Developmental Biology

14. Study of permanent slides of different developmental stages (fertilized egg, cleavage, blastula and gastrula) of frog.

Unit 8: Human Biology

15. Detect the presence of starch in the given sample.
16. Detect the presence of protein in the given sample.
17. Study the effect of the different temperatures and pH on the activity of salivary amylase on starch.
18. Detect the presence of urea, sugar, albumin and bile salts in urine
19. Detect the presence of sugar in human blood.
20. Study of Human skeleton and different types of joints.

Unit 9: Human Population and Health Disorders

21. Study of human skeleton and different types of joints.
22. Study of external morphology of cockroach through models.

d) Sample project works for grade 12 in Biology

Botany

1. Prepare a report on the topic "significances of the biology and biology education with different sectors i.e. industrial development, medicine, bio-technology, agriculture etc".
2. Prepare a report on "recent development of genetic field and their implications in human life"
3. Prepare model of DNA and RNA
4. Visit the human beings and observe the dominant and recessive characteristics of human beings and prepare a report on it.

Zoology

5. Measure the blood pressure (BP) of human bodies and predict the trends of age wise BP.
6. Visit the poultry farming or fish farming in local area and prepare a report by including the place, farming method, marketing etc.
7. Conduct the survey on common communicable diseases prevailing in local area. Prepare a report by including the disease, causes, preventing measures.
8. Prepare a report on trends, causes and consequences of migration in local level.
9. Prepare functional models of different system of human body.

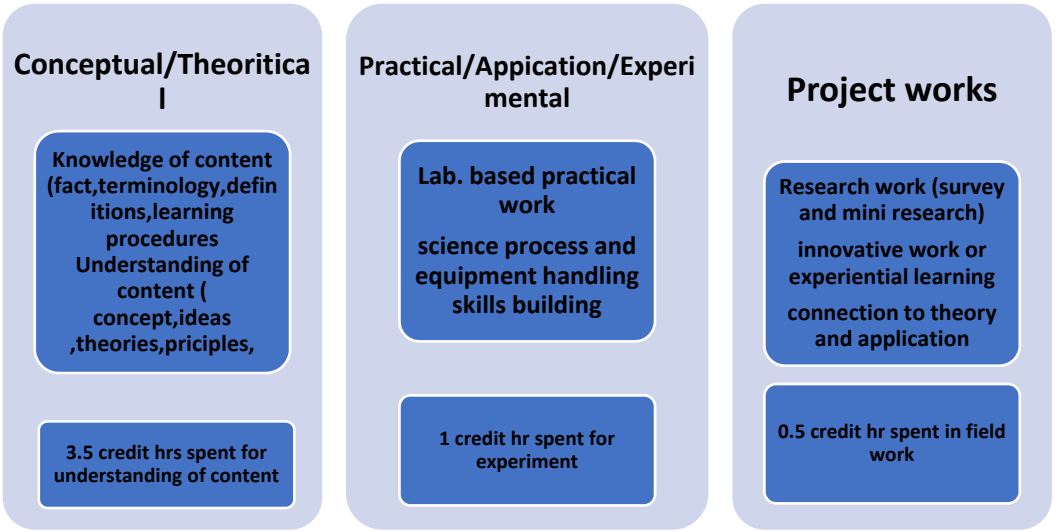
Note: The above are only the specimens of activities. In order to arouse creativity, the students must be encouraged to take up new activities (other than mentioned above) in consultation with the teacher concerned.

6. Learning Facilitation Process

Students should be facilitated to learn rather than just accumulation of information. Teacher plays vital role for delivering subject matters although others' role is also important. Student centered teaching-learning process is highly emphasized. Students are supposed to adopt multiple pathway

of learning, such as online search, field visit, library work, laboratory work, individual and group work, research work etc. with the support of teacher. Self-study by students is highly encouraged and learning should not be confined to the scope of curriculum. Teacher should keep in mind intra and inter-disciplinary approach to teaching and learning, as opposed to compartmentalization of knowledge. Supportive role of parents/guardians in creating conducive environment for promoting the spirit of inquiry and creativity in students' learning is anticipated.

During the delivery process of science teaching in grade 11 and 12, basically following three approaches will be adopted;



a) Conceptual/Theoretical Approach

Possible theoretical methods of delivery may include the following;

- lecture
- interaction
- question answer
- demonstrations
- ICT based instructions
- cooperative learning
- group discussions (satellite learning group, peer group, small and large group)
- debate
- seminar presentation
- Journal publishing
- daily assignment

b) Practical/Application/Experimental approach

Practical work is the integral part of the learning science. The process of lab based practical work comprises as;

- familiarity with objective of practical work
- familiarity with materials, chemicals, apparatus
- familiarity with lab process (safety, working modality etc.)
- conduction of practical work (systematically following the given instruction)
- analysis, interpretation and drawing conclusion

c) Project work Approach

Project work is an integral part of the science learning. Students should be involved in project work to foster self-learning of students in the both theoretical and practical contents. Students will complete project work to have practical idea through learning by doing approach and able to connect the theory into the real world context. It is regarded as method/ process of learning rather than content itself. So use of project work method to facilitate any appropriate contents of this curriculum is highly encouraged.

In this approach student will conduct at least one **research work, or an innovative work** under the guidance of teacher, using the knowledge and skills learnt. It could include any of the followings;

- Mini research
- Survey
- Model construction
- Paper based work
- study of ethno-science

General process of research work embraces the following steps;

- Understanding the objective of the research
- Planning and designing
- Collecting information
- analysis and interpretation
- Reporting /communicating (presentation, via visual aids, written report, graphical etc.)

General process of innovative work embraces the following steps;

- identification of innovative task (either assigned by teacher or proposed by student)
- planning
- performing the task
- presentation of the work
- Record keeping of the work

Students are free to choose any topic listed in this curriculum or a topic suggested by teacher provided that it is within the theoretical contents of the Curriculum. However, repetition of topic should be discouraged.

Learning process matrix

Knowledge and understanding	Scientific skills and process	Values, attitudes and application to daily life
• Scientific phenomenon, facts, definition, principles, theory, concepts and new discoveries • Scientific vocabulary, glossary and terminology • Scientific tools, devises, instruments apparatus • Techniques of uses of scientific instruments with safety • Scientific and technological applications	• Basic and integrated scientific process skills **Process** • Investigation • Creative thinking • problem solving	• Responsible • Spending time for investigation

Basic Science Process Skills includes

1. Observing: using senses to gather information about an object or event. It is description of what was actually perceived.
2. Measuring: comparing unknown physical quantity with known quantity (standard unit) of same type.
3. Inferring: formulating assumptions or possible explanations based upon observations.
4. Classifying: grouping or ordering objects or events into categories based upon characteristics or defined criteria.
5. Predicting: guessing the most likely outcome of a future event based upon a pattern of evidence.
6. Communicating: using words, symbols, or graphics to describe an object, action or event.

Integrated Science Process Skills includes,

1. Formulating hypotheses: determination of the proposed solutions or expected outcomes for experiments. These proposed solutions to a problem must be testable.
2. Identifying of variables: Identification of the changeable factors (independent and dependent variables) that can affect an experiment.
3. Defining variables operationally: explaining how to measure a variable in an experiment.
4. Describing relationships between variables**:** explaining relationships between variables in an experiment such as between the independent and dependent variables.
5. Designing investigations: designing an experiment by identifying materials and describing appropriate steps in a procedure to test a hypothesis.

6. Experimenting: carrying out an experiment by carefully following directions of the procedure so the results can be verified by repeating the procedure several times.
7. Acquiring data: collecting qualitative and quantitative data as observations and measurements.
8. Organizing data in tables and graphs: presenting collected data in tables and graphs.
9. Analyzing investigations and their data: interpreting data, identifying errors, evaluating the hypothesis, formulating conclusions, and recommending further testing where necessary.
10. Understanding cause and effect relationships: understanding what caused what to happen and why.
11. Formulating models: recognizing patterns in data and making comparisons to familiar objects or ideas.

7. Student Assessment

Evaluation is an integral part of learning process. Both formative and summative modes of evaluation are emphasized. Formative evaluation will be conducted so as to provide regular feedback for students, teachers and parents/guardians about how student learning is. Class tests, unit tests, oral question-answer, home assignment etc, are some ways of formative evaluation.

There will be separate evaluation of theoretical and practical learning. Summative evaluation embraces theoretical examination, practical examination and evaluation of research work or innovative work.

(a) Internal Evaluation

Out of 100 full marks, internal evaluation covers 25 marks. Internal evaluation consists of Practical Activities (Practical works and projects works) (16 marks), (b) Marks from trimester examinations (6 marks), and (c) Classroom participation (3 marks)

- **Practical Activities**

Practical work should be based on list of activities mentioned in this curriculum. Project works should be based on the mentioned lists or created by teachers. Mark distribution for practical work and project work will be as follows:

S. N.	Criteria	Elaboration of criteria	Marks
1.	Laboratory experiment	Correctness of apparatus setup/preparation	2
		Observation/Experimentation	2
		Tabulation	1
		Data processing and Analysis	1
		Conclusion (Value of constants or prediction with justification)	1
		Handling of errors/precaution	1
2.	Viva-voce	Understanding of objective of the experiment	1

		Skills of the handling of apparatus in use	1
		Overall impression	1
3.	Practical work records and attendance	Records (number and quality)	2
4	Project work	Reports (background, objective, methodology, finding, conclusion	2
		Presentation	1
		Total	**16**

Note:

(i) Practical examination will be conducted in the presence of internal and external supervisors. Evaluation of laboratory experiment will focus both the product of work and skills competencies of student in using apparatus.

(ii) Project work assessment is the internal assessment of reports and presentation of their project works either individually or group basis. In case of group presentation, every member of the group should submit a short reflection on the presented report in their own language. Records of project works must be attested by external supervisor.

- **Marks from trimester examinations**

Total of 6 marks, 3 marks from each trimester.

- **Classroom participation (3 marks)**

Classroom participation includes attendance (1) and participation in learning (2).

(b) External Evaluation

Out of 100 marks theoretical evaluation covers 75 marks. The tool for external evaluation of theoretical learning will be a written examination. Questions for the external examination will be based on the specification grid developed by Curriculum Development Centre. Examination question paper will be developed using various levels of revised Bloom's taxonomy including remembering level, understanding level, application level and higher ability (such as analyzing, evaluating, creating).