CURRICULUM OF SENIOR SECONDARY COURSE IN BIOLOGY (314)

RATIONALE

Biology arose in a twofold manner - firstly, as a practicing art towards exploring and improving a variety of usable plant and animal products as well as towards maintaining good health; secondly, as an academic pursuit out of curiosity to know about humans and other living beings and to understand their position on the planet Earth. In other words, the storehouse of knowledge about living beings started building up only when humans were curious to know about life. The course in Biology helps us to respect and appreciate the great diversity of life at all its levels of organization and to understand the impact of progress in biology on our life style.

Biology is not merely a correlational science but also an experimental discipline, which deals with different tools and techniques. In most of the activities that we perform, biology has a role to play. Therefore, the present course aims at imparting biological knowledge vis-a-vis the ever growing human needs. Besides integrating the content and adequate depth into the subject recent advancements in concepts as well as emerging areas like biotechnology and immunology have also been introduced.

OBJECTIVES

The course would enable the learner to,

- acquire knowledge of biological terms, facts, concepts, principles and processes in order to understand the living world as a whole;
- appreciate diversity in the living world as also the interrelationships of various living organisms, ecological balance in nature, and the role of biology in human welfare;
- visualize the hazards of environmental pollution, and to create awareness for sustainable use of natural resources in the service of humankind;
- develop insight into the role and impact of Biology in various allied areas such as medicine, agriculture, forestry, biotechnology, veterinary sciences and pharmacology etc.;
- develop interest in the living world with an aim to respect life.

As a part of this process, the curriculum also aims at developing the following abilities in the learners such as to –

- apply knowledge and understanding of biology in situations which are novel and unfamiliar by developing abilities to analyze, hypothesize, extrapolate draw conclusions and predict results;
- develop skills in handling and improvising scientific apparatus, and recording observations and data;
- inculcate scientific attitude and practice it in day to day life.

COURSE STRUCTURE

The present curriculum contains 5 modules. These modules are compulsory for all learners, thus, each learner studies five modules in all. Each module has been divided further into units and then into lessons. The number of lessons, suggested study time and marks allotted for each unit are as follows:

Unit wise Distribution of Core Modules	Marks	Minimum Study Time (hours)
Module 1 : Diversity and Evolution of Life	12	50
Module 2: Forms and Functions of Plants and Animals	26	70
Module 3: Reproduction and Heredity	22	60
Module 4: Environment and Health	13	50
Module 5: Emerging Areas in Biology	7	10
	80	**240 hrs**

COURSE DESCRIPTION

Introduction to Biology (Non-Evaluative)

Biology and its branches, relationship with other sciences, scientific methodology, historical breakthroughs, recent advancements and careers in biology.

Module 1 Diversity and Evolution of Life

Time: 50 hr **Marks : 12**

Approach

This module would enable the learner to visualize the origin of life on earth and the vast diversity in the living world, and also to group them together at various classification levels. It also intends to stimulate our learner to understand the concepts and theories of evolution. The module also highlights the cell as the basic unit of life and its organization into various forms of tissues.

Unit 1 Evolution and Classification of Organisms

Time: 30 hr **Marks: 8**

1.1.1 Origin and Evolution of Life and Introduction to Classification

Characteristics of life, origin of life, spontaneous generation, Oparin-Haldane theory, Stanley Miller's experiment, organic evolution, evidence of evolution, sources of variation, natural selection, isolation and speciation. Hardy-Weinberg Equilibrium

Need for classification of organisms, principles of classification and taxonomic categories, Linnaeus and binomial nomenclature, position of virus, characteristics, structure and habit of virus, infective properties of viruses (general account of TMV, Polio, HIV, Influenza virus, Bacteriaphage) Viroids.

Scheme of five kingdom classification, merits and demerits of five-kingdom classification.

1.1.2 Kingdoms Monera, Protoctista and Fungi

Kingdom Monera - General structure and characteristics of bacteria and cyanobacteria with examples.

Kingdom Protoctista - General structure and

characteristics of protozoa and algae with common examples.

Kingdom Fungi - General characteristics of fungi with common examples.

1.1.3 Kingdoms Plantae and Animalia

Classification and characteristics of Plantae up to division - Algae, Bryophyta, Pteridophyta, Spermatophyta, classification of Spermatophyta upto classes - Gymnospermae and Angiospermae, Dicotyledonae (Malvaceae and Fabaceae) and Monocotyledonae (Poaceae and Liliaceae).

Classification and characteristics of Kingdom Animalia upto phyla - Porifera, Cnidaria, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata, Hemichordata, Chordata, Classification of Arthropoda and Chordata upto classes, class Mammalia upto major orders.

Unit 2. Cell and Tissues

Times 20 hr **Marks: 4**

1.2.1 Cell - the basic unit of life

Cell - Cell theory, prokaryotic and eukaryotic cells, animal and plant cells.

Cell organization - plasma membrane, cell wall, cytoskeleton, endoplasmic reticulum, cilia and flagella, nucleus, ribosomes, mitochondria, chloroplasts, golgi bodies, centrosome, peroxisomes, cell inclusions.

Cell molecules - water, mineral ions, carbohydrates, lipids, amino acids, proteins, nucleotides, nucleic acids, enzymes, vitamins, hormones, steroids and alkaloids.

Cell cycle - significance of mitosis and meiosis, karyotype analysis.

1.2.2 Tissues

Plant Tissues - classification, structure and functions of meristematic and differentiated tissues.

Animal tissues - structure and functions of epithelial, connective, muscular and nervous tissues.

Module 2 Form and Functions of Plants and Animals

Time : 70 hr **Marks : 26**

Approach

This module highlights the complex nature of the structure and function of the different organ systems in plants and animals with special emphasis on the life processes.

Unit 1. Plants - Morphology and Physiology

Time : 35 hr **Marks: 12**

2.1.1 Root System

Characteristics and regions of root, primary structure of dicot and monocot roots, secondary growth in dicot roots, types and modifications of roots, common functions of roots.

2.1.2 Shoot System

Characteristics of stem, structure of monocot and dicot stems, difference between dicot and monocot stem, secondary growth in stem: wood, origin of lateral branches, types and modification of stem, functions of stem.

Structure and modifications of leaf, internal structure of a typical dicot and monocot leaf, stomata, hair and hydathodes, phyllotaxy.

Flower - Parts of flower, arrangement of various floral parts, placentation, inflorescence, major types of inflorescence.

Fruit - Definition, structure, major categories, edible parts of common fruits.

2.1.3 Absorption, Transport and Water Loss

Water relation - permeability, diffusion, osmosis, plasmolysis, active and passive absorption and movement, imbibition, water potential, Transpiration - The process and its significance, factors affecting rate of transpiration, opening and closing mechanism of stomata (potassium ion theory), factors affecting stomatal movements, guttation and factors affecting rate of guttation, translocation of solutes.

2.1.4 Plant Nutrition

Mineral nutrition, functions of minerals (aeroponics and hydroponics), macro and micro nutrients, deficiency symptoms of elements, mode of nutrition in plants - autotrophic, heterotrophic, saprophytic, parasitic and insectivorous plants.

2.1.5 Nitrogen Metabolism

Molecular nitrogen, nitrogen fixation (biological and abiological both), nitrogen fixation by free living organisms and symbiotic nitrogen fixation, nitrate and ammonia assimilation by plants, amino acid synthesis by plants. Nitrogen cycle

2.1.6 Photosynthesis

The process and its significance, site of photosynthesis (functional aspect of chloroplast structure), photosynthetic pigments photo-chemical aspects of photosynthesis, photo-phosphorylation (cyclic and non-cyclic), C3 and C4 pathways, factors affecting photosynthesis, chemosynthesis, Chemiosmotic synthesis.

2.1.6 Respiration

Aerobic and anaerobic respiration, respiratory quotient, glycolysis, Krebs cycle, pentose phosphate pathway, factors affecting respiration (excluding biochemical pathways), fermentation, photorespiration, Amphibolic Pathway.

Unit 2. Animals -Morphology and Physiology

Time: 35 hr **Marks: 14**

2.2.1 Nutrition and Digestion

Nutrition and its types, digestive system of invertebrate (Cockroach), digestive system and process in humans (ingestion, digestion, absorption, assimilation, egestion), intracellular and intercellular digestion, role of enzymes and hormones in digestion.

Some of the digestive disorders are vomiting, diarrhoea, constipation, Indigestion and jaundice

2.2.2 Locomotion and Movement

Movement and Locomotion, types of movements for locomotion, flagellar movement. Muscular movement in animals structure of muscle, myofilaments, the sliding of muscle contractions, stimulation of muscle contraction.

2.2.3 Respiration and Nitrogenous Waste Elimination

Respiratory organs of humans, mechanism of breathing and its regulation, gaseous transport through blood and tissue respiration, gaseous exchange in animals (earthworm/cockroach), common respiratory disorders - prevention and cure.

Ammnotelism, ureotelism, uricotelism, urinary system in cockroach and humans, finer structure of mammalian kidney, ultrafiltration and urine formation, role of kidney in osmoregulation,

kidney failure, dialysis, kidney transplantation, role of Antidiuretic Hormones (ADH), role of liver in excretion.Emphysema, Renin-angiotensin and Atrial Antinatriuretic factor.

2.2.4 Circulation of Body Fluids

Types of blood circulation, open circulatory system in cockroach, circulatory organs in humans, blood circulation, histology and functions of blood, blood coagulation, blood transfusion, blood groups, blood pressure, lymph and lymph glands, spleen, immune system (basic idea of immunocytes and immunity), blood related disorders - hypertension, atheroma and arteriosclerosis, ECG, pacemaker.

2.2.5 Coordination and Control

Central and Peripheral Nervous System in humans, structure and function of brain and spinal cord, transmission of nerve impulse, reflex action, sensory receptors, sense organs - structure and functions.

Endocrine glands, nature and role of hormones, an elementary knowledge of pheromones, hormonal imbalance and diseases, role of hormones as messengers and regulators - hypothalamo-hypophyseal axis, feed-back mechanism.

The skeletal system, types of skeleton, human skeleton muscular and skeletal disorders, movement in plants

Nervous system in animals, central nervous system peripheral nervous system sympathetic nervous system

2.2.6 Homeostasis

Concept, regulation of body fluids, feedback mechanism - positive and negative, thermoregulation including skin.

Module 3: Reproduction and Heredity

Time : 60 hr **Marks: 22**

Approach

This module is designed to highlight the diverse methods of reproduction in living beings from unicellular organisms to complex forms including humans. This module highlights the increase in human population all over the world and also provides adequate information about the methods of family planning and birth control. The principles and mechanisms of heredity in determining the characteristics of organism has also been discussed in this module.

Unit 1. Reproduction, Growth and Development

Time : 30 hr **Marks: 12**

3.1.1 Reproduction in Plants

Vegetative, asexual and sexual reproduction in lower plants (general account), Apomixis reproduction in flowering plants - juvenility, flowering, factor affecting flowering (photoperiodism), flower as a reproductive organ, development of gametes in flowering plants, polyembryony pollination - types and agencies, adaptation to promote cross pollination, fertilization and seed formation, seed - structure of dicot and monocot seeds, seed germination, parthenocarpy.

Natural and artificial vegetative propagation, advantages and disadvantages of vegetative propagation, micropropagation, advantages of micropropagation.

3.1.2 Growth and Development in Plants

Definition of growth and development, growth curve, growth regulators (phytohormones) -

Auxins, gibberellins, cytokinins, ethylene, abscissic acid; seed germination - mechanism and factors affecting germination, role of growth regulators in seed dormancy, vernalisation, senescence, abscission, stress factors (salt and water), measurement of growth, plant movements - geotropism, phototropism, turgor growth movements (tropic, nastic and turgor), phytohormones and their role in plant development. Differentiation, dedifferentiation

3.1.3 Reproduction in Humans and Population Management

Female and male reproductive organs, histology of gonads, gametogenesis, fertilization, cleavage, blastulation, gastrulation, fate of germ layer (general account only), embryonic development and nutrition, childbirth, twins, growth, ageing and senescence, death, in-vitro fertilization.

Demography - birth rate, death rate and population growth rate, position of India in world population, consequences of overpopulation management of population growth, methods of contraception. Lactation, gemmule, Reproductive system of insects, male reproductive system, female reproductive system

Unit 2. Principles and Applications of Genetics

Time: 30 hr **Marks:10**

3.2.1 Principles of Genetics

Heredity and variation, Mendel's laws of inheritance, incomplete dominance, lethal genes, pleiotropic genes, polygenic inheritance with examples, chromosomal basis of inheritance, linkage and crossing over, cris-cross inheritance, maternal inheritance. Sex Determination in Birds, Sex Determination in Honey Bees.

Human karyotypes, autosome and sex chromosomes, abnormalities due to multiple sets of genome - colour blindness, haemophilia, Down syndrome (Mongolism), Turner syndrome, Klinefelter syndrome, Rh factor, ABO blood group, amniocentesis, human genome.

3.2.2 Molecular Inheritance and Gene Expression

One-gene-one enzyme hypothesis, discovery of DNA as genetic material, structure of DNA and RNA, types of RNA, functions of nucleic acids, DNA replication, protein synthesis, transcription and translation, house keeping genes, regulation of gene expression, positive and negative control systems, Operon model, mutations and their types, mutagens, useful and harmful effects of mutation.

3.2.3 Genetics and Society

Genetics through ages, recombinant DNA technology, gene cloning, gene bank, Polymerase Chain Reaction, DNA fingerprinting, genomics, genetic engineering and its importance, transgenic plants, animals and microbes, genetic counselling. Bt crops, Biopiracy, Biopatent

Module 4 Environment and Health

Time: 50 hr **Marks: 13**

Approach

This module emphasizes the basic understanding of rules governing the interrelationships in a biotic community. It brings out the basic principle of conservation by pointing out that conservation of natural resources would brighten the prospect of future of humankind. This module aims to create an idea about healthy living. It also imparts knowledge regarding role of proper and balanced diet to prevent nutritional deficiency diseases. The types, causes and modes of transmission of human diseases are discussed

in this module. This module also intends to make the learner understand various emerging areas in biology.

Unit 1. Environment and its Conservation

Time: 25 hr **Marks : 7**

4.1.1 Ecological Principles

Biotic and abiotic factors in ecosystem, interrelationship between plants and animals, energy flow in the biosphere, food chain, food web, man's place in the environment, biomes, flora and fauna of different biomes.

4.1.2 Conservation and use of Natural Resources

Population growth, Ecological succession biotic interaction

Types of natural resources – non-renewable and renewable with examples, need for conservation and restoration, Indian traditions of conservation of nature, conservation of soil, water and biodiversity, endangered and threatened species, wildlife reserves in India, agencies (national and international) dealing with conservation of wildlife, environmental legislation, sustainable development, conventional and non-conventional sources of energy (hydel, wind, tidal, nuclear, solar, geothermal, hydrogen energy, biogas and bio fuels), depleting energy resources, conservation of energy.

- Our Biodiversity Richness
- Non-conventional Sources of Energy

4.1.3 Pollution

Causes, prevention and control of different kinds of pollution, (air, water, thermal, soil, noise and radiation), entry and translocation of pollutants in our body, waste management.

Unit 2. Healthy Living

Time: 25 hr **Marks: 6**

4.2.1 Nutrition and Health

Health and nutrition, types of nutrients - macro and micronutrients, sources and functions of carbohydrates, fats, proteins, vitamins, minerals, water and roughage; energy requirement of the body, balanced diet, balanced diet for special needs growing children, persons in different occupations, pregnant and lactating mothers, deficiency diseases - Protein Energy Malnutrition (PEM), mineral deficiency and vitamin deficiency with examples - hypervitaminosis, obesity, food-fads.

4.2.2 Diseases

Definition, types and transmission of diseases, define - parasite, pathogens, infection, infestation, vector; causes, symptoms, prevention and control of some common communicable diseases - influenza, measles, polio, hepatitis, tuberculosis, diphtheria, leprosy, malaria, filariasis and dengue; cardiovascular diseases - diabetes, osteoporosis, cancer, allergy, syphilis, gonorrhea and AIDS (awareness, symptoms and prevention), drug abuse.

Module 5 Emerging areas in Biology

Time: 10 hr **Marks: 7**

Approach

This module has been included in the Biology course to familiarize the learners with the importance of the new emerging areas of biology like Biotechnology and Immunology which have an impact on human lifestyles.

5.1.1 Biotechnology

Introduction, industrial biotechnology (alcohol, beverages, yoghurt, cheese, vinegar, antibiotics),

general idea of genetic engineering, importance of transgenic organisms, gene therapy, bioremediation, biopesticides.

5.1.2 Immunology

Types of defense mechanisms of body, cells of immune system (T-cells, B-cells, macrophages), antigens and antibodies humoral and cell mediated immune response, types of immunity, immunization.

PRACTICAL WORK

Purpose

The purpose of teaching biology is not only to acquaint the learners with biological terms, facts, concepts and principles but also to develop practical skills. Development of practical skills leads to better understanding through firsthand experience and mutual reinforcement. It takes into account the development of psychomotor skills. Since this is an import aspect of development, the present biology course considers practical work as an integral part of the theory.

The skills which the present course intends to develop are:

(i) observational skills in the form of identifying relevant details in given specimens, locating the desired parts in a dissection or specimen.

(ii) manipulative skills in the form of arranging, handling and reading apparatus and instruments.

(iii) collecting, mounting and preserving skills.

(iv) drawing, labelling and reporting experimental results thereby interpreting them.

List of Practicals

1. To study parts of a compound microscope.
2. To prepare temporary stained glycerine mounts of
   (i) epidermal peel of onion
   (ii) cheek cells of humans
   (iii) epidermal peel of leaf to observe stomata
   (iv) T.S. of stem to observe xylem and phloem
   (v) striated muscles from cockroach leg.
3. To study the various modifications in root, stem and leaf
   (a) Root (i) Storage (carrot beet root/ radish) (ii) Support -Prop root, stilt root
   (b) Stem (i) Underground - Rhizome, tuber, corm, bulb (ii) Aerial - Tendril, thorn, phylloclade, cladode
   (c) Leaf (i) Tendril (ii) Spine (iii) Phyllode
4. To observe and study the T.S. of dicot and monocot root and stem from permanent slides.
5. To study the microscopic structure of human cartilage, bone, blood, testis and ovary from permanent slides.
6. To study the structure and function of different parts of the following flowers : China rose, Petunia
7. To identify the characteristic features of the following animals and classify upto class sponge, earthworm, butterfly, snail, starfish, bony fish, cartileginous fish, toad, houselizard, pigeon and bat.
8. To study the stages of mitosis from temporary stained mount of onion root tips.
9. To study the morphological adaptations of (a) plants living in xeric and aquatic habitats e.g. cactus and water hyacinth. (b) animals to parasitic mode of life e.g. tapeworm.
10. To study the (a) texture and (b) water holding capacity of two different types of soils.

11. To study osmosis by potato osmometer.
12. To study the rate of photosynthesis in aquatic plants.
13. To study the structure and germination in gram and bean seeds.
14. To demonstrate respiration in germinating seeds.
15. To study the action of salivary amylase on starch.

SCHEME OF STUDY

The revised course in Biology provides you with package of learning opportunities which comprise of:

- Printed Self Learning Material (SLM) is in three parts i.e. Part-1 , Part-2 and a laboratory manual.
- Supplementary Materials in the form of Audio and Video Programmes.
- Video tutorials in Chemistry available on the NIOS website (www.nios.ac.in) as well as YouTube.
- 30 Personal Contact Programme (PCP) sessions for theory part and 06 Personal Contact Programme (PCP) sessions for practicals at your study centre. Please contact your study centre for the PCP schedule or visit our NIOS website at www.nios.ac.in.
- Face-to-Face Personal Contact Programme (PCP) at your study centre, live Personal Contact Programmes (PCPs) through audio streaming are webcast on Mukta Vidya Vani, which can be accessed through NIOS website (www.nios.ac.in).

SCHEME OF EVALUATION

The learner will be assessed through Continuous and Comprehensive Evaluation (CCE) in the form of Tutor Marked Assignment (TMA) as well as Public Examination. The following table shows the details:

Mode of Evaluation	Syllabus/Contents	Duration	Weightage
Tutor Marked Assignment (TMA)	All Contents assigned for TMA	Self Paced	20%
Public/Final Examination	All Contents assigned for PE and Practical Examination	3 Hours	80%

PRACTICAL EXAMINATION

There will be a practical examination of 3 hours duration and maximum marks 20, apart from the theoretical examination. The distribution of marks is as follows

(i)	Performing an experiment	4	marks
(ii)	Submitting a project	2	marks
(iii)	Identification of given samples (4 samples)	2	marks
(iv)	Preparing mounts	2	marks
(v)	Maintenance of record book	3	marks
(vi)	Viva-voce	2	marks
	Total	15	marks + 5 marks for CCE
	Total	20	marks