



## SOPHIA COLLEGE (AUTONOMOUS)

Affiliated to the University of Mumbai

Syllabus for Semesters V to VI

Program: B.Sc.

Course: Life Sciences

(Choice Based Credit System with effect from the year 2022-23)

**PREAMBLE Programme:**

**B.Sc.**

**Course: Life Sciences (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. SBSLSC502 and SBSLSC602
3. SBSLSC503 and SBSLSC60
4. SBSLSC504 and 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. SBSLSC502 and SBSLSC602

**LIFE SCIENCE SYLLABUS**  
Choice based Credit and Grading System Academic year 2022 -2023

**SEMESTER V**

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

<b>SBSLSC504</b>	<b>1</b>	Introduction to fundamentals of Environmental science	<b>2.5</b>	<b>15</b>
	<b>2</b>	Biodiversity and habitats		<b>15</b>
	<b>3</b>	Pest management and toxicology		<b>15</b>
	<b>4</b>	Sustainable development		<b>15</b>
<b>SBSLSCP504</b>		Practical	<b>1.5</b>	

**SEMESTER VI**

<b>COURSE CODE</b>	<b>UNIT</b>	<b>TOPIC HEADINGS</b>	<b>CREDITS</b>	<b>LECTURES</b>
<b>Paper I</b>		<b>Genetics and Immunology II</b>		
<b>SBSLSC601</b>	1	Organisms and techniques used in the understanding of Genetics	<b>2.5</b>	15
	2	Tools and Techniques in Molecular Genetics		15
	3	Hypersensitivity, Infectious		15
		diseases, Vaccines and Immunodeficiency		
	4	Transplantation, Tumor Immunology, Tolerance and Autoimmunity		15
<b>SBSLSCP601</b>		Practical	<b>1.5</b>	
<b>Paper II</b>		<b>Developmental Biology and Neurobiology II</b>		
<b>SBSLSC602</b>	1	Animal and plant development – Basic cellular and molecular aspects	<b>2.5</b>	15
	2	Applications of developmental biology		15
	3	Sensory and motor systems		15
	4	Neurobiological basis of behaviour		15
		Practical		<b>1.5</b>
<b>SBSLSCP602</b>		Practical	<b>1.5</b>	
<b>Paper III</b>		<b>Biotechnology and Genetic Engineering II</b>		
<b>SBSLSC603</b>	1	Fermentation technology – Enzyme and Pharmaceuticals Production	<b>2.5</b>	15
	2	Tissue Culture biotechnology		15
	3	Applications of recombinant DNA technology		15
	4	Tools in genetic engineering Bioinformatics: Structural and functional Genomics, Comparative Genomics		15
		Practical		<b>1.5</b>
<b>SBSLSCP603</b>		Practical	<b>1.5</b>	
<b>Paper IV</b>		<b>Environmental Biology II</b>		

<b>SBSLSC604</b>	<b>1</b>	Environmental degradation	<b>2.5</b>	<b>15</b>
	<b>2</b>	Natural resources		<b>15</b>
	<b>3</b>	Environmental impact study		<b>15</b>
	<b>4</b>	Society and environment		<b>15</b>
<b>SBSLSCP604</b>		Practical	<b>1.5</b>	

**SEMESTER V**  
**COURSE CODE: SBSLSC501**  
**PAPER I GENETICS AND IMMUNOLOGY I**

**Course Objectives**

- CO1:** Make the students understand the history of genetic organization of genomes subsequently gene expression and regulation
- CO2:** Make the students able to study the mechanism of genetic inheritance and variation
- CO3:** Make the students gain the knowledge about the immune system and its involvement in generating immune response
- CO4:** Make the students learn the significance of antigen antibody interaction and its downstream effects on effector mechanisms

**Course Outcomes :**

Students will be able to

- LO1:** summarize the discovery of the genetic material
- LO2:** comprehend the complexity of nucleic acid and organization of eukaryotic and prokaryotic genome
- LO3:** articulate gene regulation, genetic recombination and inheritance, and mutational variation in eukaryotes
- LO4:** gain an understanding regarding the immune cells , organs of the immune system and immune response

Course Code	Title	Lectures (60L)
SBSLSC501	GENETICS AND IMMUNOLOGY I	2.5 credits
<b>UNIT 1: The Genetic Material</b>		<b>15 L</b>
<b>Discovery of the genetic material:</b> Griffith's experiment of 1928; Avery, McLeod and McCarty's experiment of 1944; Hershey-Chase's experiment – (Brief review, only for short notes.)		2
<b>1. Organization of Prokaryotic and Eukaryotic Genome:</b>		
Structural organization of Prokaryotic and Eukaryotic genome (CCC DNA, Nucleosome structure, higher orders of chromosome packaging, Solenoid model, zig-zag model)		3
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.		3
<b>2. Gene regulation in eukaryotes</b>		
Chromatin condensation (Euchromatin, heterochromatin)		3
Modification and remodelling by acetylation and methylation		
Transcriptional regulation		4
Cis-acting regulatory sequences, promoters and enhancers. Transcription activators and repressors.		

<b>UNIT 2: Mechanisms of Inheritance and variation</b>	<b>15 L</b>
<p><b>1. Inheritance pattern of Genetic Disorders in Humans</b> Prognosis, Testing, of any human genetic disorder</p>	2
<p><b>2. Introduction to genetic recombination</b></p> <p>2.1 Types of naturally occurring genetic recombination. (e.g Homologous/Non homologous/site directed)</p>	2
2.2 Mechanism and proposed models for genetic recombination (e.g Holliday Model/Double strand break model)	2
2.3 Advantages of genetic recombination during meiosis	2
<p><b>3. Mutational Variation:</b></p> <p>Natural biological mutagenic agents – Prokaryotic Transposable elements and their significance</p>	2
2.4. A. Types of eukaryotic transposons, their mechanism of action,(e.g AcDs system in maize, P element transposition) and inheritance	4
2.5.B. Application of transposable elements in genetics	1
<b>UNIT – III Overview and cells and organs of immune system</b>	<b>(15L)</b>
<b>Historical Perspective - Early Vaccination studies; Infection and immunity</b>	1
<p><b>Overview of the Immune system - Innate Vs Adaptive Immunity</b></p> <p>A. Innate immunity</p> <p>i) Anatomical, Physiological, Phagocytic, Inflammatory barrier</p> <p>ii) Concept of PAMP, PRR and TLR</p>	2
<p>B. Cells and organs of the immune system</p> <p>i) Cells - structure and functions – Myeloid cells, Lymphoid cells – B and T cells, NK cells ii) Primary and secondary lymphoid organs</p>	3
<p><b>Antigens and antibodies</b></p> <p>3.1 A. Immunogenicity versus antigenicity</p> <p>i) Antigen-Specificity, avidity, affinity, cross reactivity, haptens, adjuvants, epitopes ii) Properties of immunogen contributing to immunogenicity</p>	1
<p>3.2 B. Antibodies</p> <p>i) Basic structure of antibodies</p> <p>ii) Classes of antibodies and biological activity</p> <p>iii) Polyclonal and monoclonal antibodies (Hybridoma technique)</p>	3
<p>3.3 C. Organization and expression of Immunoglobulin genes</p> <p>i) Multi gene organization and gene rearrangement</p> <p>ii) Generation of antibody diversity</p> <p>iii) Class switching</p>	3
<p>3.4 D. Antigen-antibody interactions – Principles and applications</p> <p>Precipitation, Agglutination, Radioimmunoassay, ELISA, Immunofluorescence, Western blotting, Flow cytometry, Surface Plasmon resonance</p>	



UNIT – IV Antigen recognition and Effector Mechanisms	(15L)
<p><b>4.1 Recognition of antigens.</b></p> <p><b>4.1A. Major Histocompatibility Complex</b></p> <ul style="list-style-type: none"> <li>i. MHC molecules and genes</li> <li>ii. MHC allelic polymorphism</li> <li>iii. Cellular expression of MHC</li> <li>iv. Self MHC restriction of T cells</li> </ul> <p><b>B. Antigen processing and presentation</b></p> <ul style="list-style-type: none"> <li>i. Endogenous antigens – the cytosolic pathway</li> <li>ii. Exogenous antigens – the endocytic pathway</li> </ul> <p><b>Maturation and activation of Lymphocytes</b></p> <ul style="list-style-type: none"> <li>i. B- cell Maturation, Activation and Differentiation</li> <li>ii. T- cell receptor – Structure and role of <math>\alpha\beta</math> and <math>\gamma\delta</math> receptors</li> <li>iii. T cell receptor complex and accessory membrane molecules</li> <li>iv. T- cell Maturation, Activation and Differentiation</li> </ul> <p><b>Immune Effector Mechanisms</b></p> <ul style="list-style-type: none"> <li>i) Cytokines- IL-1, IL-2, IL-4, IFNs and TNFs</li> <li>ii) Cytokine secretion by <math>T_H1</math> and <math>T_H2</math> cells</li> </ul> <p><b>Complement</b></p> <ul style="list-style-type: none"> <li>i. Classical, alternate and lectin pathways and comparison</li> <li>ii. Biological consequences of complement activation</li> <li>iii. Complement fixation tests</li> </ul> <p><b>Cell-mediated effector responses</b></p> <p>Cell-mediated cytotoxicity of T cells, NK cells, ADCC Role of <math>T_H1</math>, <math>T_H2</math>, <math>T_H17</math> and <math>T_c</math> cells</p>	<p>2</p> <p>2</p> <p>2</p> <p>1</p> <p>2</p> <p>1</p> <p>2</p> <p>3</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 and Gram Staining
3. Viable count for enumeration of bacteria by –Bulk seed method
4. Viable count for enumeration of bacteria by - Surface spread method
5. Determination of Minimum Inhibitory Concentration (MIC) using NaCl/any other suitable antimicrobial substance against a Bacterial culture

##### 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 Coombs 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: SBSLSC502**

**PAPER II- DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY I**

**Course Objectives Developmental Biology I**

- CO1:** Introduce the students to the concepts in development with basic understanding of the processes involved  
**CO2:** Aid the students to further understand the concepts like body plan, potency, regulatory development, spemann's organizer in development using model organism  
**CO3:** Familiarize the students with detailed development in plants especially in the model plant Arabidopsis, further introduction to double fertilization and seed formation

**Neurobiology I**

- CO 3** Make the students gain an understanding of general organization of the nervous system.  
**CO 4** Make the students understand the cellular organization of the nervous system.

**Course Outcomes**

**Developmental Biology -I**

Student will be able to

- LO1:** differentiate concepts like morphogen gradient, growth, morphogenesis and pattern formation  
**LO2:** familiarize oneself with experimental approaches like fate mapping, large scale mutagenesis screens and use of transgenics to study development of model organisms  
**LO3:** gain knowledge about plant development

**Neurobiology I**

Student will be able to

- LO 4:** describe the anatomical organization, functioning of the nervous system and its early development.  
**LO 5:** analyze the cellular basis of nerve conduction within a neuron and transmission across synapses.

Course Code	Title	Lectures(60L)
SBSLSC502	DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY I	2.5 Credits
<b>UNIT 1 : Developmental Biology : Concepts, Model organisms and techniques</b>		<b>15 L</b>
<b>History of concepts in development</b>		1
<b>Some basic concepts of developmental biology:</b> 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
<b>Life Histories of Model Organisms highlighting some important concepts:</b> i. <i>Dictyostelium</i> - cell signaling and morphogenetic gradient ii. <i>Drosophila</i> : Overview of invertebrate body plan (Life Cycle and body plan) iii. Zebrafish :Overview of vertebrate body plan (Life Cycle and body plan)		6

<b>Experimental approaches to studying development:</b> iv. Fate mapping and lineage tracing (Chick) Mutations and large scale mutagenesis screens(Drosophila) v. Transgenic techniques and gene silencing (Zebra fish/mice)	6
<b>Unit 2: Animal and Plant development – Basic Cellular aspects</b>	<b>15 L</b>
<b>2.1 Development in Animals</b> <b>2.1 a</b> Amphibian development- Germ cell formation: meiosis and cytoplasmic state of the egg; Fertilization: Cell signaling 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 <b>2.2 b</b> Chick development – In Comparison with amphibian in the processes of Germ cells and Fertilization, Cleavage, Morula and blastula, Gastrulation and Neurulation <b>2.3 Development in Plants</b> 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 5 5
<b>UNIT 3 :General organization of nervous system:</b>	<b>15 L</b>
<b>3.1. Comparative overview of vertebrate and invertebrate nervous system</b> 3.1.a Vertebrate nervous system: Anatomy and functional features of CNS (cerebral hemispheres, cerebellum, diencephalon, medulla, pons, midbrain and spinal cord),PNS (autonomous, somato sensory, cranial, spinal,plexii) 3.1.b Role of meninges and CSF, concept of blood brain barrier. 3.1.c Limbic System (emotions and memory) 3.1. d. Hypothalamo – Hypophysial Axis(stress) <b>Development of the nervous system:</b> 3.2.a Specification of cell identity in the nervous system 3.2.b The formation and migration of neuron 3.2.c Axon navigation 3.2.d Synapse formation and refinement	2 5 1 1 1 1 1 2

<b>UNIT 4: Cellular organization of the nervous system</b>	<b>15 L</b>
<b>4.1 Chemical Basis of Neural transmission-</b> Introduction Ionic basis of resting membrane potential: types of ion channels, Nernst's potential, Goldman's equation, Sodium –Potassium pump	3
<b>4.2 Action Potential &amp; propagation:</b> Hodgkin and Huxley's model, voltage clamp experiment and the generation and propagation of Action Potential, Graded potential. A comparative Plant example: Electrical signaling and closing of Venus fly trap.	3
<b>4.3 Synaptic potential and synaptic integration</b> [Electrical and Chemical Synaptic Potential] Excitatory Post Synaptic Potential (EPSP), Inhibitory Post Synaptic Potential(IPSP)	2
<b>4.4 Synapse and synaptic transmission:</b> Synapse: Structure, Types – Electrical and chemical; Neuro – muscular junctions; miniature endplate potentials(MEPPs)	2
<b>4.5 Neurotransmitters</b> – 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).	5

**Course code: SBSLSCP502**

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

### **I) Developmental Biology:**

Animals:

- 1) Study of developmental stages of chick embryo
- 2) Cytochrome C- oxidase activity in a developing chick embryo

Plants:

- 1) Effect of temperature on cell viability in pollen grains/yeast using Trypan blue/acetocarmine. 2) Root and shoot development in sections of a 2-day old plant embryo.

Demonstration experiments (Any two of the following):

- 1) Programmed cell death in limb bud using Janus Green B stain (in chick embryo).
- 2) Alizarin stain to study limb development in chick embryo/bone zebrafish
- 3) Acid and alkaline Phosphatase in Chick embryo / Alcian blue staining to study cartilage in zebrafish

### **II) Neurobiology:**

- 1) Dissection & display of Nervous system in invertebrates –earthworm
- 2) Dissection & display of Nervous system in vertebrates – chick brain
- 3) Study of chick embryo for identification of fore, mid & hind brain areas (Refer above Developmental Biology Practicalno.1)

4) Study of Permanent slides of:

- a) Medullary nerve fibre
- b) TS of Spinal cord
- c) Meninges

5) Electron micrographs of neural tissue

Demonstration Experiments (Any two of the following):

- 5) Study of the Nervous system of Sepia with special reference to Giant axon and stellate ganglia
- 6) Assignment - Bird songs and neurophysiology involved (as a group practical)
- 7) Understanding the principle and basic interpretation of brain imaging tests like PET and MRI

**COURSE CODE: SBSLSC503**

**PAPER III- BIOTECHNOLOGY AND GENETIC ENGINEERING I**

**Course Objectives**

**CO1:** To introduce students with different aspects of fermentation technology

**CO2:** To familiarize students with industrial production of food and beverage

**CO3:** Understanding principle behind the working of instruments in Biotechnology

**CO4:** To Familiarize students with Intellectual property rights.

**CO5:** Acquaint the students with the components of genetic engineering and biotechnology

**CO6:** Introduce the students to different types of tools and techniques used in recombinant DNA technology

**Course Outcome:**

Students will be able

**LO1:** to understand the process behind biotechnological products from biotechnological industries.

**LO2:** to analyze, interpret the data coming from instruments used in Biotechnology.

**LO3:** to apprehend the concepts of genetic engineering that includes details about the vector, restriction enzymes, DNA recombination and cloning.

**LO4:** to compare and contrast the principle and procedure of tools and techniques used in recombinant DNA

Course Code	Title	Lectures (60L)
SBSLSC503	Biotechnology and Genetic Engineering I	2.5 Credits
<b>UNIT I: Fermentation technology – Principles</b>		<b>15 L</b>
History and development of Food & Fermentation Technology		
a. The Bioreactor / Fermenter & accessories (Stirred tank & Airlift)		1
b. Sterilization requirements in Bioprocess technology		1
Principles of microbial growth,		1
Screening (primary & secondary)		1
		2
Strain improvement (mutation & selection using auxotrophy & analogue resistance		2
1.5. Media design for fermentation (include molasses, corn steep liquor)		2
Downstream processing		1
Instrumentation: Principles and technique of Centrifugation, Spectrophotometry & Chromatography		4

<b>UNIT II: Fermentation technology - Food and Beverage Production</b>	<b>15 L</b>
Technological aspects of industrial production of: Cheese/ Yoghurt Beer/ Wine /Vinegar Single Cell Protein Mushroom Food quality assurance: Regulatory & social aspects of food biotechnology 2.3. Intellectual Property Rights	2 3 2 2 3 3
	<b>15 L</b>
<b>UNIT III: Tools in Recombinant DNA technology</b>	
<b>3.1: Tools in Molecular Biology</b>	3
3.1.a. Restriction Enzymes – Nomenclature, General nature of action, Major categories based on type of cut, two typical examples each and recognition sites	2
3.2.b. DNA joining strategies: DNA ligase, Homopolymer tailing, Adaptors, Linkers, Use of Alkaline Phosphatase.	4
<b>3.2 Vectors in genetic engineering –</b>	
3.2.a. Phages ( $\lambda$ , M13, SV40, Adenovirus)	3
3.2.b. Plasmids (pBR322, pUC with blue white screening), Ti plasmids in plants	1
3.2.c. Cosmids, Phagemids	2
3.2.d. YAC, BAC, PAC	
<b>Unit IV: Techniques in Recombinant DNA technology and applications</b>	<b>15 L</b>
<b>4.1. Gel electrophoresis</b> (Principle, technique and application of Agarose, PAGE, 2D-GE)	3
<b>4.2. Blotting</b> (Principle, technique and application of Western, Southern, Northern blotting)	3
<b>4.3. Polymerase Chain Reaction</b>	1
4.3.a. Basics of PCR	1
4.3.b. Variations of PCR – RT-PCR, QPCR (Principle, technique and application)	1
4.3.c. Variations in Primer – Nested PCR, Poison Primer Technique, Universal primers	4
4.4. Restriction mapping, DNA fingerprinting (Principle, technique, applications) - SNP, VNTR, RFLP, AFLP	2
4.5. Cloning of a gene (Somatostatin / Insulin)	



**Course Code: SBSLSC P503**

**[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  $K_m$  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 CO<sub>2</sub> with under different conditions. (Demonstration / group experiment)
9. Microbial culture and Growth Curve

**COURSE CODE: SBSLSC504**

**PAPER IV-ENVIRONMENTAL BIOLOGY-I**

**Course Objectives**

**CO1:** To appraise the environment around us.

**CO2:** To introduce the fundamental concepts of environment and the biodiversity around us.

**CO3:** To introduce the India and Multilateral Environmental agreements

**CO4:** Comprehend the significance of pests, pesticides, toxicology management

**CO5:** To inculcate the knowledge of Community and Environment Conservation.

**Course Outcome:**

Student will be able to

**LO 1:** identify issues and problems regarding the natural resources.

**LO 2:** infer community and environment conservation.

**LO3:** understand the importance of toxicology management and the subsequent importance of Community and Environment Conservation

Course Code	Title	Lectures (60L)
SBSLSC504	ENVIRONMENTAL BIOLOGY I	2.5 Credits
<b>UNIT I</b>		<b>15 L</b>
<b>1.1. Environmental History and Natural resources:</b> Definition, Scope and Importance		
<b>1.1.a. Environmental History:</b> 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		
<b>1.1.b. Community Ecology:</b> 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).		
<b>1.1.c. Population ecology:</b> Population parameters- Spacing, size and density, Age composition, Survivorship curves, recruitment, Population growth- logistic, exponential, Geometric growth.		
Population cycles, population dynamics and models of population regulation: Competition and predation		
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>		
<b>1.2. Ecosystem dynamics:</b>		
1.2.a. Energy flow, primary and secondary productivity, Ecological Pyramids.		
1.2.b. Soil Ecology: Soil Profile, Soil food web (components and interactions) sustainable soil management and agriculture.		

1.2.c. Anthropogenic effects on Biogeochemical cycles of Carbon and Nutrient cycles (S, P and N)	
<b>UNIT II</b>	<b>15 L</b>
<b>2.1. Biodiversity and Habitats:</b>	
2.1. a. Biomes of the world: climate, vegetation and Geographical distribution pattern. Tropical biomes, desert, temperate, taiga and tundra biome.	1
b. Biological diversity of India: Indian Biogeographic Zones, climate and its impact on biodiversity.	2
<b>Indian flora and fauna</b>	
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
2.2. b. Environmental biotechnology: Role of biotechnology in conservation of species, <i>in-situ</i> and <i>ex-situ</i> conservation, (concept of Gene Bank)	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.	2
<b>2.3. India and Multilateral Environmental agreements</b>	
2.3. a. Implications of Environmental Agreements to India: Ratification, Becoming a Signatory, Responsibilities, Obligations, expectations and challenges.	1
2.3.b. RAMSAR Convention on Wetlands	
2.3.c. IUCN (International Union for Conservation of Nature and Natural Resources)	1
2.3.d. Convention on Biological Diversity	
2.3.e. CMS (Convention on the Conservation of Migratory Species)	1
2.3.f. Basel Convention on the Control of Trans boundary Movement of Hazardous Waste and Their Disposal	1
2.3g. Kyoto Protocol	
2.3h. IWC (International Whaling Commission)	
<b>2.4 Population and consumption Dynamics with special reference to Humans:</b>	3
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.	

<p><b>Unit III</b></p> <p><b>3.1. Pest and pesticides:</b></p> <p>3.1 a. Basic introduction about Pests, Pesticides and Environment</p> <p>3.1b. 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</p> <p>3.1 c. Bioremediation of pesticide: using <i>Bacillus</i> Sps.(eg. Malathion Pesticide)</p> <p>3.1.d.Phytoremediation of Organochlorine pesticide(Chloropyrifos) using plants</p> <p>3.1.e.Pesticide regulation: eg.Endosulphan issue.</p> <p><b>3.2 ToxicologyManagement:</b></p> <p>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.</p> <p>3.2.b.Limitation of Toxicological studies: Comparison of animal toxicological models and Toxicity in Humans.</p> <p>3.2. c Human clinical trials: Concept of Clinical trial phases-I, 2, 3and Pharmacovigilance.</p> <p>3.2.d.Ethical issues of clinical trials: (e.g. Thalidomide) and significance of Helsinki declaration.</p>	<p><b>15 L</b></p> <p>1</p> <p>3</p> <p>1</p> <p>2</p> <p></p> <p>3</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>
<p><b>UNIT IV</b></p> <p><b>4.1 Community and Environment Conservation.</b></p> <p>4.1a. Case study- Amur Falcon and tribal community of Nagaland</p> <p>4.1b.Oneman 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- Kokrabelur Village.</p> <p><b>4.2. Citizen Awareness and environmental legal provisions:</b></p> <p>4.2 a. Environmental Law and Constitution of India: Constitutional Provisions: Article 21,Article 48A, Article 51A(g), Environment protection Act1986,MoEF(1985)</p> <p>4.2 b. 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><b>15 L</b></p> <p>3</p> <p>2</p> <p>2</p> <p>3</p> <p></p> <p>5</p>

**Coursecode: SBSLSC P504**

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

1. Plankton collection/Plankton identification and quantification from river/Lake water samples
2. Vegetation studies by line, quadrates and belt transect methods and their analysis.
3. 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 examples)
4. Preparation of media for microbial culture, Isolation and culturing of microbes from soil/water samples (Fungal/Bacterial/Algal organism).
5. Study of fecundity from the given sample of fresh water/ marine fish
6. Isolation and culturing of Rhizobium from the given sample
7. Analysis of soils for pH, moisture, soil types.
8. Water analysis for physicochemical characteristics:(any three) Salinity/Acidity/Alkalinity/BOD/DO/COD/Copper
9. Study of effect of a metal toxicity on the heartbeat of Daphnia and statistical analysis of the same t Test/LC50
10. A visit to a Nature Park/Mangrove

**SEMESTER VI COURSE CODE: SBSLSC601**

**PAPER I- GENETICS AND IMMUNOLOGY II**

**Course Objectives**

**CO1:** Understanding the concept of gene mapping

**CO2:** Studying the various tools and techniques involved in human genetics and recombination

**CO3:** Learning about immune mediated hypersensitivity, infectious, vaccines and importance immunodeficiency diseases

**CO4:** Introducing the concepts of transplantation, tumor immunology, tolerance and autoimmunity

**Course Outcomes**

The student will be able

**LO1:** perform gene mapping using numerical problems

**LO2:** interpret the knowledge of gene recombination and mapping in detection of polymorphism and personalized medicine

**LO3:** compare and contrast between between different tools and techniques in molecular genetics

**LO4:** make use of the knowledge to understand the mechanistic insight involved in hypersensitivity, immunodeficiency diseases and vaccine development

**LO5:** summarize the the concepts of transplantation, tumor immunology, tolerance and autoimmunity

Course Code	Title	Lectures(60 L)
	<b>Genetics and Immunology II</b>	<b>2.5 credits</b>
<b>UNIT 1: Organisms and techniques used in the understanding of Genetics</b>		<b>(15 L)</b>
<b>1. Genetic recombination and Gene mapping (Processes and numerical problems)</b>		
1.1. Bacterial Conjugation		1
1.2. Three factor crosses in maize		2
1.3. Co-efficient of co-incidence and interference in Drosophila		2
1.4. Complementation analysis in Humans using Haemoglobin		2
1.5. Life Cycle of lytic and lysogenic phages; Deletion mapping		2
<b>2. Human Genetics</b>		
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		
2.2 The Human Genome Project : aims, major features and applications(e.g. detecting polymorphism, personalized medicine)		3
		3

<p><b>3. Genetic recombination and Gene mapping (Processes and numerical problems)</b></p> <p>3.1. Bacterial Conjugation</p> <p>3.2. Three factor crosses in maize</p> <p>3.3. Co-efficient of co-incidence and interference in Drosophila</p> <p>3.4. Complementation analysis in Humans using Haemoglobin</p> <p>3.5. Life Cycle of lytic and lysogenic phages; Deletion mapping</p> <p><b>4. Human Genetics</b></p> <p>4.1. 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</p> <p>4.2. The Human Genome Project : aims, major features and applications(e.g. detecting polymorphism, personalized medicine)</p>	
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<p><b>UNIT II: Tools and Techniques in Molecular Genetics</b></p> <p>2.1 Agarose gel electrophoresis (Principle, methodology, Applications)</p> <p>2.2 Polymerase Chain Reaction (Principle, methodology, Applications)</p> <p>2.3 Restriction enzymes and Restriction mapping</p> <p>2.4 DNA Sequencing – Sanger’s Method, Next Gen Sequencing</p> <p>2.5 PCR based methods of Induced mutagenesis (Site-directed mutagenesis, Cassette mutagenesis).</p> <p>2.6 Mutagenicity testing- Ames test, Sister chromatid exchange test, mouse specific locus test (Advantages and disadvantages)</p> <p>2.7 Nucleic acid in situ Hybridization (FISH) and Chromosome painting</p> <p>2.8 Hybrid arrest and Hybrid release method (HRT and HART)</p>	<p><b>(15L)</b></p> <p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>
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<p><b>UNIT – III: Hypersensitivity, Infectious diseases, Vaccines and Immunodeficiency</b></p> <p><b>3.1. Hypersensitivity</b></p> <p>Gell and Coombs classification:</p> <p>Types of hypersensitivity – Examples and methods of diagnosis</p> <p>i) IgE- mediated (Type I) hypersensitivity mechanism, mediators and control methods: RIST and RAST</p> <p>ii) Antibody-mediated (Type II) hypersensitivity: Agglutination</p> <p>iii) Immune complex-mediated (Type III) hypersensitivity: Immunofluorescence, ELISA</p> <p>iv) Delayed type hypersensitivity (Type IV): Tuberculin test</p> <p><b>3.2. Infectious Diseases and Vaccines</b></p>	<p><b>(15L)</b></p> <p><b>5</b></p>
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<p>3.2.a. Important immune mechanisms against various infectious diseases</p> <ul style="list-style-type: none"> <li>i) Viral infections</li> <li>ii) Bacterial infections</li> <li>iii) Fungal infections</li> <li>iv) Parasitic infections</li> </ul> <p>3.2 b. Vaccines</p> <ul style="list-style-type: none"> <li>i) Passive immunization - Preformed antibodies and their disadvantages</li> <li>ii) Use of Chimera / humanized antibodies</li> <li>iii) Active immunization-Whole organisms (attenuated vs. inactivated eg. Polio)</li> <li>iv) Subunit Vaccines (Polysaccharide, toxoid and peptide vaccines)</li> <li>v) DNA vaccines</li> </ul> <p><b>Immunodeficiency: Primary and acquired Immunodeficiency</b></p> <ul style="list-style-type: none"> <li>a) Primary immunodeficiency <ul style="list-style-type: none"> <li>i) B-cell- X-linked agammaglobulinemia</li> <li>ii) T-cell- Di George Syndrome</li> <li>iii) Lymphoid deficiency - Severe Combined Immunodeficiency</li> <li>iv) Deficiency of myeloid lineage- Chronic Granulomatous Disease</li> </ul> </li> <li>b)Acquired Immunodeficiency <ul style="list-style-type: none"> <li>i) Acquired Immunodeficiency Syndrome</li> </ul> </li> </ul>	<p style="text-align: center;">7</p> <p style="text-align: center;">3</p>
<p><b>UNIT – IV : Transplantation, Tumor Immunology, Tolerance and Autoimmunity</b></p>	<p><b>(15L)</b></p>
<p><b>4.1 Transplantation</b></p> <ul style="list-style-type: none"> <li>i) Types of grafts</li> <li>ii) Tissue typing (serological and MLR)</li> <li>iii) Mechanisms of graft rejection</li> <li>iv) Immunosuppressive therapy</li> <li>v) Graft vs. host disease - bone marrow transplant</li> </ul> <p><b>4.2 Tumor Immunology</b></p> <ul style="list-style-type: none"> <li>i) Tumor specific and associated antigens</li> <li>ii) Role of NK cells and macrophages</li> <li>iii) Tumor evasion of immune system</li> <li>iv) Cancer immunotherapy.</li> </ul> <p><b>Tolerance and Autoimmunity</b></p> <p>4.3.a Establishment and maintenance of tolerance</p> <ul style="list-style-type: none"> <li>i) Mechanisms of central tolerance</li> <li>ii) Mechanisms of peripheral tolerance</li> <li>iii) Role of T regulatory cells</li> <li>iv) Immunology of pregnancy</li> </ul> <p>4.3.b. Autoimmunity</p> <ul style="list-style-type: none"> <li>i) Mechanisms for induction (Aetiology)</li> <li>ii) Organ specific diseases – ex. Myasthenia gravis, Graves disease</li> <li>iii) Systemic diseases – ex. Systemic Lupus Erythematosus, Multiple sclerosis</li> </ul>	<p style="text-align: center;">4</p> <p style="text-align: center;">4</p> <p style="text-align: center;">4</p> <p style="text-align: center;">3</p>



## SEMESTER VI PRACTICAL SYLLABUS

Course code: SBSLSCP601

[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

#### III) 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.

#### IV) 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 IgG subfraction
11. Qualitative ELISA using albumin

**COURSE CODE: SBSLSC602**

**PAPER II- DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY II**

**Course Objectives**

**Developmental Biology II**

**CO1:** Explains the molecular and cellular aspects of the important genes involved in early development in plants and animals

**CO2:** Introduction to regeneration, advances in stem cell and regenerative medicine, apoptosis and types of cancer and the treatment strategies

**Neurobiology II**

**CO 1:** Describes the structural and functional features of the various sensory and motor systems.

**CO 2:** Elaborates on some behavioral aspects such as sleep and memory.

**Course Outcomes**

Students will be able to

**Developmental Biology II**

**LO1:** differentiate between determination and transdetermination

**LO2:** have knowledge of the molecules deposited by the mother and the role of Maternal genes and zygotic genes

**LO3:** familiarize oneself with the plant genome project

**Neurobiology II**

**LO1:** describe the sensory and motor systems

**LO2:** deduce the neurobiological basis of behavior and diseases that arise due to malfunction of the nervous system.

Course Code	Title	Lectures (60 L)
	<b>DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY II</b>	<b>2.5 credits</b>
<b>UNIT 1: Animal and Plant development – Basic Cellular and Molecular Aspects</b>		<b>(15L)</b>
<b>Potency:</b> Totipotency (Nuclei), Pluripotency (Inner cell mass/embryonic stem cells), Multipotency (mesenchymal stem cells), Oligopotency (Monocytes)		2
<b>Determination and Trans determination</b> (Imaginal Discs)		
<b>Differentiation:</b> Hematopoietic stem cells and Neural crest cells (migration and differentiation)		3
<b>Molecular basis of development</b>		
i. Genes in early development (with <i>Drosophila</i> as example)		
ii. Determination of anterior- posterior and dorso-ventral axis		
iii. Role of Maternal genes and zygotic (Gap genes, pair-rule genes,		3
iv. Segmentation genes and Homeotic genes)		
v. Beta globin gene – as an example of change in gene expression		

<p><b>Conserved nature of developmental genes</b> (Evo- Devoperspective Hox/Pax6 genes with respect to Drosophila)</p> <p><b>Organogenesis</b> of Eye OR Limb with references to inductive/ instructive signals, cytoplasmic determinants and gradients</p> <p><b>Plant Development</b></p> <p>i. Role of Homeotic genes specifying parts of a flower: Classical ABC Model (ABCD and ABCDE model on floral evolution to be given as assignment)</p> <p>ii. Plant genome project (Arabidopsis/rice)</p>	<p>2</p> <p>1</p> <p>2</p> <p>2</p>
<b>UNIT 2: Applications of Developmental Biology</b>	<b>(15L)</b>
<p><b>2.1. Assisted human reproduction</b></p> <p><b>2.2. Regeneration</b></p> <p>a. Examples in animal world (vertebrates and invertebrates)</p> <p>b. Epimorphic (Salamander limb) and Morphallactic (Hydra)</p> <p>c. Compensatory regeneration (mammalian liver)</p> <p>d. Recent advances in stem cells and regenerative medicine (student assignment)</p> <p><b>2.3. Aging-</b> Theories of Aging</p> <p><b>2.4. Congenital abnormalities</b> : sensitive periods during development and 3 causes of congenital abnormalites with special references to the following</p> <p>a. Zika virus b. Alcohol c. Spina bifida</p> <p><b>2.5. Cell cycle regulation</b> - check points in cell cycle and role of cyclins and cdks<sup>1</sup></p> <p><b>2.6. Apoptosis</b> and its role in development</p> <p><b>2.7. Cancer-</b> Types of Cancer, Causes of Cancer, Oncogenes, Tumour suppressor genes, Treatment strategies for Cancer (example breast cancer)</p>	<p>1</p> <p>4</p> <p>2</p> <p>3</p> <p>1</p> <p>1</p> <p>2</p>
<b>Unit 3: Sensory and motor systems</b>	<b>(15 L)</b>
<p><b>3.1 Introduction to Human Sense organs:</b> receptors, receptor mechanisms and pathways</p> <p><b>3.1.a. Visual system:</b> Vision - structure of the eye, retina, photoreceptors (rods and cones), photo transduction, binocular vision, visual pathway (flow chart only – LGN to visual cortex), light &amp; dark adaptation, colour vision.</p> <p><b>3.1.b. Auditory System:</b> Structure of the ear, cochlea and organ of corti receptors 1 Mechanism of transduction, Auditory pathway: (MGN to audio cortex) Diagrammatic representation only.</p> <p><b>3.1.c. Vestibular System:</b> Structure of the vestibular labyrinth, maculae and cristae. Mechanism of transduction.</p> <p><b>3.1. d. Chemosensory system:</b> Olfactory and Gustatory receptors –structure.</p> <p><b>3.1.e.Skin as sense organ:</b> somatic receptors - Types of mechano- receptors, pain reception&amp; Pain management (example analgesic effect by prostaglandin inhibition - aspirin)</p>	<p>1</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p>

<b>3.2. Motor System:</b>	1
3.2.a. Organization, Reflex Coordination(ascending and descending pathways diagrammatic representation only)	1
3.2.b. Role of cerebellum in motor co-ordination	1
3.2.c. Types of muscles, Molecular basis of Muscle contraction	1
3.2.d. Reflexes: Simple reflex arc, mono and poly-synaptic reflexes (one example of each)	1
<b>UNIT 4 : Neurobiological basis of behaviour</b>	<b>(15 L)</b>
<b>4.1.a Sleep</b> , Stages of sleep – REM and non REM	4
<b>4.1.b Short term memory and Long Term Memory</b> (eg. Pathway in Aplysia and molecular events)	4
<b>4.2 Neurobiological basis of Diseases:</b>	7
4.2.a Epilepsy	
4.2b Parkinson's disease	
4.3c Schizophrenia- Relevance with regard to neurotransmitters	
4.4d Prions associated diseases	
4.5e Duchene's muscular Dystrophy	
4.5f Alzheimer's disease	

**Course Code: SBLSCP602**

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

## **I) Developmental**

### **Biology Plant**

1. Effect of boron / calcium on pollen tube germination pollen tube length in *Vinca rosea* or any other suitable sample
2. Role of GA in seed germination.
3. Demonstration experiments: Plant Tissue Culture: Initiation of plant tissue culture from neem and /or carrot callus/any other suitable source: (project to be performed in groups of 4-5students)

### **Animal**

4. Live observations of Developmental stages of  
*C.elegans/Dictyotelim/Drosophila/Zebrafish* Demonstration experiments: (Any two)
5. Imaginal discs of *Drosophila*
6. Regeneration in earthworm / any other suitable system /hydra
7. Animal Cell Culture /Assays: Cell proliferation assay/ Cell migration assay/ Cell adhesion assay

## **II) Neurobiology**

1. Differential staining of white and grey matter of vertebrate brain.
2. Temporary mounts of the following (Any three):
  - 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
- f) Olfactory & gustatory sensillae
- g) Histological staining of neuronal tissue using Heamatoxylin-Eosin staining or Nissl's staining.

3) Making clay model of vertebrate brain and cranial nerves

4) Demonstration Experiments

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

6. Mammalian retina (Study of Histology)

**COURSE CODE: SBSLSC603**

**PAPER III- BIOTECHNOLOGY AND GENETIC ENGINEERING II**

**Course Objectives**

**CO 1:** Familiarizing students with the process of production of enzyme and pharmaceutical products.

**CO 2:** Introducing students to tissue culture techniques.

**CO3:** Inculcate the knowledge of transgenic animals and its applications

**CO4:** Introduce the students to *in silico* and *in vitro* tools used in genetic engineering

Students will be able to

**LO1:** relate the application of fermentation technology in the production of various pharmaceutically important compounds.

**LO2:** comprehend the knowledge in understanding the application of genetic engineering tools in the field of medical/pharmaceutical and agricultural biotechnology

**LO3:** understand the ethical, legal, and social Implications of recombinant DNA technology

**LO4:** compare and contrast between different tools used *in silico* and *in vitro* tools used in genetic engineering

Course Code	Title	Lectures (60L)
SBSLSC603	Biotechnology and Genetic Engineering II	2.5 credits
<b>Unit I Fermentation technology – Enzyme and Pharmaceuticals Production</b>		<b>(15 L)</b>
<b>1.1. Enzyme Technology</b>		3
1.1.a. Enzyme production ex. Amylase (bacterial / fungal)		2
1.1.b. Immobilized Biocatalyst (method of immobilization, applications –biosensors )		2
<b>1.2. Application of fermentation technology in medicine:</b>		2
1.2.a. Production of antibiotics (Penicillin)		2
1.2.b. Vitamins (Vitamin B12)		2
1.2.c. Vaccines (polio / HbsAg)		
1.2.d. Probiotics, Nutraceuticals (one example of each)		
1.2.e. Biopharmaceuticals/Biomolecules (Insulin/IFN)		
<b>UNIT II Tissue Culture biotechnology</b>		<b>(15 L)</b>
<b>2.1. Application of fermentation technology in Agriculture</b>		4
Biopesticides – bacteria ( <i>B.thuringiensis</i> )		
Virus ( <i>Polyhedrosis</i> virus)		
fungal ( <i>Trichoderma</i> )		4
<b>2.2 Plant and Animal Tissue culture:</b>		4
2.2.a. Animal – Laboratory setup, Media, Basic techniques (Disaggregation of tissue and primary culture, maintenance of cell lines- see also Practicals)		
2.2.b. Plant – Media, Basic techniques (callus and suspension culture, organogenesis, & somatic embryogenesis, Protoplast isolation and fusion)		

2.2.c. Secondary metabolites and Biotransformation in plant tissue culture	3
<b>Unit III: Applications of recombinant DNA technology</b>	<b>(15 L)</b>
3.1. Knockouts, Knock in, Knock down systems (Transgenic animals)	2
3.2. Transgenic plants: Bt cotton and weedicide resistant gene (any one example)	2
3.3. Xenopus oocyte as an expression system	1
3.4. Giant Mouse (MMT promoter growth hormone fusion gene)	1
3.5. Drosophila (using p element mediated technique-enhancer trap)	1
3.6. Transformation of Plant Cells and Applications for Plant Genetic Engineering:	1
3.6.a. Microinjection method	1
3.6.b. Ti plasmid based Vectors (Binary vector and Co-integrative vector)	1
3.7. Applications in industry – Medical/pharmaceutical, agricultural	1
3.8. Gene therapy using any one example (Parkinson disease/SCID)	2
3.9. Ethical, Legal, and Social Implications of recombinant DNA technology	1
3.10. Consumer awareness (Labelling of GM food)	1
<b>Unit IV: Tools in genetic engineering, Bioinformatics: Structural and functional Genomics, Comparative Genomics</b>	<b>(15 L)</b>
<b>4.1 Tools in genetic engineering</b>	
4.1.a. Preparing genomic and cDNA libraries	2
4.1.b. Screening techniques (Nucleic acid hybridization methods, immunological methods, gene inactivation)	2
4.1.c. Microarrays	2
4.1.d. Brief overview of Cre-Lox system	2
<b>Bioinformatics: Structural and functional Genomics</b>	
Biological databases (formats: FASTA and GenBank)	2
Sequence annotation and comparison	2
Assigning Gene/protein Function Experimentally	
.d. Applied genomics: Drug designing and basic concept of Docking	
<b>4.2. Comparative Genomics</b>	
4.2.a. Sequence alignment [Pairwise alignment (BLAST), Multiple alignment (CustalW)]	4
4.2.b. Phylogenetic trees (Rooted, Unrooted, Concept of Boot-strapping)	
4.3.c. Examples of Comparative Genomics Studies and Uses	3

**Coursecode: SBSLSC P603**

**[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  $T_m$ ) 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 Time Line

**Open-ended projects:(Anyone of the following, along with its costing)**

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 2hrs
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
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: SBSLSC604**

**PAPER IV - ENVIRONMENTAL BIOLOGY II**

**Course Objectives**

**CO 1:** Deals with the human dimension of development and its effect on the environment.

**CO 2:** Aims to provide adequate insight on management of natural resources.

**CO 3:** It introduces critical issues in environmental studies, both in an Indian and global perspective.

**Course Outcomes**

Student will be able to

**LO 1:** interpret the process of urbanization with respect to consumption of resources.

**LO 2:** analyze the environmental consequences of urban transformation, waste disposal and pollution.

**LO 3:** interpret sustainability in relation to safety , health and environment.

Course Code	Title	Lectures (60 L)
SBSLSC604	ENVIRONMENTAL BIOLOGY II	2.5 Credits
<b><u>UNIT I</u></b>		<b>(15L)</b>
a. <b>Environmental effects of urbanization:</b> Availability of public/open and green spaces/sustainable use of urban space)		1
b. <b>Expansion pattern of cities-</b> Megacities, smart cities and Eco-cities, problem of Urban sprawl.		2
c. <b>Urban growth Challenges:</b> Drinking water supply, Air pollution, generation of waste and waste management.		2
d. <b>Rural environmental degradation:</b> (a) deforestation; (b) declining soil quality (including soil desiccation); and (c) loss of biodiversity.		2
e. <b>Use of fresh water Resources:</b> ground water, contamination of ground water, rural sewage management, freshwater wet lands, Rural Migration, Impact of cities on rural environment.		3
f. <b>River linking Project: Ken and Betwa river.* to be given as Student Assignment</b>		
g. <b>Impact of environmental degradation on rural women</b>		1
h. <b>Toxic and solid waste management:</b> Types of waste, solid waste disposal, E-waste and toxic waste trading, economics of recycling, recycling plastic, Biocomposting and producing less waste.		4
		<b>(15L)</b>
<b><u>UNIT II</u></b>		2
a. <b>Energy and Environment:</b> Classification of Energy resources, Types of renewable and Non-renewable energy resources.		2
b. <b>Evaluating energy resources:</b> Nuclear Power, Coal, Natural Gas, Biomass burning, Gas turbines and Biofuels.		2
c. <b>Alternative Energy Resources:</b> Geothermal, Tidal/Wave power, Ocean		2
d. d. Thermal Energy, Inland Solar ponds, Energy efficient buildings		2

e. <b>Meeting the growing demands:</b> Transportation, residential, commercial and industrial needs.	2
f. <b>Meeting energy efficiency:</b> Household connected devices	1
<b>g. Concept of carbon credit and carbon footprint</b>	
<b><u>UNIT III</u></b>	<b>(15L)</b>
<b>1. Environmental Impact Analysis of a Development Project</b>	3
a. Risk management (EIA and Environment protection agency) perception of and gain, setting up standards	
b. Preparation of EIA report: For e.g.: Selection of a Land fill site. For e.g.: Post Chernobyl disaster.	
<b>2. Environmental Audit</b>	4
a. Definition, Types of Audit, Processes and decision making. Environmental Audit of an Industry eg: Sugar factory	
b. Environmental Audit of Solid waste Management eg. Bangalore City	
<b>3. Environmental Justice Movement:</b>	5
a. Narmada Bachao Andolan and Project Affected people.	
b. Chipko Movement, Hargila Army– Conservation efforts in Assam	
c. Bauxite Mining and Battle for Niyamgiri Hills.	
d. Plachimada struggle against destruction of groundwater	3
<b><u>UNIT IV</u></b>	<b>(15L)</b>
<b>1. Sustainable Development</b>	3
a. UN Agenda for sustainable development.	
b. Sustainable development goals (Global goals),2030	
c. War and Sustainability: Eg. Consequences of Vietnam war. Cost benefit analysis	
<b>2. Safety, Health and Environment:</b>	4
a. Safety and Health Hazards: Identification of potential safety and health hazards in industrial and development projects, reduction strategies, policies and legislation.	
b. Lessons after 30 years of Bhopal gas tragedy	3
c. International and national perspective, safety standards and management systems, ISO 18000 (Occupational Health and Safety Management Systems)	4
d. Consumption Dynamics with special reference to Human	
e. 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.	1

**Course Code: SBSLSC P604**

**[Practical Syllabus Based on SBSLSC604SemesterVICredits:1.5, Lectures: 60]**

1. EC, conductivity, N/P/K/Sulphates/Na/Ca. /Estimation of  $\text{Co}^{2+}$  and  $\text{Ni}^{2+}$  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)
2. Estimation of  $\text{Co}^{2+}$  and  $\text{Ni}^{2+}$ /Pb by colorimetry / spectrophotometry (Anyone)
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).
4. Collection and Interpretation of weather data/Climatology of Mumbai city (Satellite images and  
statistical analysis of weather data).
5. Study of anatomical modifications and plant habitat
6. Study of Leaf margins as climate indicators.
7. Estimation of stomatal index (2 different leaf types and two different micro-climatic conditions  
e.g. Sun loving, shade loving)/Chlorophyll content.
8. Field visit to river/lake and waste water treatment plants.
9. A visit to National Park. Identification of local plant species as: Ecological indicators,  
exotic species
10. Environmental Project(compulsory)
  - a. \*The film documentary/Video making for project should not be more than 10 min duration.  
Example: food sustainability, environmental justice and climate change, Sustainable future.
  - b. Project Submission and viva

**Note: All practicals in each course in both semesters have to be understood in terms of Instrumentation, Technique, Concept and Relevance or whichever may be applicable**

## **Text Books and References**

### **Reference Books for Paper I**

#### **Unit I and II – Genetics (SBSLSC501 and SBSLSC601)**

1. Principles of Genetics by Snustad and Simmons 4<sup>th</sup>edn. John Wiley andsons,2006.
2. iGenetics; A Molecular approach by Peter Russel 2<sup>nd</sup>edn.Pearson,2006.
3. iGenetics; A Mendelian approach by Peter Russel 2<sup>nd</sup>edn.Pearson,2006.
4. Introduction to Genetic Analysis by Griffiths et al 8<sup>th</sup>edn Freeman andco.,2005.
5. Genes IX by Benjamin Lewin; Jones and Bartlettpublishers,2008.
6. Principles of Gene Manipulation and Genomics by S. B. Primrose and R. M. Twyman 7<sup>th</sup>ed., Blackwellpublication,2007.
7. Concepts of Genetics by W. S. Klug and M. R. Cummings 7<sup>th</sup>ed.Pearson,2003.
8. Concepts of Genetics by W. S. Klug, M. R. Cummings, C. A. Spencer 8<sup>th</sup>ed.Pearson,2006. 9. Human Molecular Genetics by Tom Strachan and Andrew Read, 3<sup>rd</sup>ed. Garland Sciencepub.,2004. 10. Principles of Genetics by R. Tamarin, 7<sup>th</sup>ed, BrownCo.,2002

#### **Unit III and IV – Immunology (SBSLSC501 and SBSLSC601)**

1. Immunology by R.A.Goldsky, T. J. Kindt, B. A. Osborne, J. Kuby, 5<sup>th</sup>ed.W. H. Freeman,2006. 2. Immunology: The immune system in health and disease by C. A. Janeway, P. Travers, M. Walport, M. Shlomchik, 6<sup>th</sup> ed, Garland Science Pub., 2005.
3. Cellular and Molecular Immunology, by A. K. Abbas, A. H. Litchman, 5<sup>th</sup> ed, Saunders,2003. 4. Basic Immunology: Functions and disorders of the immune system, by A. K. Abbas,A.H. Litchman, 2<sup>nd</sup>ed Saunders,2004.
5. Roitt'sEssentialImmunology,byPeterJ.DelvesSeamusJ.MartinDennisR.BurtonIvanM.Roitt,11<sup>th</sup>e d, Blackwellpublication,2006.
6. Immunology by D. Mole, J. Bronstoff, D. Roth, I. Roitt, Mosbey, 7<sup>th</sup>Internationaled, Elsevier, 2006.
7. An Introduction to Immunology by C. V. Rao, Narossa Publishers,2002.

## **Reference books for Paper II**

### **UNIT I and II - Developmental Biology (SBSLSC502 and SBSLSC602)**

1. Instant Lecture Notes- Developmental Biology, R.M.Twyman, 1<sup>st</sup> ed, Viva Books Private Limited,2001
2. Principles of Development by L. Wolpert, Cheryl Tickle, 4<sup>th</sup> ed, Oxford University Press.,2011
3. Developmental Biology by Scott F Gilbert, 10<sup>th</sup> ed, Sinauer Associates Inc.Publishers,2013
4. Molecular Biology of the Cell by B. Alberts, D. Bray, J.Lewis, M. Raff, K.Roberts and J.D.Watson. 3<sup>rd</sup> ed, Garland Publishing Inc., N T and London,1994
5. Plant Cell and Tissue Culture by I. Vasil and T.A. Thorpe. Kluwer Academic Publishers,1994
6. Practical Zoology by K.C. Ghone and B. Manna, 2<sup>nd</sup> ed, New Central Book Agency Publishers,2000
7. Pollen Biology – A laboratory manual by K.R. Shivanna and N.S. Rangaswamy,Narosa Publishing,1992.
8. Developmental Biology by L.W.Browder, 2<sup>nd</sup> edition Saunders College Publishing Co.,1985
9. Developmental Biology – Patterns, Problems and Principles by J. W. Saunders. 6<sup>th</sup> ed, MacMillan Publishing Co.
10. An Introduction to the Embryology of Angiosperms by P. Maheshwari, Nabu Press,2011

### **UNIT III and IV- Neurobiology (SBSLSC502 and SBSLSC602)**

1. Neuroscience: Exploiting the brain by M.F.Baer, B.W.Connors&M.A.Paradiso, William& Wilkins, Baltimore,1996
2. Neurobiology by G.M. Shepherd, 3<sup>rd</sup> ed, Oxford University Press,1994
3. Principles Of Neural Science by E.R.Kandel, J.H.Schwartz and T.M. Jessel, 5<sup>th</sup> ed, McGraw Hill, 2012
4. Instant Notes – Neurosciences by A.Longstaff, Viva Books Pvt Ltd., New Delhi,2002
5. Text Book Of Medical Physiology by A.C.Guyton and J.E.Hall,13<sup>th</sup> ed, Saunders College Publishers,2015.
6. Elements Of Molecular Neurobiology by C.U.M. Smith, 3<sup>rd</sup> ed, J Wiley and Sons Publishers,2007
7. An Introduction to Molecular Neurobiology by Z.W. Hall, Sinauer Associates Inc.Publishers,1992
8. Ion Channels – Molecules in Action by D. J. Aidley,P.R. Stanfield, Cambridge University Press, 1996
9. Physiology Of the Nervous Systems by D Ottoson, McMillan Press,1983
10. Neuroscience by Dale Purves, 3<sup>rd</sup> edition, Sinauer Associates,2004

### **Reference books for Paper III**

#### **Unit I to II – Biotechnology (SBSLSC503 and SBSLSC603)**

1. Industrial Microbiology by L.E. Casida, New Age International (P)Ltd., 2003
2. Industrial Microbiology by Prescott And Dunn's, Chapman & Hall., 2003
3. Industrial Microbiology by A H PATEL, Macmillan India. 2005
4. Principles of Fermentation Technology by P.F Stanbury, Whitaker and Hall, 3<sup>rd</sup> ed, Elsevier, 2016
5. Plant Cell and Tissue Culture by I. Vasil and T.A. Thorpe, Kluwer Academic Publishers, 1994
6. Animal Tissue Culture by Ian Freshney, 6<sup>th</sup> ed, Wiley-Blackwell; 2010

#### **Unit III to IV – Genetic Engineering (SBSLSC503 and SBSLSC603)**

1. Principles of gene manipulation and Genomics by Primrose and Twyman, 7<sup>th</sup> ed, Blackwell, 2006
2. Molecular Techniques in Biochemistry and Biotechnology by S Shrivastava, New central book Agency (P)Ltd, 2006
3. Molecular Biology by Robert Weaver, 2<sup>nd</sup> ed, McGraw Hill, 2003
4. Text book of cell and Molecular Biology by Ajoy Paul, 2<sup>nd</sup> ed, Books and Allied (P) Ltd., 2009
5. Cell and molecular biology by Vyas and Mehta, CBS pub and Dist Pvt Ltd., 2009

## **Reference Books for Paper IV**

### **Unit I to IV–Environmental Biology (SBSLSC504 and SBSLSC604)**

1. Essential environmental studies by Misra and Pandey, AneBooks,2011
2. Health and climate change by Martens, EarthScan,1998
3. Environmental Analysis of soil and air by Saxena, Agrobotanica,1998
4. Energy efficient and environment friendly technologies for rural development by Chakraborti, AlliedPublishers,2005
5. Ecology, chemistry and Management of environmental Pollution by Dash M C, Mac MillanIndia,2004
1. Sustainable sewage water Management by Nayak and Amar, Mc MillanIndia,2006
6. Endangered animals by Dolder, Willi, Parragon,2009
7. Methods in environmental Analysis by Gupta P K, Agrobio(India),2000
8. Frontiers of Environment : Issues in Medieval and Early Modern by BhargavaMeena, Oxford University Press, 2005
9. Vulnerable India by Kapur, SAGE,2010
10. Silent Invaders by Jacob, Miriam, Orient Longman,2004
11. Ecology by Subramnyam, 2<sup>nd</sup>ed.Narosa, 2006
12. Environmental Biotechnology by Dilip Kumar, Rajvaidya, APH,2004
13. Ozone Depletion and Environmental Impacts by Sharma and Khan, Pointerpublishers,2004
14. State of India's Environment 2020. - A Down To Earth Annual.
15. Environmental Justice: Concepts, Evidence & politics by Walker,Gordon, RoutledgePublishers,2012
16. This Fissured Land An Ecological History of India by Gadgil, Madhav; Guha Ramachandra, Oxford University Press,2012
17. Water: Growing Understanding, Emerging Perspectives by Shah Mihir; Vijayshankar: P. S, OrientBlackSwan,2016
18. Environmental Studies and Green Technologies by Garg Santosh Kumar & Garg Ranjini, KhannaPublisher, 2018
19. Climate change and Paris agreement: Challenges after US withdrawal by Pradeep Chauhan, New Century Publications,2019
20. Environmental Science: A global concern by Cunningham William P, 14<sup>th</sup> ed, McGraw-Hill Education,2017
21. Origin: The corporate war on nature and culture by Shiva Vandana and others, NATRAJ PUBLISHERS 2018
22. The twice born: Life and death on the Ganges by Taseer, Aatish, Farrar, Straus and Giroux,20