



SOPHIA COLLEGE

(AUTONOMOUS)

Affiliated to the University of Mumbai

Syllabus for Semesters III to IV

Program : B.Sc.

Course: Life Sciences

(Choice Based Credit System with effect from the year 2018-19)

PREAMBLE Programme:

B.Sc.

Course: Life Sciences (SBSLSC)

(Semester–V&VI)

As mentioned in the outline of the syllabus, all the 08 courses of theory and Practical (Semester V and VI together) are compulsory to the students offering Life Sciences as a Single Major Subject.

These courses are:

1. SBSLSC501and SBSLSC601
2. SBSLSC502and SBSLSC602
3. SBSLSC503and SBSLSC603
4. SBSLSC504and SBSLSC604

However, the students opting for Double Major Subject shall have following 04 courses of theory and Practical (Semester V and VI) compulsory:

1. SBSLSC501and SBSLSC601
2. SBSLSC502and SBSLSC602

Life Sciences Syllabus
Choice based Credit and Grading System
Academic year 2018-2019

SEMESTER V

COURSE CODE	UNIT	TOPIC HEADINGS	CREDITS	LECTURES
Paper I	Genetics and Immunology I			
SBSLSC501	1	The Genetic material	2.5	15
	2	Mechanisms of Inheritance and variation		15
	3	Overview and cells and organs of immune system		15
	4	Antigen recognition and Effector Mechanisms		15
SBSLSCP501		Practical	1.5	
Paper II	Developmental Biology and Neurobiology I			
SBSLSC502	1	Developmental biology: concepts, model organisms and techniques	2.5	15
	2	Animal and plant development – basic cellular aspects		15
	3	General organization of nervous system		15
	4	Cellular organization of the nervous system		15
SBSLSCP502		Practical	1.5	
Paper III	Biotechnology and Genetic Engineering I			
SBSLSC503	1	Fermentation technology – Principles	2.5	15
	2	Fermentation technology - Food and Beverage Production		15
	3	Tools in Recombinant DNA technology		15
	4	Techniques in Recombinant DNA technology and applications		15
SBSLSCP503		Practical	1.5	
Paper IV	Environmental Biology I			
SMSLSC504	1	Introduction to fundamentals of Environmental science	2.5	15
	2	Biodiversity and habitats		15
	3	Pest management and toxicology		15
	4	Sustainable development		15
SMSLSCP504		Practical	1.5	

SEMESTER II

COURSE CODE	UNIT	TOPIC HEADINGS	CREDITS	LECTURES
Paper I		Genetics and Immunology II		
SMSLSC601	1	Organisms and techniques used in the understanding of Genetics	2.5	15
	2	Tools and Techniques in Molecular Genetic		15
	3	Hypersensitivity, Infectious diseases, Vaccines and Immunodeficiency		15
	4	Transplantation, Tumour Immunology, Tolerance and Autoimmunity		15
SMSLSCP601		Practical	1.5	
Paper II		Developmental Biology and Neurobiology I		
SMSLSC602	1	Animal and plant development – basic cellular and molecular aspects	2.5	15
	2	Applications of developmental biology		15
	3	Sensory and motor systems		15
	4	Neurobiological basis of behaviour		15
SMSLSCP602		Practical	1.5	
Paper III		Biotechnology and Genetic Engineering II		
SMSLSC603	1	Fermentation technology – Enzyme and Pharmaceuticals Production	2.5	15
	2	Tissue Culture biotechnology		15
	3	Applications of recombinant DNA technology		15
	4	Tools in genetic engineering Bioinformatics Bioinformatics: Structural and functional Genomics, Comparative Genomics		15
SMSLSCP603		Practical	1.5	
Paper IV		Environmental Biology II		
SMSLSC604	1	Environmental degradation	2.5	15
	2	Natural resources		15
	3	Environmental impact study		15
	4	Society and environment		15
SMSLSCP604		Practical	1.5	

SEMESTER V

SBSLSC501: Genetics I: The course is designed to give students understanding of basic principles of Genetics. Brief History of Genetics, Organization of Genome and ways in which gene expression is regulated is covered in first unit. The next unit deals with genes are inherited, and how variation is introduced in the genome.

Course Code	Title	No.of Lectures
SBSLSC501	Genetics I	(60L)
Unit I: The Genetic material:		(15L)
Discovery of the genetic: Griffith's experiment of 1928; Avery, McLeod and McCarty's experiment of 1944; Hershey-Chase's experiment – (Brief review, only for short notes.)		02
1. Organization of Eukaryotic and Prokaryotic Genome :		
1.1 Structural organization of Prokaryotic and Eukaryotic genome (CCC DNA, Nucleosome structure, higher orders of chromosome packaging, Solenoid model, zig-zag model)		03
1.2 Sequence complexity of DNA - Unique and repetitive sequences (SINE, LINE, Microsatellite, mini satellite DNA), Denaturation kinetics and „CoT“ value and interpretation of Cot curves; „C value paradox“;		03
2. Gene regulation in eukaryotes		
2.1 Chromatin condensation (Euchromatin, heterochromatin)		
2.2 Modification and remodelling by acetylation and methylation		03
2.3 Transcriptional regulation		
Cis-acting regulatory sequences, promoters and enhancers.		
Transcription activators and repressors		04
Unit II: 1.2 Mechanisms of Inheritance and variation		(15L)
1. Inheritance pattern of Genetic Disorders in Humans (Prognosis, Testing, of any human genetic disorder)		02
2. Introduction to genetic recombination		
2.1 Types of naturally occurring genetic recombination. (e.g Homologous/Non homologous/site directed)		02
2.2 Mechanism and proposed models for genetic recombination (e.g Holliday Model/Double strand break model)		02
2.3 Advantages of genetic recombination during meiosis		02
3. Mutational Variation:		
3.1 Natural biological mutagenic agents – Prokaryotic Transposable elements and their significance		02
3.2. A. Types of eukaryotic transposons , their mechanism of action,(e.gAcDs system in maize,P element transposition) and inheritance		04
3.2.B. Application of transposable elements in genetics		01

SBSLSC501: Immunology I: This course of Immunology is formulated to provide good knowledge of the immune system, its response and involvement in health and disease. While immunology as a science has been defined as the “science of self/non self discrimination”, it also includes our innate ability to defend against microorganisms (Innate Immunity); and its ability to recognize and respond to fight the infections through Acquired Immunity. Specific topics being covered include antigens and antibodies, antigen-antibody interactions, antibody structure and formation, Effector responses etc.

Course Code	Title	No.of Lectures
SBSLSC501	Immunology I	(60L)
UNIT – III Overview and cells and organs of immune system		(15L)
3.1. Historical Perspective - Early Vaccination studies; Infection and immunity		01
Overview of the Immune system - Innate Vs Adaptive Immunity		
3.1.a Innate immunity		
i) Anatomical, Physiological, Phagocytic, Inflammatory barrier		02
iii) Concept of PAMP, PRR and TLR		
3.1.b Cells and organs of the immune system		03
i) Cells - structure and functions		
Myeloid cells -		
Lymphoid cells – B and T cells, NK cells		
ii) Primary and secondary lymphoid organs		
3.2 Antigens and antibodies		01
3.2.a.Immunogenicity versus antigenicity		
i) Antigen-Specificity, avidity, affinity, cross reactivity, haptens, adjuvants, epitopes		
ii) Properties of immunogen contributing to immunogenicity		
3.2.b Antibodies ⁰² i) Basic structure of antibodies		
ii) Classes of antibodies and biological activity		
iii) Polyclonal antibodies		
3.2 c. Organization and expression of Immunoglobulin genes		03
i) Multigene organization and gene rearrangement		
ii) Generation of antibody diversity (Brief description)		
iii) class switching		
3.2 d. Antigen-antibody interactions – Principles and applications		03
Precipitation, Immunoelectrophoresis, Agglutination, Radioimmunoassay, ELISA, Immunofluorescence, Monoclonal antibodies (Hybridoma Technique)		

(15L)

UNIT – IV Antigen recognition and Effector Mechanisms	
4.1 Recognition of antigens.	
4.1.a Major Histocompatibility Complex	02
i) MHC molecules and genes	
ii) MHC allelic polymorphism	
iii) Cellular expression of MHC	
iv) Self MHC restriction of T cells	
4.1 b Antigen processing and presentation	02
i) Endogenous antigens – the cytosolic pathway	
ii) Exogenous antigens – the endocytic pathway	
4.2 Maturation and activation of Lymphocytes	
4.2.a B- cell Maturation, Activation and Differentiation	02
4.2.b i) T- cell receptor – Structure and role of $\alpha\beta$ and $\gamma\delta$ receptors	01
ii) T cell receptor complex and accessory membrane molecules	
4.2.c T- cell Maturation, Activation and Differentiation	02
4.3 Immune Effector Mechanisms	
4.3.a Cytokines - IL-1, IL-2, IL-4, IFNs and TNFs	
ii) Cytokine secretion by T_H1 and T_H2 cells	01
4.3.b Complement	02
i) Classical, alternate and lectin pathways and comparison	
ii) Biological consequences of complement activation	
iii) Complement fixation tests	
4.3.c Cell-mediated effector responses	
Cell-mediated cytotoxicity of T cells, NK cells, ADCC	03
Role of T_H1 , T_H2 , T_H17 and T_c cells	

SBSLSC502: Developmental Biology I: The course will introduce to the students the basic concepts of developmental biology, which is the process by which animals and plants grow from a single original zygote. This module describes the important model systems and technique used to understand developmental process. The early process of animal development will be explained using the amphibian and chick as examples and plant development using Arabidopsis.

Course Code	Title	Lectures
SBSLSC 502	DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY I	2.5 Credits (60 Lectures)
UNIT 1 : Developmental Biology : Concepts, Model organisms and techniques		15 Lectures
1.1	History of concepts in development	1 lecture
1.2	Some basic concepts of developmental biology: Overview: Development is a gradual process by which a complex multicellular organism arises from a single cell (the zygote). It involves 5 major overlapping processes: 1. Growth: increase in size 2. cell division: increase in number 3. differentiation: diversification of cell types 4. pattern formation: organization 5. morphogenesis: generation of shapes and structures	2 lectures
1.3	Life Histories of Model Organisms highlighting some important concepts: <i>Dictyostelium</i> - cell signalling and morphogenetic gradient <i>Drosophila</i> : Overview of invertebrate body plan (Life Cycle and body plan) Zebrafish :Overview of vertebrate body plan (Life Cycle and body plan)	6 lectures
1.4	Experimental approaches to studying development: Fate mapping and lineage tracing (Chick) Mutations and large scale mutagenesis screens (<i>Drosophila</i>) Transgenic techniques and gene silencing (Zebra fish/ mice)	6 lectures
Unit 2: Animal and Plant development – Basic Cellular aspects		15 lectures
2.1	Development in Animals :-	
2.1 a	Amphibian development- Germ cell formation : meiosis and cytoplasmic state of the egg; Fertilization : Cell signalling and Factors affecting fertilisation; Cleavage, Morula and blastula: Concept of potency and regulatory development; Gastrulation : Spemann's Organizer; Three germ layers and origins of organs; Neural tube Induction and formation of neural tube	5 lectures
2.1 b	Chick development – In Comparison with amphibian in the processes of Germ cells and Fertilization, Cleavage, Morula and blastula,	5 lectures

2.2	Gastrulation and Neurulation Development in Plants :- Life cycle of Arabidopsis – sporophytic and gametophytic generation, Fertilization and embryo development, Development of meristems (root and shoot), Development of different organs – leaf, flower, androecium [including development of anthers, pollen grain, pollen tube etc.] and gynoecium [development of pistil - up to formation of embryo sac], Double fertilization, seed formation. [Eventual formation of fruit],	5 lectures

SBSLSC502:Neurobiology I:This module describes the anatomical organization of the nervous system and its early development. It also explains the cellular basis of nerve conduction within a neuron and transmission across synapses including a description of the neurotransmitters

UNIT 3 :General organization of nervous system:		15 Lectures
3.1.	Comparative overview ofvertebrate and invertebrate nervous system	2 lectures
3.1.b	Vertebrate nervous system:- Anatomy and functional features of CNS (cerebral hemispheres, cerebellum, diencephalon, medulla, pons, midbrain and spinal cord), PNS (autonomous, somatosensory, cranial, spinal, plexii)	5 lectures
3.1.c	Role of meninges and CSF, concept of blood brain barrier.	1 lecture
3.1.d	Limbic System (emotions and memory)	1 lecture
3.1.e	Hypothalamo – Hypophysial Axis (stress)	1 lecture
3.2	Development of the nervous system:	
3.2.a	Specification of cell identity in the nervous system	2 lectures
3.2.b	The formation and migration of neuron	1 lecture
3.2.c	Axon navigation	1 lecture
3.2.d	Synapse formation and refinement	1 lecture
UNIT 4: Cellular organization of the nervous system		15 lectures
4.1	Typical nerve cell, Types of cells: Neurones, Glial cells	1 lecture

4.2	Chemical Basis of Neural transmission- Introduction Ionic basis of resting membrane potential: types of ion channels, Nernst's potential, Goldman's equation, Sodium –Potassium pump	3 lectures
4.3	Action Potential & propagation: Hodgkin and Huxley's model, voltage clamp experiment and the generation and propagation of Action Potential, Graded potential	3 lectures
4.4	Synaptic potential and synaptic integration [Electrical and Chemical Synaptic Potential] Excitatory Post Synaptic Potential (EPSP), Inhibitory Post Synaptic Potential (IPSP)	2 lectures
4.5	Synapse and synaptic transmission: Synapse: Structure, Types – Electrical and chemical; Neuro – muscular junctions; miniature endplate potentials (MEPPs)	2 lectures
4.6	Neurotransmitters – General Introduction Biosynthesis, physiological role, pharmacological significance, (examples of one agonist and one antagonist for each neurotransmitter mentioned below. Acetylcholine (Nicotinic and muscarinic receptors). Dopamine (D1 and D2 receptors). GABA and Glutamate Neuropeptide (Endorphin and Enkephalin).	4 lectures

SBSLSC503: Biotechnology I: The course is designed to make students familiar with basics of fermentation techniques. Students will learn how food and beverages are produced at Industrial scale using fermentation.

Course Code	Title	No. of Lectures
SBSLSC503	Biotechnology and Genetic Engineering	2.5 credits 60
UNIT I: Fermentation technology – Principles		15
1.1. History and development of Food & Fermentation Technology		01
1.2. Fermentation technology & Instrumentation		01
1.3.a. Principles of microbial growth,		01
1.3.b. Screening (primary & secondary)		01
1.3.c. Strain improvement (mutation & selection using auxotrophy & analogue resistance		02
1.4. The Bioreactor / Fermenter & accessories (Stirred tank & Airlift)		02
1.5. Media design for fermentation (include molasses, corn steep liquor)		02

1.6. Downstream processing (use example of Penicillin and an enzyme for cell disruption)	01
1.7. Instrumentation: Principles and technique of Centrifugation, Spectrophotometry & Chromatography	04
UNIT II: Fermentation technology - Food and Beverage Production	15
2.1. Batch vs. Continuous fermentation	02
2.2. Technological aspects of industrial production of:	
2.2.a. Cheese	02
2.2.b. Beer	02
2.2.c. Vinegar	01
2.2.d. Single Cell Protein	01
2.2.e. Mushroom	02
2.2.f. Yoghurt	01
2.2.g. Wine	01
2.3. Food quality assurance: Regulatory & social aspects of food biotechnology	02
2.4. IPR and patents (Example, Organism, technology)	01

SBSLSC503: Genetic Engineering

I: This course is structured to make students understand basic tools utilized in Recombinant DNA technology. Students will be familiar with various enzymes, vectors, and analytical techniques that are fundamental to understanding of genetic engineering. Students should be able to plan cloning strategy of gene of interest by end of this course.

UNIT III: Tools in Recombinant DNA technology	15
3.1: Tools in Molecular Biology	
3.1.a. Restriction Enzymes – Nomenclature, General nature of action, Major categories based on type of cut, two typical examples each and recognition sites	03
3.2.b.DNA joining strategies: DNA ligase, Homopolymer tailing, Adaptors, Linkers, Use of Alkaline Phosphatase.	02
3.2 Vectors in genetic engineering –	
3.2.a. Phages (λ , M13, SV40, Adenovirus)	04
3.2.b. Plasmids (pBR322, pUC with blue white screening), Ti plasmids in plants	03
3.2.c. Cosmids, Phagemids	01
3.2.d. YAC, BAC, PAC	02
Unit IV: Techniques in Recombinant DNA technology and applications	15
4.1. Gel electrophoresis (Principle, technique and application of Agarose, PAGE, 2D-GE)	03
4.2. Blotting (Principle, technique and application of Western, Southern, Northern blotting)	03
4.3.a.PCR	01
4.3.b. Variations of PCR – RT-PCR, QPCR (Principle, technique and application)	01
4.3.c. Variations in Primer – Nested PCR, Poison Primer Technique, Universal primers	01
4.4. Restriction mapping, DNA fingerprinting (Principle,technique, applications) - SNP, VNTR, RFLP, AFLP	04
4.5. Cloning of a gene (Somatostatin)	02

SBSLSC504: ENVIRONMENTALBIOLOGY1: This syllabus is designed to understand the environment around us. It introduces the fundamental concepts of environment and the biodiversity around us. The students will understand different features of a habitat, also the problems associated with their management and conservation. The issues and problems regarding the natural resources is featured along with detailed coverage on sustainability.

CourseCode	Title	Lectures
SBSLSC504	ENVIRONMENTALBIOLOGY1	2.5Credits (60 Lectures)
Unit I Introduction to Fundamentals of environmental science		15 Lectures
1.1.Environmental History and Naturalresources: Definition, Scope and Importance		1lectures
1.1.a. Environmental History: Historical Modes of Resource Use: a) Gathering, b) Nomadic c) Settled cultivation d) Industry Controlled exploitation of natural resources: A case study of British India- timber/coal mining		2Lectures
1.1.b. Community Ecology: Concept of community (E.g. Forest as a community) Species Interaction, Prey Predator interaction. Food chain, Food web and Higher order interactions: Succession seral communities in secondary succession, redistribution of population after land fragmentation, loss of species (fire and succession).		3Lectures
1.1.c. Population ecology: Population parameters- Spacing, size and density, Age composition, Survivorship curves, recruitment, Population growth- logistic, exponential, Geometric growth.		1lectures
Population cycles, population dynamics and models of population regulation- Competition and predation		3Lectures
Natality, Mortality, Biotic potential, Carrying capacity, density dependence, regulation. Improving carrying capacity and its application in wildlife management. Invasive species: example: <i>Lantana camara</i> / <i>Prosopis julifera</i>		1Lectures
1.2. Ecosystem dynamics:		
1.2.a. Energy flow, primary and secondary productivity, Ecological Pyramids.		1lectures
1.2.b. Soil Ecology: Soil Profile, Soil food web (components and interactions) sustainable soil management and agriculture.		1lectures
1.2.c. Anthropogenic effects on Biogeochemical cycles of Carbon and Nutrient cycles (S, P and N).		

UNIT II	15 Lectures
2.1. Biodiversity and Habitats:	1 Lecture
2.1.a. Biomes of the world: climate, vegetation and Geographical distribution pattern. Tropical biomes, desert, temperate, taiga and tundra biome.	1 Lecture
2.1.b. Biological diversity of India: Indian Biogeographic Zones, climate and its impact on biodiversity.	
2.2. Indian flora and fauna	2 Lectures
2.2.a. Indian forest and vegetation types: diversity of flora and fauna. Endangered, Endemic and Extinct Species of India: Threatened species categories of IUCN, threatened species of plants and animals in India and their reasons, Red data books.	1 Lecture
2.2.b. Environmental biotechnology: Role of biotechnology in conservation of species, in-situ and ex-situ conservation. (concept of Gene Bank)	2 Lectures
2.2. c. Wildlife management and conservation: Wild life management: Goals and Strategies., Human land-use and wildlife management – Elephant Corridor Vulture Conservation Centre, Haryana. (an BNHS initiative), Wildlife crossings.	4 Lectures
2.3. India and Multilateral Environmental agreements	
2.3.a. Implications of Environmental Agreements to India: Ratification, Becoming a Signatory, Responsibilities, Obligations, expectations and challenges.	
2.3.b. RAMSAR Convention on Wetlands	
2.3.c. IUCN (International Union for Conservation of Nature and Natural Resources)	
2.3.d. Convention on Biological Diversity	
2.3.e. CMS (Convention on the Conservation of Migratory Species)	
2.3.f. Basel Convention on the Control of Trans boundary Movement of Hazardous Waste and Their Disposal	
2.3g. Kyoto Protocol	
2.3h. IWC (International Whaling Commission)	4 Lectures
2.4. Population and consumption Dynamics with special reference to Human:	
2.4.a Energy and food production (grains, Livestock, aqua culture): Green revolution, Blue revolution. Nutrition: micro and macro nutrition, Ecological costs of food production. Organic Farming, Climate change and impact on Agriculture.	
2.4.b. GM foods and their environmental concerns eg .Bt Brinjal, Politics and economics of Hunger, Intellectual Property Rights (IPR), Biopiracy (e.g., Neem/Basmati) Relevance of Seed Bank.	

UNIT III	15 Lectures
3.1. Pest and pesticides:	
3.1.a. Basic introduction about Pests, Pesticides and Environment	1 Lecture
3.1.b. Pesticide toxicity: Bioaccumulation and Biomagnification, persistence, resistance and pollution health of farmers. New methods of pest control: Biological pest control: predators, parasites, and pathogens. Genetically Engineering and pest control, Integrated pest management	3 Lectures
3.1.c. Bioremediation of OP pesticide: using Bacillus Sps. (eg. Malathion Pesticide)	1 Lecture
3.1.d. Phytoremediation of Organochlorine pesticide (Chloropyrifos) using plants	2 Lectures
3.1.e. Pesticide regulation: eg. Endosulphan issue.	
3.2. Toxicology Management.	
3.2.a. Toxicology: Basic concepts, toxicity and its impacts Distribution of Toxic material in the environment and Exposure risk assessment. Routes of entry, Absorption and translocation, fate of toxic agent Assessment of toxicity - Indices of toxicity (e.g. LD50, LC50, EL50, NOEL) Industrial toxicants and hazardous materials, toxic and hazardous waste management, measurement of toxicity, TLM and lethality studies, physiological and metabolic effects on flora and fauna.	3 Lectures
3.2.b. Limitation of Toxicological studies: Comparison of animal toxicological models and Toxicity in Humans.	2 Lectures
3.2.c. Human clinical trials: Concept of Clinical trial phases - I, 2, 3 and Pharmacovigilance.	1 Lecture
3.2.d. Ethical issues of clinical trials: (e.g. Thalidomide) and significance of Helsinki declaration.	

<p>Unit IV</p> <p>4.1 Community and Environment Conservation.</p> <p>4.1a. Case study- Amur Falcon and tribal community of Nagaland</p> <p>4.1b. One man role in conservation A Case Study – Dr. Rajendra Singh (Water man of India)</p> <p>4.1c. Role of local communities in wildlife management initiatives. Case study- Kokrabbellur Village.</p> <p>4.2. Citizen Awareness and environmental legal provisions:</p> <p>Environmental Law and Constitution of India:</p> <p>Constitutional Provisions: Article 21, Article 48A, Article 51A(g), Environment protection Act 1986, MoEF (1985)</p> <p>Laws related to environmental protection and wildlife : The Environment (Protection) Act, 1986; The Forest (Conservation) Act, 1980; The Wildlife Protection Act, 1972; Water (Prevention and Control of Pollution) Act, 1974; Air (Prevention and Control of Pollution) Act, 1981 and Forest Rights Act, 2006. National Green Tribunal</p>	<p><u>15 Lectures</u></p> <p>3 Lectures</p> <p>2 Lectures</p> <p>2 Lecture</p> <p>3 Lecture</p> <p>5 Lectures</p>
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Semester VI

SBSLSC601: Genetics II: The course deals with organisms and techniques used in understanding molecular genetics. Students are expected to learn how genes are mapped on chromosomes. The second unit introduces principle and applications behind tools used in Genetics.

Course Code	Title	No.of Lectures
SBSLSC601	Genetics II	
(60L) Unit I: Organisms and techniques used in the understanding of Genetics		
(15L)		
1. Genetic recombination and Gene mapping (Processes and numerical problems)		
1.1 Bacterial Conjugation		01
1.2 Three factor crosses in maize		02
1.3 Co-efficient of co-incidence and interference in Drosophila		02
1.4 Complementation analysis in Humans using Haemoglobin		02
1.5. Life Cycle of lytic and lysogenic phages; Deletion mapping		02
2. Human Genetics		
2.1. Human Genetic Maps, Somatic cell Genetics: Use of cell hybrids and hybridomas for gene mapping; The lod Score Method for Analyzing Linkage of Human Genes		03
2.2 The Human Genome Project : aims, major features and applications(e.g. detecting polymorphism, personalized medicine)		03
Unit II: Tools and Techniques in Molecular Genetics		(15L)
3.1 Agarose gel electrophoresis (Principle, methodology, Applications)		02
3.2 Polymerase Chain Reaction (Principle, methodology, Applications)		02
3.3 Restriction enzymes and Restriction mapping		02
3.4 DNA Sequencing – Sanger’s Method, Next Gen Sequencing		02
3.5 PCR based methods of Induced mutagenesis (Site-Directed mutagenesis , Cassette mutagenesis)		02
3.6 Mutagenicity testing – Ames test, Sister chromatid exchange test, mouse specific locus test (Advantages and disadvantages)		02
3.7 Nucleic acid in situ Hybridization (FISH) and Chromosome painting		01
3.8 Hybrid arrest and Hybrid release method (HRT and HART)		01
3.9 Overview of Cloning Insulin		01

SBSLSC601: Immunology II : This course mainly deals with the section of immunology which encompasses the aetiology of various diseases caused by disorders of the immune system either due to its failure (immunodeficiency), aberrant action (Hypersensitivity, autoimmunity), or malignant growth of cellular elements (Cancer) and clinical management (Vaccines).

Course Code	Title	No.of Lectures
SBSLSC601	Immunology II	(60L)
UNIT – III :Hypersensitivity, Infectious diseases, Vaccines and Immunodeficiency		(15L)
3.1 Hypersensitivity Gell and Coombs classification: 3.1. Types of hypersensitivity – Examples and methods of diagnosis i) IgE- mediated (Type I) hypersensitivity: RIST and RAST ii) Antibody-mediated(Type II) hypersensitivity : Agglutination iii) Immune complex-mediated(Type III) hypersensitivity: Immunofluorescence, ELISA iv) Delayed type hypersensitivity(Type IV) : Tuberculin test		05
3.2 Infectious Diseases and Vaccines 3.2.aImportant immune mechanisms against various infectious diseases i) Viral infections ii) Bacterial infections iii) Fungal infections iv) Parasitic infections 3.2 b. Vaccines i) Passive immunization - Preformed antibodies and their disadvantages ii) Use of Chimera / humanized antibodies iii) Active immunization- Whole organisms (attenuated vs. inactivated ex. Polio) iv) Subunit Vaccines (Polysaccharide, toxoid andPeptide vaccines) v) DNA vaccines		07
3.3 Immunodeficiency Primary and acquired Immunodeficiency 3.3.aPrimary immunodeficiency i) B-cell- X-linked agammaglobulinemia ii) T-cell- Di George Syndrome iii) Lymphoid deficiency - Severe Combined Immunodeficiency iv) Deficiency of myeloid lineage- Chronic Granulomatous Disease 3.3.bAcquired Immunodeficiency i) Acquired Immunodeficiency Syndrome		03

UNIT – IV : Transplantation, Tumor Immunology, Tolerance and Autoimmunity	(15L)
4.1 Transplantation	04
<ul style="list-style-type: none"> i) Types of grafts <ul style="list-style-type: none"> ii) Tissue typing (serological and MLR) iii) Mechanisms of graft rejection iv) Immunosuppressive therapy v) Graft vs. host disease - bone marrow transplant 	04
4.2 Tumor Immunology	04
<ul style="list-style-type: none"> i) Tumour specific and associated antigens <ul style="list-style-type: none"> ii) Role ofNK cells and macrophages iii) Tumour evasion of immune system iv)Cancer immunotherapy. 	
4.3 Tolerance and Autoimmunity	03
4.3.a Establishment and maintenance of tolerance	
<ul style="list-style-type: none"> i) Mechanisms of central tolerance <ul style="list-style-type: none"> ii) Mechanisms of peripheral tolerance iii) Role of T regulatory cells iv) Immunology of pregnancy 	
4.3 b. Autoimmunity	
<ul style="list-style-type: none"> i) Mechanisms for induction(Aetiology) <ul style="list-style-type: none"> ii) Organ specific diseases – ex. Myasthenia gravis, Graves disease iii) Systemic diseases – ex. Systemic Lupus Erythematosus, Multiple sclerosis 	

SBSLSC 602: Developmental Biology II:This module explains the molecular and cellular aspects of and the important genes involved in early development. This module also looks at the applications of Developmental Biology such as regeneration, ageing, cancer and assisted human reproduction

Course Code	Title	Lectures
SBSLSC 602	DEVELOPMENTAL BIOLOGY ANDNEUROBIOLOGY II	2.5 Credits (60 Lectures)
Unit 1: Animal and Plant development – Basic Cellular and Molecular Aspects		15 Lectures
1.1	Potency: Totipotency (Nuclei) Pluripotency (Inner cell mass / Embryonic stem Cell) Multipotency (Adult stem cells – mesenchymal) Oligopotency (Monocytes)	2 lectures

1.2	Determination and Trans determination (Imaginal Discs)	2 lectures
1.3	Differentiation: Hematopoietic stem cells and Neural crest cells (migration and differentiation)	3 lectures
1.4	Molecular basis of development:-	3 lectures
1.4a	Genes in early development (with <i>Drosophila</i> as example)	
	Determination of anterior- posterior and dorso-ventral axis	
	Role of Maternal genes and zygotic (Gap genes, pair-rule genes, Segmentation genes and Homeotic genes)	
1.4b	Beta globin gene – as an example of change in gene expression	
1.5	Conserved nature of developmental genes (Evo- Devoperspective Hox/Pax6 genes with respect to <i>Drosophila</i>)	2 lectures
1.6	Organogenesis of Eye OR Limb with references to inductive/ instructive signals, cytoplasmic determinants and gradients	1 lectures
1.7	Plant Development :- Role of Homeotic genes specifying parts of a flower Plant genome project (<i>Arabidopsis</i> /rice)	2 lectures
UNIT 2 : Applications of Developmental Biology		15 lectures
2.1	Assisted human reproduction	2 lectures
2.2	Regeneration a. Examples in animal world (vertebrates and invertebrates) b. Epimorphic (<i>Salamander</i> limb) and Morphallactic (<i>Hydra</i>) c. Compensatory regeneration (mammalian liver) d. Recent advances in stem cells and regenerative medicine (student assignment)	3 lectures
2.3	Aging- Theories of Aging	2 lectures
2.4	Congenital abnormalities : sensitive periods during development and causes of congenital abnormalities with special references to the following a. Zika virus b. Alcohol c. Spina bifida	2 lectures
2.5	Cell cycle regulation - check points in cell cycle and role of cyclins and cdks	2 lecture
2.6	Apoptosis and its role in development	1 lecture
2.7	Cancer- Types of Cancer, Causes of Cancer, Oncogenes, Tumour suppressor genes, Treatment strategies for Cancer (example breast cancer)	3 lectures

SBSLSC602:Neurobiology II: This module describes the structural and functional features of the various sensory and motor systems. It elaborates on some behavioural aspects such as sleep and memory. Examples of diseases that arise due to malfunction of the nervous system are described.

Unit 3: Sensory and motor systems		15 Lectures
3.1	Introduction to Human Sense organs: receptors, receptor mechanisms and pathways	1 lecture
3.1.a	Visual system: Vision - structure of the eye, retina, photoreceptors (rods and cones), photo transduction, binocular vision, visual pathway (flow chart only – LGN to visual cortex), light & dark adaptation, colour vision.	2 lectures
3.1.b	Auditory System: Structure of the ear, cochlea and organ of corti receptors 1 Mechanism of transduction, Auditory pathway: (MGN to audio cortex) Diagrammatic representation only.	2 lectures
3.1.c	Vestibular System: Structure of the vestibular labyrinth, maculae and cristae. Mechanism of transduction.	2 lectures
3.1.d	Chemosensory system: Olfactory and Gustatory receptors – structure.	2 lectures
3.1.e	Skin as sense organ: somatic receptors - Types of mechano- receptors, pain reception& Pain management (example analgesic effect by prostaglandin inhibition - aspirin)	2 lectures
3.2	Motor System:	
3.2.a	Organisation, Reflex Coordination(ascending and descending pathways diagrammatic representation only)	1 lecture
3.2.b	Role of cerebellum in motor co-ordination	1 lecture
3.2.c	Types of muscles, Molecular basis of Muscle contraction	1 lecture
3.2.d	Reflexes: Simple reflex arc, mono and poly-synaptic reflexes (one example of each)	1 lecture
UNIT 4 : Neurobiological basis of Behaviour:		15 lectures

4.1.a	Sleep, Stages of sleep – REM and non REM	4 lectures
4.1.b	Short term memory and Long Term Memory (eg. Pathway in Aplysia and molecular events)	4 lectures
4.2	Neurobiological basis of Diseases:	7 lectures
4.2.a	Epilepsy	
4.2.b	Parkinson's disease	
4.2.c	Schizophrenia- Relevance with regard to neurotransmitters	
4.2.d	Prions associated diseases	
4.2.e	Duchene's muscular Dystrophy	
4.2.f	Alzheimer's disease	

SBSLSC603: Biotechnology II: This course deals with details of applied aspects of Biology. Students will learn how fermentation technology, and plant / animal tissue culture are used for production of various pharmaceutically important compounds.

Course Code	Title	No. of Lectures
SBSLSC603	Biotechnology and Genetic Engineering	2.5 credits 60
Unit I Fermentation technology – Enzyme and Pharmaceuticals Production		15
1.1. Enzyme Technology		
1.1.a. Enzyme production ex. Amylase (bacterial & fungal)		03
1.1.b. Immobilized Biocatalyst (method of immobilization, applications – biosensors)		02
1.2. Application of fermentation technology in medicine:		02
1.2.a. Production of antibiotics (Penicillin)		02
1.2.b. Vitamins (Vitamin B12)		02
1.2.c. Vaccines (polio, HbsAg)		02
1.2.d. Probiotics, Nutraceuticals (one example of each)		02
1.2.e. Biopharmaceuticals/Biomolecules (Insulin/IFN)		
UNIT II Tissue Culture biotechnology		15
2.1. Application of fermentation technology in Agriculture Biopesticides – bacteria (<i>B.thuringiensis</i>), Virus (<i>Polyhedrosis virus</i>) and fungal (<i>Trichoderma</i>)		04

2.2. Plant and Animal Tissue culture:	
2.2.a. Animal – Laboratory setup, Media, Basic techniques (Disaggregation of tissue and primary culture, maintenance of cell lines- see also Practical's)	05
2.2.b. Plant – Media, Basic techniques (callus and suspension culture, organogenesis, & somatic embryogenesis, Protoplast isolation and fusion)	04
2.2.c. Secondary metabolites from plant tissue culture	02

SBSLSC603: Genetic Engineering II: In this course students will learn about Applications of tools and techniques in Recombinant DNA technology. They will also learn about bioinformatics and Genomics. Students should be aware of vast scope of Genetic Engineering in transforming human lives by end of this course.

Unit III: Applications of recombinant DNA technology	15
3.1. Knockouts , Knock in, Knock down systems(Transgenic animals)	02
3.2. Transgenic plants: Bt cotton and weedicide resistant gene (any one example)	02
3.3. Xenopus oocyte as an expression system	
3.4. Giant Mouse (MMT promoter growth hormone fusion gene)	01
3.5. Drosophila (using p element mediated technique-enhancer trap)	01
3.6. Transformation of Plant Cells and Applications for Plant Genetic Engineering:	01
3.6.a. Microinjection method	
3.6.b. Ti plasmid based Vectors (Binary vector and Cointegrative vector)	01
3.7. Applications in industry – Medical/pharmaceutical, agricultural	01
3.8. Gene therapy using any one example (Parkinson disease/SCID)	01
3.9. Ethical, Legal , and Social Implications of recombinant DNA technology	02
3.10. Consumer awareness (Labelling of GM food)	01
	01
Unit IV Tools in genetic engineering, Bioinformatics: Structural and functional Genomics, Comparative Genomics	15
4.1 Tools in genetic engineering	
4.1.a. Preparing genomic and cDNA libraries	02

4.1.b. Screening techniques (Nucleic acid hybridization methods , immunological methods , gene inactivation)	01
4.1.c. Microarrays	01
4.1.d. Brief overview of Cre-Lox system	01
4.2 Bioinformatics: Structural and functional Genomics	
4.2.a. Biological databases (formats: FASTA and GenBank)	01
4.2.b. Sequence annotation and comparison	02
4.2.c. Assigning Gene/protein Function Experimentally	01
4.2.d. Applied genomics: Drug designing and basic concept of Docking	02
4.3 Comparative Genomics	
4.3.a. Sequence alignment [Pairwise alignment (BLAST), Multiple alignment (Clustalw)]	01
4.3.b. Phylogenetic trees (Rooted, Unrooted, Concept of Bootstrapping)	
4.3.c. Examples of Comparative Genomics Studies and Uses	02
	01

SBSLSC604: ENVIRONMENTAL BIOLOGY II: The paper deals with the human dimension of development and its effect on environment. It aims to provide adequate insight on management of natural resources. It introduces critical issues in environmental studies, both in an Indian and global perspective. The process of urbanization is explored with respect of consumption of resources; environmental consequences of urban transformation, waste disposal and pollution.

Course Code	Title	No. of Lectures
SBSLSC604	ENVIRONMENTALBIOLOGYII	2.5Credits (60 Lectures)
<u>Unit I</u>		<u>15 Lectures</u>
1.1.Environmental effects of urbanization: Availability of public/open and green spaces/sustainable use of urban space)		1
1.2.Expansion pattern of cities- Megacities, smart cities and Ecocities, problem of Urban sprawl.		2
1.3.Urban growth Challenges: Drinking water supply, pollution of surface water, generation of waste and waste management.		2
1.4.Rural environmental degradation: (a) deforestation; (b) declining soil quality (including soil desiccation); and (c) loss of biodiversity.		2
1.5. Use of fresh water Resources: ground water, contamination of ground water, rural sewage management, freshwater wet lands, Rural Migration , Impact of cities on rural environment.		3
River linking Project: Ken and Betwa river.* to be given as Student Assignment		
1.6.Impact of environmental degradation on rural women		1
1.7. Toxic and solid waste management: Types of waste, solid waste disposal,E-waste and toxic waste trading, economics of recycling, recycling plastic,Biocomposting and producing less waste.		4
<u>UNITII</u>		
2.1. Energy and Environment: Classification of Energy resources, Types of renewable and Non-renewable energy resources.		2
2.2. Evaluating energy resources: Nuclear Power, Coal, Natural Gas, Biomass burning, Gas turbines and Biofuels.		3
2.3. Alternative Energy Resources: Geothermal, Tidal/Wave power, Ocean Thermal Energy, Inland Solar ponds, Energy efficient buildings		4
2.4. Meeting the growing demands: Transportation, residential, commercial and industrial needs.		3
2.5. Meeting energy efficiency: Household connected devices		1
2.6. Concept of carbon credit and carbon foot print		2

<p><u>Unit III</u></p> <p>3.1. Environmental Impact Analysis of a Development Project Risk management (EIA and Environment protection agency) perception of risk and gain, setting up standards.</p> <p>3.1a. Environmental Audit Definition, Types of Audit, Processes and decision making. Environmental Audit of an Industry Eg: Sugar factory Environmental Audit of Solid waste Management Eg. Bangalore City</p> <p>3.2. Environmental Justice Movement:</p> <p>3.2a. Narmada Bachao Andolan and Project Affected people.</p> <p>3.2b. Chipko Movement , Hargila Army– Conservation efforts in Assam</p> <p>3.2c. Bauxite Mining and Battle for Niyamgiri Hills.</p> <p>3.2d. Plachimada struggle against destruction of groundwater</p>	<p><u>15 Lectures</u></p> <p>3 Lectures</p> <p>5 Lectures</p> <p>3 Lectures</p> <p>2 Lectures</p> <p>2 Lectures</p>
<p><u>Unit IV</u></p> <p>4.1. Sustainable Development</p> <p>4.1a. UN Agenda for sustainable development.</p> <p>4.1b. Sustainable development goals (Global goals), 2030</p> <p>4.1c. War and Sustainability: Eg. Consequences of Vietnam war. Cost benefit analysis</p> <p>4.2. Safety, Health and Environment:</p> <p>4.2a. Safety and Health Hazards : Identification of potential safety and health hazards in industrial and development projects, reduction strategies, policies and legislation. Lessons after 30 years of Bhopal gas tragedy</p> <p>4.2b. International and national perspective, safety standards and management systems, ISO 18000 (Occupational Health and Safety Management Systems)</p> <p>4.2c. Consumption Dynamics with special reference to Human: Land scape Ecology: Effects of changing landscape pattern on organisms, populations, communities and ecosystem processes. Use of GIS and Remote sensing technology in Land use mapping. -case study of Bangalore city.</p>	<p><u>15 Lectures</u></p> <p>5 lectures</p> <p>4 lectures</p> <p>6 Lectures</p>

Practical Syllabus

Semester V

**Course code:
SBSLSCP05**

[Practical Based on SBSLSC501, Credits-1.5, Lectures- 60]

Genetics

I) Experiments to be performed by students:

1. Extraction of chromosomal DNA from suitable sample (Chicken/goat/any other suitable source)
2. Streak plating of saliva on two different media
3. Viable count for enumeration of bacteria by –Bulk seed method
4. Viable count for enumeration of bacteria by - Surface spread method

II) Demonstration experiments:

5. a) Study of *Drosophila* mutants from specimen / slides / photographs
b) Collection and observation of virgin *Drosophila* females for setting up of genetic crosses
6. Study of UV-Visible Spectrophotometer using DNA/ Protein from suitable sample, checking purity of sample.

Immunology

I) Experiments to be performed by students:

1. Study of ABO Blood groups and quantitative Coomb's Test.
2. Study of Isohemagglutinin titer in blood.
3. Quantitative Widal Test.

II) Demonstration experiments:

4. a) Dissect and expose the lymphoid organs of rat / photograph
b) Study of Thymus, Spleen, and Lymph node tissue sections
c) Observation of Blast cells in bone marrow of any mammal from slides / photographs.

**Course code:
SBSLSCP05**

[Practical Syllabus Based on SBSLSC502, Credits: 1.5, Lectures : 60

] Developmental Biology:

Animals:

- 1) Study of developmental stages of chick embryo- C, T
 - 2) Cytochrome C- oxidase activity in a developing chick embryo. C, T
- Demonstration experiments (Any two of the following):
1. Programmed cell death in limb bud using Janus Green B stain (in chick embryo).C, T,R
 2. Alizarin stain to study limb development in chick embryo/ Regeneration of cartilage / bone C, T,R
 3. Acid and alkaline Phosphatase in Chick embryo.

Plants :

- 1) Effect of temperature on cell viability in pollen grains/yeast using Trypan blue/ acetocarmine .C, T, R
- 2) Root and shoot development in sections of a 2-day old plant embryo. I,C,T,R.
- 3) Study of plant embryo and determination of seed viability using NBT I,C,T,R.

Neurobiology:

- 1) Dissection& display of Nervous system in invertebrates – earthworm / cockroach or any other suitable animal C,T,R
- 2) Dissection & display of Nervous system in vertebrates – chick brain/goat brain or any other suitable system C,T ,R
- 3) Study of chick embryo for identification of fore, mid & hind brain areas (Refer above Developmental Biology Practical no.1)
- 5) Study of Permanent slides of: C,R
 - a) Medullary nerve fibre
 - b) TS of Spinal cord
 - c) Mammalian retina
 - d) Electron micrographs of neural tissue

Demonstration Experiments (Any two of the following):

- a)Study of the Nervous system of Sepia with special reference to Giant axon and stellate ganglia T,C,R.
- b)Assignment - Bird songs and neurophysiology involved (as a group practical)
- c)Understanding the principle and basic interpretation of brain imaging tests like PET (Positron Emission Tomography) and MRI (Magnetic Resonance Imaging)

Coursecode: SBSLSC

P06

[Practical Based on SBSLSC503,Credits-1.5,Lectures-60]

1. Extraction and purification (salting out method) of enzyme: (Amylase from sweet-potato / salivary amylase/egg white lysozyme or any other convenient enzyme)
2. Determination of - i) enzyme activity ii) specific activity.
3. Effect of inhibitors on Km of amylase/any other convenient enzyme.
4. Agarose gel electrophoresis of the extracted amylase or serum
5. Non-denaturing Poly Acrylamide Gel Electrophoresis of *E.coli* extract / Serum proteins / Saliva / Egg white any other suitable sample
6. Alcohol and sugar tolerance in yeast and strain improvement studies by exposing yeast to UV rays.
7. Gene Cloning strategy (Craft)
8. Sugar Fermentation rate in presence of different substrate/pH/temperature measure accumulated CO₂ with under different conditions. (Demonstration / group experiment)

Coursecode: SBSLSC P06

[Practicals Based on SBSLSC504,Credits-1.5,Lectures- 60]

Note:I–Instrumentation,C–Conceptual understanding,T–Technicalskill,R–Relevance to daily life.

1. Plankton collection/Plankton identification and quantification from river/
Lake water samples (CTR)
- 2.Vegetation studies by line,quadrates and belt transect methods and their analysis.(CT)
- 3.Preparation of media for microbial culture, Isolation and culturing of microbes from
Soil/water samples (Fungal/Bacterial/Algal organism). (CTR)
- 4.Study of fecundity from the given sample of freshwater/marine fish (CTR)
5. Isolation and culturing of Rhizobium from the given sample. (CTR)
- 6.Analysis of soils for pH, moisture, soil types. (CTR)
- 7.Water analysis for physicochemical characteristics:(any three) (CTR)
Salinity/Acidity/Alkalinity/BOD/DO/COD/Copper
8. Study of effect of a metal toxicity on the heart beat of Daphnia and statistical analysis
of the same T Test/LC 50 (CTR)
9. A visit to Mahim Nature Park/ Vikhroli Mangroves(CTR)

**Practical
Syllabus
Semester VI**

**Course code: SBSLSC
P07**

**[Practical Based on SBSLSC601, Credits-1.5, Lectures-
60]**

Genetics

I) Experiments to be performed by students:

1. Giant Chromosome preparation (*Drosophila / Chironomus*)
2. Estimation of bacteriophage titre by plaque assay
3. Effect of UV light on microorganisms - Determination of percent viability of an *E. coli* culture after U.V. exposure- in the absence of light repair
4. Isolation of antibiotic resistant / auxotrophic mutants using Replica plate technique.

II) Demonstration experiments:

5. Extraction of plasmid DNA, restriction enzyme digestion and visualization by agarose gel electrophoresis.

Immunology

I) Experiments to be performed by students:

6. Ouchterlony test for Immunodiffusion – (Qualitative).
7. Mancini test – Single Radial Immunodiffusion (Qualitative)
8. Agarose slide gel electrophoresis of Serum.

II) Demonstration experiments:

9. Separation of Mononuclear cells using a gradient and the determination of viable count of the same
10. SDS- PAGE for separation of Ig Gsubfraction
11. Qualitative ELISA using albumin

**Course Code: SBSMB
P07**

**[Practical Syllabus Based on SBSLSC602 Credits: 1.5, Lectures:
60]**

Plant Developmental Biology

1. Effect of boron / calcium on pollen tube germination in *Vinca rose* or any other suitable sample I, C,T,R
2. Role of GA in seed germination. C,T
3. Demonstration experiments: Plant Tissue Culture: Initiation of plant tissue culture from germinated chick pea/any other suitable source: (project to be performed in groups of 4-5 students) C, T,R

Animal Developmental Biology

4. Live observations of Developmental stages of. *C.elegans/Dictyoteliium/Drosophila/zebrafish*
Demonstration experiments: C, T (Any two of the following):
5. Imaginal discs of *Drosophila*
6. Regeneration in earthworm / any other suitable system / hydra (using permanent slide / photographs)
7. Animal Cell Culture /Assays: Cell proliferation assay/ Cell migration assay/ Cell adhesion assay

Neurobiology

1. Differential staining of white and grey matter of vertebrate brain.
- 2 Temporary mounts of **any three** of the following: C, T, R
 - a) Cornea of prawn. b) Statocyst of prawn. c) Columella of bird. d) Striated / smooth muscle fibre.
 - e) Methylene blue staining of earthworm nerve cord or any other suitable nerve cord or brain to observe organization of neuronal cell bodies in invertebrates
 - f) Olfactory & gustatory sensillaeg) Histological staining of neuronal tissue using Heamotoxilin-Eosin staining or Nessil"s staining.
- 3) Making clay model of vertebrate brain and cranial nerves. C,T,R
Demonstration Experiments - C, T, R
 1. Stroop test.
 2. Olfactory /Gustatory Behavioral study: Snail / Earthworm / insect larvae
 3. Associative conditioning
 4. Knee-jerk and pupillary reflex.
 5. Testing for locating the Blind Spot in the retina

Coursecode: SBSLSC

P08

[Practicals Based on SBSLSC603,Credits-1.5,Lectures-60]

1. Thin layer chromatography of lipids/plant alkaloids/any other suitable extract
2. Bioassay of antibiotic / plant extract / for anti-bacterial activity or B-12 assay.
3. Assay of fermentation product / Substrate – Estimation of (a) alcohol/Acetic/lactic acid (b)
4. Extraction of plasmid DNA& Agarose Gel Electrophoresis of plasmid DNA/Restriction Digest with costing of the experiment.
5. Immobilization of Enzyme (Amylase/any other convenient enzyme) using hen egg-white or alginate method and assay its activity.
6. Quality control: Probiotics or Vaccine
7. Bioinformatics :
 - i) Design primers (Forward and reverse primers with matching Tm) for amplifying “x” gene of “y” species. (They will search for sequence, and design primers)
 - ii) Manual annotation of DNA sequence: Prokaryotic/Eukaryotic
 - iii) Sequence alignment – pair wise (For Match Score: Specify values for match, mismatch and gap penalty)
 - iv) Construction of Cladogram/Phylogram with TimeLine

Open-endedprojects:(Anyoneofthefollowing,alongwithitscosting)

1. Home-Wine production / Home-Vinegar production from any convenient source & assay for fermentation products
2. Culturing & biomass estimation of mushroom/ Spirulina /chlorella by cell count/dry weight and estimation of percentage total protein.
3. Plant tissue culture: i) Callus production ii) Preparation of protoplasts and estimate viability by trypan blue staining
4. Animal tissue culture: Tissue dissociation by trypsinization technique and to estimate the viability of cells in physiological saline/MEM at 0 hrs and 2 hrs
5. Growth curve of E coli (DH5 alpha) and preparation of competent cell for transformation experiment.
6. Finger Printing technique using electrophoresis of protein/DNA digest 38
7. SDS PAGE with suitable Protein sample for Comparison with Experiment no.3 above.
8. Agarose Gel Electrophoresis of extracted DNA samples with & without Molecular marker ladder

9. Genomic DNA extraction, purification and estimation by UV spectroscopy Development of cost effective method using Liquid Soap, Common Salt and Alcohol or any convenient variation

**Course Code: SBSLSC
P08**

[Practical Syllabus Based on SBSLSC604 Semester VI Credits: 1.5, Lectures: 60]

Note:I–Instrumentation,C–Conceptual understanding,T–Technical skill,R–Relevance to daily life

1. EC, conductivity, N/P/K/Sulphates/Na/Ca. /Estimation of Co^{2+} and Ni^{2+} by colorimetry/spectrophotometry/ Water analysis for physico-chemical characteristics/Estimation of Heavy metal in various samples by titrimetry or spectrometry/Potability of the given drinking water sample by MPN. (any three of the above) **(CTR)**
2. Estimation of Co^{2+} and Ni^{2+} /Pb by colorimetry / spectrophotometry (any one) **(CTR)**
3. Remote Sensing and GIS: Principles of Remote Sensing and its application of Environmental Science. Application of GIS in Environmental Management (Use photographs and models). **(CTR)**
4. Collection and Interpretation of weather data/Climatology of Mumbai city (Satellite images and statistical analysis of weather data). Statistical methods for analysis of environmental data: diversity and similarity indices, for the given data. Use of EXCEL or SPSS **(CT)**
5. Using a Simulated data perform the following:-
Classify the data and calculate ecological indices; Dominance index, Shannon-Wiener Index, Similarity Index, Diversity index. Evaluate and interpret each of the index values. (any two) **(CT)**
6. Estimation of stomatal index (2 different leaf types and two different micro-climatic conditions e.g. Sun loving, shade loving)/ Chlorophyll content. **(CTR)**
7. Field visit to river/lake and waste water treatment plants. **(CTR)**
A visit to Sanjay Gandhi National Park . Identification of local plant species
as: Ecological indicators, exotic species **(CTR)**
8. Environmental Project (compulsory) **(CTR)**
Environmental audit of an institution Ex. Electricity and water audit and preparing a report./Make an ecological evaluation of a local site and interpret its ecological health./Make a report/ Making video film on a local well defined environmental issue along with resolving the conflict– Photographic documentation of a local environmental issue and record its progress for at least three months./Make a report and your evaluation on environmental issue/ Project on role of a chosen organism in your immediate environment or its significance to the local biodiversity/Measurement of sounds by DB meter in silent , industrial, residential and commercial zones/A Survey related to environmental issues amongst the citizens: Data to be collected and analyzed statistically with suggestions for environmental management.

*The film documentary/Video making for project should not be more than 10 min duration.

Project Submission and viva

Semester V

Text Books and References

SBSLSC

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References books for Unit I and II Genetics

1. Principles of Genetics by Snustad and Simmons 4thedn. John Wiley and sons 2006.
2. I Genetics; A Molecular approach by Peter Russel 2ndedn. Pearson 2006.
3. I Genetics; A Mendelian approach by Peter Russel 2ndedn. Pearson 2006.
4. Introduction to Genetic Analysis by Griffiths et al 8thedn Freeman and co. 2005.
5. Genes IX by Benjamin Lewin; Jones and Bartlett publishers, 2008.
6. Principles of Gene Manipulation and Genomics by S. B. Primrose and R. M. Twyman 7thedn., Blackwell publication, asianedn Oxford publishers 2007.
7. Concepts of Genetics W. S. Klug and M. R. Cummings 7thedn. Pearson 2003.
8. Concepts of Genetics W. S. Klug, M. R. Cummings, C. A. Spencer 8thedn. Pearson 2006.
9. Human Molecular Genetics by Tom Strachan and Andrew Read, 3rdedn. Garland Science pub. 2004.
10. Principles of Genetics by R. Tamarin 7thedn 2002

References books for Unit III and IV Immunology

11. Immunology 5thedn. R.A.Goldsky, T. J. Kindt, B. A. Osborne, J. Kuby 2003.
12. Immunology: The immune system in health and disease 6thedn. C. A. Janeway, P. Travers, M. Walport, M. Shlomchik Garland Science Pub. 2005.
13. Cellular and Molecular Immunology, 2ndedn. A. K. Abbas, A. H. Litchman, 5thedn 2000.
14. Basic Immunology: Functions and disorders of the immune system, 2ndedn. A. K. Abbas, A. H. Litchman, 2ndedn 2004.
15. Roitt's Essential Immunology 11thedn. Blackwell publication 2006.
16. Immunology 7thInternationaledn. D. Mole, J. Bronstoff, D. Roth, I. Roitt, Mosbey Elsevier publication, 2006.
17. An Introduction to Immunology C. V. Rao Narossa Publishers 2002. USLSC502:

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Reference books for UNIT I and II Developmental Biology

1. Instant Lecture Notes- Developmental Biology R.M.Twyman, Viva Books Private Limited, New Delhi, Latest Edition (First Edition – 2001)
2. Developmental Biology T.Subramaniam, Narosa publishing Hopuse, Mumbai, Latest Edition (First Edition- 2002)
3. Principles of Development L. Wolpert, R. Beddington, J. Brockes, T. Jesell and P. Lawrence 23 Oxford University Press.
4. Developmental Biology. W.A. Miller Springer – Verlag.
- 5.. Molecular Biology 3rd Ed., H.Lodish, D.Baltimore, A.Berk, S.L. Zipurski, P.Matsudaira and J. Darnell. Scientific American Book, W.H. Freeman, N.Y.
6. Molecular Biology of the Cell 3rd Edition. B. Alberts, D. Bray, J.Lewis, M. Raff, K. Roberts and J.D.Watson. Garland Publishing Inc., N T and London.
7. 5. Plant Cell and Tissue Culture I. Vasil and T.A. Thorpe. Kluwer Academic Publishers.

8. Practical Zoology 2nd Edition. K.C. Ghone and B. Manna. New Central Book Agency Publishers.
9. Developmental Biology 4th edition. S.F. Gilbert. Sinauer Associates Inc. Publishers.
10. Pollen Analysis 2nd edition. P.D. Moore, J.A. Webb and M.E. Collinson Blackwell Scientific Publishers.
11. Pollen Biology – A laboratory manual (1992) K.R. Shivanna and N.S. Rangaswamy, Narosa Publishing, Calcutta.
12. Developmental Biology 2nd edition, L.W. Browder, Saunders College Publishing Co.
13. An Introduction to Embryology 5th Ed B. I. Ballinsky“ Saunders, College Publishing Co.
14. Developmental Biology – Patterns, Problems and Principles. J. W. Saunders. J. R. MacMillan Publishing Co.,
15. An Introduction To the Embryology of Angiosperms. P. Maheshwari. 16. An Atlas Of Descriptive Embryology 2nd ed. W.W. Mathews. MacMillan Publishing Co.
16. Essential Developmental Biology – A Practical Approach Ed C.D. Stern and P.W.H. Holland. Oxford University Press UNIT III and IV – Neurobiology (Latest Editions Recommended).

**Reference books for
UNIT III and IV Neurobiology**

17. Neuroscience: Exploring the brain M.F. Baer, B.W. Connors & M.A. Paradiso, William & Wilkins, Baltimore, Latest Edition (First Edition 1996)
18. Neurobiology 3rd edition G.M. Shepherd Oxford University Press.
18. Principles Of Neural Science. E.R. Kandel, J.H. Schwartz and T.M. Jessel. Prentice Hall International.
19. Instant Notes – Neurosciences, A. Longstaff Viva Books Pvt Ltd., New Delhi, 2002
20. Text Book Of Medical Physiology A.C. Guyton and J.E. Hall Saunders College Publishers.
21. Elements Of Molecular Neurobiology C.U.M. Smith J Wiley and Sons Publishers, N.Y.
22. An Introduction to Molecular Neurobiology Z.W. Hall Sinauer Associates Inc. Publishers.
23. Ion Channels – Molecules in Action D. J. Aidley and P.R. Stanfield. Cambridge University Press.
24. Comparative Neurobiology J. P. Mill Edward Arnold Publishers.
25. Physiology Of the Nervous Systems D Ottoson, McMillan Press 25

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**Reference books for Unit I to IV
Biotechnology and Genetic Engineering**

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