Secondary Education Curriculum
Biology

Grades: 11 and 12 **Subject code:** 201 **(Grade 11),**
202 **(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.

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 **7.1 Life and its Origin:** Oparin-Haldane theory, Miller and Urey's experiment. **7.2 Evidences of evolution**: Morphological, Anatomical, Paleontological, Embryological and Biochemical. **7.3 Theories of evolution:** Lamarckism, Darwinism & concept of Neo Darwinism. **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.	2 5 3 5	**7. Developmental Biology** **7.1 Gametogenesis:** Spermatogenesis & Oogenesis. **7.2 Development of frog:** Fertilization & its effects, cleavage, morulation, blastulation, gastrulation, organogenesis – formation of notochord, nerve cord & coelom.	2 4
8. Faunal Diversity **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*. **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. **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,	4 10 10 10	**8. Human Biology** **8.1 Digestive system:** Alimentary canal and digestive glands, physiology of digestion. **8.2 Respiratory System:** Respiratory organs, respiratory mechanism - exchange of gases, transport of gases and regulation of respiration. **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. **8.4 Excretory System:** Concept of modes of excretion (ammonotelism,	**2** **2** **4** **3** **3** **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

IBO Syllabus

The IBO is an association that organises annual Biology competitions for secondary school students. It is one of the most popular International Science Olympiads. The first IBO exam was held in Czechoslovakia in 1990, and to date, the exam is conducted annually. The competition has students participating across 75 countries and five continents. All participating countries send the four winners of their National Biology Olympiad to the IBO. These students are accompanied by two adults who are members of the international jury for the duration of the competition.

About the Examination

One must have heard of many olympiad exams, and IBO is also one of the prominent olympiad exams that emphasise biology. First of all, the **IBO full form** is the International Biology Olympiad. The learner who is keen on learning about anatomy and knows the biological facts of animals and plants can take this examination and pursue a career in the biology field. As we all know that biology is a vast subject with many branches such as botany, zoology, anatomy, physiology, biotechnology, ecology, immunology, genetics and microbiology. The IBO exam is a combination of all these subjects. A student with an interest and curiosity to learn in any of these branches of biology can write the exam.

Purpose of IBO

The main purpose of this olympiad exam is to inspire and empower the upcoming generation in the field of life sciences and showcase their talent on an international platform. Listed below are the few purposes of the IBO examination.

- The main motto is to respect the curiosity and eagerness shown by the candidate in the life sciences subject.
- To enrich young biologists and young scientists to develop their interest in this field.
- To bring closer connections to frame an international network of biology scientists and their talent and future biologists.
- To recognise highly gifted biology students and to promote their talents in the long run.
- To develop intercultural conversations and nations by taking biology students from around the world and develop strong bonds between the countries worldwide.
- To set up high standards in the field of education and evaluation of highly dexterous biology students.
- The Olympiad exam brings out the opportunity to compare the syllabi and educational trends of biology on a global aspect across different countries.
- To promote and boost the exchange of ideas and knowledge about life sciences.

Highlights of the examination

The International Biology Olympiad is conducted once a year. The exam is held in July of every year.

- All disciplines of biology are accepted for the IBO.
- In addition, widely oriented topics should encourage the candidates to showcase not only their knowledge and skills but also their capability to think independently and creativity towards the new research and advancements.
- The exam consists of two parts, namely the theoretical and practical parts.
- The content of the theoretical part is the main syllabus for the examination, and the practical part includes the basic skills required for the life science subject.
- There should be at least a one-day interval between the two sections of the examination.
- In a practical examination, it is taken care that no experiments are carried out that cause deterioration of the living conditions of vertebrates.

Syllabus for the Exam

The syllabus plays an important role in the preparation of any examination. A prescribed syllabus is framed for every exam. The **IBO exam** syllabus is designed in such a manner that students taking the examination from any country can study easily as per the curriculum. The syllabus includes various topics, such as cell biology, molecular biology, plant anatomy and physiology, animal anatomy and physiology, ethology, genetics and evolution, ecology, and biosystematics.

Syllabus for Theoretical Examination

The questions in the theory test are separately grouped by domains with different preference and weightage for the topics depending on the concepts.

- Cell biology has a weightage of around 20% in the examination.
- Animal anatomy & physiology has a weightage of around 25% in the examination.
- Plant anatomy & physiology has a weightage of around 15 % in the examination.
- Ethology has a weightage of around 5% in the examination.
- Genetics & evolution has a weightage of around 20% in the examination.
- Ecology has a weightage of around 10% in the examination.
- Biosystematics has a weightage of around 5% in the examination.

The column below has detailed information on the theoretical exam syllabus of the International Biology Olympiad examination.

Name of the Chapter	Name of the Topic
Cell Biology	All living organisms are made of cells. Cell biology is a branch of biology that deals with the structure, function and behaviour of cells. The topics in this lesson include: • Structure and function of cells • Microbiology • Biotechnology
Plant Anatomy and Physiology	Plant anatomy refers to the detailed structure of the parts of the plant. Plant physiology is concerned with the processes that occur within the plant that help it be alive and productive. The topics in this lesson include: • Photosynthesis, transpiration and gas exchange • Transport of water, minerals and assimilates • Growth and development, reproduction (including ferns and mosses)
Animal Anatomy and Physiology	Animal anatomy describes the science that deals with the form and structure of animals. Physiology deals with the study of functions of the body or any of its parts. The topics in this lesson include: • Digestion and nutrition • Respiration • Circulation • Excretion • Regulation (neural and hormonal) • Reproduction and development • Immunity

Ethology	Ethology is described as the scientific study of animal behaviour, usually with a focus on behaviour under natural conditions and viewing behaviour as an evolutionarily adaptive trait. The topics in this lesson include: • Methodology of ethnology • Innate and learned behavior • Communication and social organization • Foraging behaviour • Defensive behaviour • Mating systems and parental care • Biological rhythms
Genetics and Evolution	Evolution and genetics deals with the study of how genetic variation leads to evolutionary change. The topics in this lesson include: • Variation • Mendelian inheritance • Multiple allelism, recombination, sex linkage • Hardy-Weinberg principle • Mechanism of evolution
Ecology	Ecology is the study of organisms and how they interact with the environment around them. The topics in this lesson include: • Individual organisms • populations • Biotic communities • Ecosystems • Biosphere and man
Biosystematics	Biological systematics is the study of the diversification of living forms, both past and present, and the relationships among living things through time. The topics in this lesson include: • the structure and function of evolutionary and ecological relationships among typical organisms in the following groups. • Knowledge of scientific terms will not be required much. Yet, one should have knowledge of this.

Syllabus for Practical Examination

The practical examination determines the overall skills of the candidate. The practical knowledge of the subject is also given like theoretical knowledge. The column shown below has detailed information on the practical exam skills of the International Biology Olympiad examination.

Type of Skills	Name of the Topics
Science Process Skills	Science process skills are described as the ability used by scientists during their work and the competencies displayed in solving scientific problems. • Observation during the experiment • Measurement from the instruments • Grouping or classification of organisms • Determining the relationship between the given quantities • Calculation of the data obtained • Data organization and presentation: Tables, graphs, diagrams and charts, photographs • Prediction/projection • Hypothesis formulation • Operational definition: Scope, condition, assumption • Variable identification and control • Experimentation: Experimental design, experimenting, result/data recording, result in interpretation and drawing conclusions • Representing numerical results with appropriate accuracy
Basic Biological Skills	Basic biological skills are a collection of skills or tasks that demonstrate a wide range of biological concepts and processes via practical. • Observation of biological objects using magnifying glasses • Working with a microscope and handling it • Work with a stereomicroscope drawing of preparations (from a microscope, etc.) • An exact description of a biological drawing using tables of biological terms marked with a numerical code

Biological Methods	The various methods involved in determining the biological quantities. Listed below are a few methods: • Cytological methods • Methods to study plant anatomy and physiology • Techniques to study animal anatomy and physiology • Ethological methods • Ecological and environmental methods • Taxonomic methods
Physical and Chemical Methods	The various methods involved in determining the physical and chemical quantities involved in a biology experiment. Listed below are a few methods: • Separation methods such as chromatography, filtration, centrifugation • Basic standard tests for monosaccharides, polysaccharides, lipids, protein (Fehling, I2 in KI(aq), biuret) • Titration • Measuring quantities by drip and strip methods • Dilution methods • Pipetting, including the use of micropipettes microscopy, including the use of counting chambers • Determination of absorption of light • Gel electrophoresis
Microbiological Methods	Microbiology techniques are methods used for the study of microbes, including bacteria and microscopic fungi and protists. They include techniques to survey, culture, stain, identify, engineer and manipulate microbes. Listed below are a few methods: • Preparing nutrient media • Aseptic techniques (flaming and heating glass material) • Inoculation techniques
Statistical Methods	Statistical methods are mathematical formulas, models, and techniques that are used in the statistical analysis of raw research data. The use of statistical methods extracts information from research data and provides different ways to assess the robustness of research outputs. • Probability and probability distributions • Application of mean, median, percentage, variance, standard deviation, standard error, T-test, chi-square test

Handling Equipment	Handling equipment refers to the handling of mechanical equipment that is utilised in experiments. Handling includes moving, storing, controlling, and protecting products and materials throughout the cycle processes of experimenting. • Proper handling of the microscope, slides • Systematic usage of biological tools such as scissors, tongs • Handling of chemicals • Cleanliness maintained during the process of experiment