



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

Programme Outline: T. Y. B. Sc. LIFE SCIENCES (SEMESTER V)

Course Code	Unit No	Name of the Unit	Credits
SBSLSC501		GENETICS AND IMMUNOLOGY I	2.5
	1	The Genetic Material	
	2	Mechanisms of Inheritance and Variation in Prokaryotes	
	3	Overview and Cells and Organs of Immune System	
	4	Antigen Recognition and Effector Mechanisms	
SBSLSCP501		Practical	1.5
SBSLSC502		DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY I	2.5
	1	Developmental Biology : Concepts and Tool Kit	
	2	Animal and plant development – basic cellular aspects	
	3	General organization of nervous system	
	4	Cellular organization of the nervous system	
SBSLSCP502		Practical	1.5
SBSLSC503		BIOTECHNOLOGY AND GENETIC ENGINEERING I	2.5
	1	Fermentation Technology – Principles	
	2	Fermentation Technology - Food and Beverage Production	
	3	Tools in Recombinant DNA technology	
	4	Gene Cloning – Technology	
SBSLSCP503		Practical	1.5
SBSLSC504		ENVIRONMENTAL BIOLOGY I	2.5
	1	Introduction to Fundamentals of Environmental Science	
	2	Biodiversity and Habitats	
	3	Pest Management and Toxicology	
	4	Sustainable Development	
SBSLSCP504		Practical	1.5

Programme Outline: T. Y. B. Sc. LIFE SCIENCES (SEMESTER VI)

Course Code	Unit No	Name of the Unit	Credits
SBSLSC601		GENETICS AND IMMUNOLOGY II	2.5
	1	Organisms and techniques used in the understanding of Genetics	
	2	Tools and Techniques in Molecular Genetics	
	3	Hypersensitivity, Infectious diseases, Vaccines and Immunodeficiency	
	4	Transplantation, Tumour Immunology, Tolerance and Autoimmunity	
SBSLSCP601		Practical	1.5
SBSLSC602		DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY II	2.5
	1	Animal and plant development– Basic cellular and molecular aspects.	
	2	Applications of developmental Biology.	
	3	Sensory and motor systems	
	4	Neurobiological basis of behaviour	
SBSLSCP602		Practical	1.5
U SBSLSC603		BIOTECHNOLOGY AND GENETIC ENGINEERING II	2.5
	1	Fermentation technology –Enzyme and Pharmaceuticals Production.	
	2	Tissue Culture biotechnology	
	3	Applications of recombinant DNA technology	
	4	Tools in genetic engineering Bioinformatics Bioinformatics: Structural and functional Genomics, Comparative Genomics	
SBSLSCP603		Practical	1.5
SBSLSC604		ENVIRONMENTAL BIOLOGY I	2.5
	1	Environmental degradation	
	2	Natural resources	
	3	Environmental impact study	
	4	Society and environment	
SBSLSCP604		Practical	1.5

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. SBSLSC501 and SBSLSC601
2. SBSLSC502 and SBSLSC602
3. SBSLSC503 and SBSLSC603
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. SBSLSC501 and SBSLSC601
2. SBSLSC502 and SBSLSC602

PROGRAMME OBJECTIVES

PO 1	Understand and analyze fundamental biological concepts while merging perspectives from several domains related to modern biology.
PO 2	Expand professional studies and research in disciplines such as neurology, genetics, cell biology, physiology, biochemistry, immunology, developmental biology, ecology, and biotechnology.
PO 3	Understand and apply information from a variety of scientific resources; assess and interpret graphical data; develop reliable hypotheses, plan experiments, and observational techniques in a laboratory setting; demonstrate problem-solving abilities; and present results from science in verbal and written form.
PO 4	Demonstrate expertise in scientific subjects such as biostatistics, bioinformatics, and analytical procedures required for productive biological research; understand biotechnological processes utilized in business; and anticipate need-based entrepreneurial opportunities in all areas of biology.
PO 5	Engage as a team, establish interpersonal communication skills, and get the confidence to pursue a career in any field of choice.

PROGRAMME SPECIFIC OUTCOMES

PSO 1	The Learner will be able to comprehend with fundamental concepts of genetics and immunology
PSO 2	The Learner will be able to draw parallels, and perceive connections developmental biology and organization of nervous system
PSO 3	The Learner will be able to learn skills involved in fermentation technology, recombinant DNA technology
PSO 4	The learner will be able to embrace the importance of sustainability, biodiversity and significance of different environmental agreements
PSO 4	The learner will be able to develop a holistic understanding of the components of our environment and the associated depletion of resources and pollution due to anthropogenic activities.

SEMESTER 5

NAME OF THE COURSE	GENETICS AND IMMUNOLOGY I	
CLASS	TYBSC	
COURSE CODE	SBSLSC501	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	Understand the history of genetic organization of genomes subsequently gene expression and regulation.
CO 2.	Study the mechanism of genetic inheritance and variation.
CO 3.	Gain the knowledge about the immune system and its involvement in generating immune response.
CO 4.	Learn the significance of antigen antibody interaction and its downstream effects on effector mechanisms.

COURSE LEARNING OUTCOMES:

CLO 1.	To summarize the discovery of the genetic material.
CLO 2.	To comprehend the complexity of nucleic acid and organization of eukaryotic and prokaryotic genome.
CLO 3.	To articulate gene regulation.
CLO 4.	To gain an understanding regarding the immune cells.

UNIT 1	The Genetic material	(15 LECTURES)
1.1	Introduction - Discovery of the genetic: Griffith's experiment of 1928; Avery, McLeod and McCarty's experiment of 1944; Hershey-Chase's experiment of 1952 –(Brief review, only for short notes.)	
1.2	Genomes: Structural organization of a prokaryotic genome. Structural organization of a eukaryotic genome. Higher orders of chromosome packing; (Solenoid model, zig-zag model)	
1.3	Molecular aspects: Sequence complexity of DNA - Unique and repetitive sequences of DNA(SINE, LINE, Microsatellite, minisatellite DNA) ; Denaturation kinetics and 'CoT' value And interpretation of Cot curves; C value paradox	
1.4	Gene regulation in eukaryotes Chromatin condensation (Euchromatin, heterochromatin) Modification and remodelling by acetylation and methylation,	
1.5	Transcriptional regulation (promoters and enhancers and Transcription initiation complex, GAL4-UAS system)	
UNIT 2	Mechanisms of Inheritance and variation	(15 LECTURES)
2.1	Inheritance pattern of Genetic Disorders in Humans(Prognosis, Testing, of any human genetic disorder)	
2.2	Types of naturally occurring genetic recombination.(e.g Homologous/Non homologous/site directed) Mechanism and proposed models for genetic recombination(e.g Holliday Model/Double strand break model) Advantages of genetic recombination during meiosis	
2.3	Mutational Variation: Natural biological mutagenic agents– Prokaryotic Transposable elements and their significance. Types of eukaryotic transposons, their mechanism of action,(e.g AcDs system in maize, P element transposition)and inheritance Application of transposable elements in genetics	

UNIT 3	Overview and cells and organs of immune system (15 LECTURES)
3.1	Overview of the Immune system - Innate Vs Adaptive Immunity 3.1.a Innate immunity i) Anatomical, Physiological, Phagocytic, Inflammatory barriers ii) Concept of Apoptosis vs Necrosis iii) Concept of PAMP, PRR and TLR 3.1.b Cells and organs of the immune system i) Primary and secondary lymphoid organs ii) Cells -Myeloid cells, Lymphoid cells, NK cells
3.2	3.2.a.Immunogenicity versus antigenicity i) Antigen-Specificity, avidity, affinity, crossreactivity, haptens, adjuvants, epitopes ii) Properties of immunogen contributing to immunogenicity 3.2.bAntibodies i) Basic structure of antibodies ii) Classes of antibodies and biological activity iii) Polyclonal antibodies 3.2c.Organization and expression of Immunoglobulin genes i) Multigen eorganization and gene rearrangement ii) Generation of antibody diversity iii) Class switching 3.2 d.Antigen-antibody interactions – Principles and applications Precipitation, Immunoelectrophoresis, Agglutination, Radioimmunoassay,ELISA,Immunofluorescence,Monoclonal antibodies (Hybridoma Technique)
UNIT – 4	Antigen recognition and Effector Mechanisms (15 LECTURES)
4.1	aMajorHistocompatibility Complex i) MHCmoleculesand genes ii) MHCallelic polymorphism iii) Cellular expressionof MHC iv) Self MHCrestriction ofT cells bAntigen processingand presentation i) Endogenousantigens–thecytosolic pathway ii) Exogenousantigens– theendocytic pathway
4.2	Maturation and activation of Lymphocytes B- cell maturation, Activation and Differentiation T- cell maturation, Activation and Differentiation T- cell receptor-Structure and role of $\alpha\beta$ and $\gamma\delta$ receptors Tcell receptor complex and accessory membrane molecules Cell Maturation, Activation and Differentiation

4.3	<p>Immune Effector Mechanisms</p> <p>Cytokines - - IL-1, IL-2, IL-4, IFNs and TNFs</p> <p>Cytokine secretion by T_H1 and T_H2 cells</p> <p>Complement</p> <p>i) Classical, alternate and lectin pathways and comparison</p> <p>ii) Biological consequences of complement activation</p> <p>iii) Complement fixation tests</p>
4.4	<p>Cell-mediated effector responses</p> <p>Cell-mediated cytotoxicity of T cells, NK cells, ADCC</p> <p>Role of TH1, TH2, TH17 and Tc cells</p>
USLSCPO 5	<p>Practicals Based on USLSC501, Credits -1.5</p> <p>(60 LECTURES)</p>
	<p>Genetics</p> <p>I. I. Experiments to be performed by students:</p> <ol style="list-style-type: none"> 1. Extraction of chromosomal DNA from chicken liver / goat spleen 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 <p>II. Demonstration experiments:</p> <ol style="list-style-type: none"> 5. a) Study of <i>Drosophila</i> mutants from specimen / slides / photographs b) Collection and observation of virgin <i>Drosophila</i> females for setting up of genetic crosses. 6. Study of UV-Visible Spectrophotometer <p>Immunology</p> <p>I) Experiments to be performed by students:</p> <ol style="list-style-type: none"> 1 Study of ABO Blood groups and quantitative Coomb’s Test. 2 Study of Isohemagglutinin titre in blood. 3 Quantitative Widal Test. <p>II. Demonstration experiments:</p> <ol style="list-style-type: none"> 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.

REFERENCES:

Units 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; AMendelian 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

Units 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 7th International edn. D. Mole, J. Bronstoff, D. Roth, I. Roitt, Mosbey Elsevier publication, 2006.
17. An Introduction to Immunology C. V. Rao Narossa Publishers 2002.

SEMESTER 5

NAME OF THE COURSE	DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY I	
CLASS	TYBSC	
COURSE CODE	USLSC502	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	Introduction to the concepts in development biology with basic understanding of the processes involved.
CO 2.	Further understanding the concepts like body plan, potency, regulatory development, spemann's organizer in development using model organism.
CO 3.	Detailed development in plants especially in the model plant Arabidopsis, further introduction to double fertilization and seed formation.
CO 4.	Gain the understanding of general organization of the nervous system.
CO 5.	CO 2 Understanding the cellular organization of the nervous system.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to differentiate concepts like morphogen gradient, growth, morphogenesis and pattern formation
CLO 2.	The learner familiarized with experimental approaches like fate mapping, large scale mutagenesis screens and use of transgenics to study development of model organisms
CLO 3.	The learner would have gained knowledge about plant development
CLO 4.	The learner will be able to describe the anatomical organization, functioning of the nervous system and its early development.
CLO 5.	The learner should be able to analyze the cellular basis of nerve conduction within a neuron and transmission across synapses.
CLO 6.	The learner will be able to describe the anatomical organization, functioning of the nervous system and its early development.

UNIT 1	Developmental Biology : Concepts and tool kit (15 LECTURES)
1.1	Developmental Biology :Concepts, Model organisms and techniques History of concepts in development
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 (thezygote). It involves5 major overlapping processes: <ol style="list-style-type: none"> 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
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)
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(<i>Zebrafish/ mice</i>)
UNIT 2	Animal and Plant development – Basic Cellular aspects (15 LECTURES)
2.1	Development in Animals Amphibian development- Germ cell formation : meiosis and cytoplasmic state of the egg; Fertilization:Cell signalling and Factors affecting fertilisation : Cleavage, Morula and blastula. Gastrulation. 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.
2.2	Chick development – In Comparison with amphibian in the processes of Germ cells and Fertilization Cleavage, Morula and blastula, Gastrulation, Neurulation.
	Development in Plants :- Lifecycle 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],
UNIT 3	General organization of nervous system (15 LECTURES)

3.1	Comparative overview of vertebrate and invertebrate nervous system
3.2	Vertebrate nervous system:-Anatomy and functional features of CNS (cerebral hemispheres, cerebellum, diencephalon, medulla, pons, midbrain and spinalcord),PNS(autonomous, somatosensory, cranial, spinal, plexii)
3.3	Role of meninges and CSF, concept of blood brain barrier.
3.4	Role of meninges and CSF, concept of blood brain barrier. Limbic System(emotions and memory) Hypothalamo– Hypophysial Axis(stress)
3.5	Development of the nervous system: Specification of cell identity in the nervous system The formation and migration of neuron Axon navigation, Synapse formation and refinement
UNIT – 4	Cellular organization of the nervous system <p style="text-align: right;">(15 LECTURES)</p>
4.1	Typical nerve cell Types of cells: Neuronal, Glial cells,
4.2	Chemical Basis of Neural transmission- Introduction Ionic basis of resting membrane potential: Donann’s equilibrium experiments, Nernst’s potential Goldman’s equation, Sodium –Potassium pumb
	Action Potential & propagation – Hodgkin and Huxley’s model, voltage clamp experiment and the derivation and propagation of Action Potential Compound Action potential. Graded potential A comparative Plant example: Electrical signaling and closing of Venus flytrap.
	Synaptic potential and synaptic integration [Electrical and Chemical Synaptic Potential] Excitatory Post Synaptic Potential (EPSP), Inhibitory Post Synaptic Potential (IPSP)
4.3	Synapse and synaptic transmission. Synapse: Structure, Types – chemical and electrical, Neuro – muscular junctions, miniature end plate potentials (MEPPs)

4.4	<p>Neurotransmitters – General Introduction Biosynthesis, physiological role, pharmacological significance, (examples of one agonist and one antagonist for each neurotransmitter mentioned below.</p> <ol style="list-style-type: none"> Acetylcholine (Nicotinic and muscarinic receptors). Dopamine (D1 and D2 receptors). GABA and Glutamate Neuropeptide (Endorphin and Enkephalin).
USLSCPO 5	<p>Practicals Based on USLSC502, Credits -1.5 (60 LECTURES)</p>
	<p>Developmental Biology</p> <p>Animals:</p> <ol style="list-style-type: none"> Study of developmental stages of chick embryo- Cytochrome C- oxidase activity in a developing chick embryo. <p>Demonstration experiments (any two of the following):</p> <ol style="list-style-type: none"> Programmed cell death in limb bud using Janus Green B stain (in chick embryo). Alizarin stain to study limb development in chick embryo/ Regeneration of cartilage / bone Acid and alkaline Phosphatase in Chick embryo. <p>Plant Developmental Biology</p> <ol style="list-style-type: none"> Effect of temperature on cell viability in pollen grains/yeast using Trypan blue/ acetocarmine . Root and shoot development in sections of a 2 day old plant embryo. Study of plant embryo and determination of seed viability using NBT <p>Neurobiology.</p> <ol style="list-style-type: none"> Dissection& display of Nervous system in invertebrates – earthworm / cockroach or any other suitable animal Dissection & display of Nervous system in vertebrates – chick brain/goat brain or any other suitable system Study of chick embryo for identification of fore, mid & hind brain areas (Refer above Developmental Biology Practical no.1) Study of Permanent slides of: <ol style="list-style-type: none"> Medullary nerve fibre: TS of Spinal cord Mammalian retina Electron micrographs of neural tissue <p>6. Demonstration Experiments (Any two of the following).</p> <ol style="list-style-type: none"> Study of the Nervous system of Sepia with special reference to Giant axon and stellate ganglia . Assignment - Bird songs and neurophysiology involved (as a group practical) UnderstandingtheprincipleandbasicinterpretationofbrainimagingtestslikePET (Positron Emission Tomography) and MRI (Magnetic Resonance Imaging)

REFERENCES:

USLSC502: REFERENCE BOOKS

UNIT I and II Developmental Biology (Latest editions recommended)

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. Wolpert, R. Beddington, J. Brockes, T. Jesell and P. Lawrence 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. Plant Cell and Tissue Culture. 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.
17. 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).

17. Neuroscience: Exploreing 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.
19. Principles Of Neural Science. E.R.Kandel, J.H.Schwartz and T.M. Jessel. Prentice Hall International.
20. Instant Notes – Neurosciences, A.Longstaff Viva Books Pvt Ltd., New Delhi, 2002
21. Text Book Of Medical Physiology A.C.Guyton and J.E.Hall. Saunders College Publishers.
22. Elements Of Molecular Neurobiology. C.U.M. Smith. J Wiley and Sons Publishers, N.Y.
23. An Introduction to Molecular Neurobiology. Z.W. Hall. Sinauer Associates Inc. Publishers.
24. Ion Channels – Molecules in Action. D. J. Aidley and P.R. Stanfield. Cambridge University Press.
25. Comparative Neurobiology. P. Mill. Edward Arnold Publishers.
26. Physiology Of the Nervous Systems D Ottoson, McMillan Press

SEMESTER 5

NAME OF THE COURSE	BIOTECHNOLOGY AND GENETIC ENGINEERING 1	
CLASS	TYBSC	
COURSE CODE	USLSC503	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	To introduce students with different aspects of fermentation technology and to familiarize students with industrial production of food and beverage
CO 2.	Understanding principle behind the working of instruments in Biotechnology
CO 3.	To Familiarize students with Intellectual property rights.
CO 4.	Acquaint the students with the components of genetic engineering and biotechnology

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to understand the process behind biotechnological products from biotechnological industries.
CLO 2.	The learner will be able to analyze, interpret the data coming from instruments used in Biotechnology.
CLO 3.	The learner will be able to apprehend the concepts of genetic engineering that includes details about the vector, restriction enzymes, DNA recombination and cloning.
CLO 4.	The learner will be able to compare and contrast the principle and procedure of tools and techniques used in recombinant DNA
CLO 5.	The learner will be able to understand the process behind biotechnological products from biotechnological industries.
CLO 6.	The learner will be able to analyze, interpret the data coming from instruments used in Biotechnology.

UNIT 1	Fermentation technology – Principles (15 LECTURES)
1.1	History and development of Food & Fermentation Technology Fermentation technology & Instrumentation Principles of microbial growth, Screening (primary & secondary) i. Strain improvement (mutation & selection using auxotrophy & analogue resistance.
1.2	i. The Bioreactor / Fermenter & accessories (Stirred tank & Airlift) a. Media design for fermentation (include molasses, corn steep liquor) b. Downstream processing (use ex of Penicillin and an enzyme? for cell disruption c. Instrumentation: Principles and technique of Centrifugation, Spectrophotometry & Chromatography
UNIT 2	Fermentation technology - Food and Beverage Production (15 LECTURES)
2.1	Batch vs Continuous fermentation
2.2	Technological aspects of industrial production of i. Cheese ii. Beer iii. Vinegar iv. Single Cell Protein v. Mushroom, vi. Yoghurt vii. Wine Food quality assurance: Regulatory & social aspects of food biotechnology IPR and patents (Example, Organism, technology)
UNIT 3	Tools in Recombinant DNA technology (15 LECTURES)
3.1	Restriction Enzymes– Nomenclature, General nature of action, Major Categories based on type of cut, two typical examples each and Recognition sites
3.2	DNA joining strategies: DNA ligase, Homopolymer tailing, Adaptors, Linkers, Use of Alkaline Phosphatase.
3.3	Vectors in genetic engineering– Phages(λ , M13, SV40, Adenovirus) Plasmids (pBR322, pUC with blue white screening), Ti plasmids in plants Cosmids, Phagemids YAC, BAC, PAC

UNIT – 4	Techniques in Recombinant DNA technology and applications (15 LECTURES)
4.1	Gel electrophoresis (Principle, technique and application of Agarose, PAGE, 2D-GE) Blotting (Principle, technique and application of Western, Southern, Northern blotting)
4.2	PCR Variations of PCR–RT-PCR, QPCR (Principle, technique and application) Variations in Primer –Nested PCR, Poison Primer Technique, Universal primers Restriction mapping, DNA fingerprinting (Principle, technique, applications) -SNP, VNTR, RFLP, AFLP Cloning of a gene (Somatostatin)
USLSCPO 6	Practicals Based on USLSC503, Credits -1.5 (60 LECTURES)
	<ol style="list-style-type: none"> 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 PolyAcrylamide Gel Electrophoresis of <i>E.coli</i> 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)

REFERENCES:

USLSC503: REFERENCE BOOKS

1. Principles of gene manipulation and Genomics by Primrose and Twyman, 7th

- edition, Blackwell publishing (2006)
2. Molecular Techniques in Biochemistry and Biotechnology by S Shrivastava (2010) Pub. New central book Agency (P) Ltd
 3. Molecular Biology by Robert Weaver, second edition Pub Mc Graw Hill (2003)
 4. Text book of cell and Molecular Biology by Ajoy Paul Pub Books and Allied (P) Ltd. Second edition (2009)
 5. Cell and molecular biology by sp Vyas and Mehta (2011) CBS pub and Dist Pvt Ltd.
 6. Industrial Microbiology. L.E.Casida (2003) New Age International (P) Ltd.
 7. Industrial Microbiology. Prescott And Dunn's (2004) Chapman & Hall.
 8. Industrial Microbiology. A H PATEL (2005) Macmillan India.

SEMESTER 5

NAME OF THE COURSE	ENVIRONMENTAL BIOLOGY 1	
CLASS	TYBSC	
COURSE CODE	USLSC504	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	To appraise the environment around us.
CO 2.	To introduce the fundamental concepts of environment and the biodiversity around us.
CO 3.	To introduce the India and Multilateral Environmental agreements
CO 4.	Comprehend the significance of pests, pesticides, toxicology management

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to identify issues and problems regarding the natural resources.
CLO 2.	The learner will be able to infer community and environment conservation.
CLO 3.	The learner will be able to understand the importance of toxicology management and the subsequent importance of Community and Environment Conservation

UNIT 1	Introduction to Fundamentals of environmental science (15 LECTURES)
1.1	<p>Environmental History and Naturalresources: Definition, Scope and Importance Environmental History: Historical Modes of Resource Use: a) Gathering, b) Nomadic c) Settled cultivationd)IndustryControlledexploitationofnaturalresources:Acase study of British India- timber/coal mining</p>
1.2	<p>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).</p>
1.3	<p>Population ecology: Population parameters- Spacing, size and density, Age composition, Survivorship curves, recruitment, Population growth- logistic, exponential, Geometric growth.</p>
1.3	<p>Population cycles, population dynamics and models of population regulation- Competition and predation</p> <p>Natality, Mortality,Bioticpotential,Carryingcapacity,density dependence, regulation. Improving carrying capacity and its application in wildlife management.</p> <p>Invasivespecies: example:<i>Lantana camara /Prosopsisjulifera</i></p>
1.4	<p>Ecosystem dynamics:</p> <p>Energy flow, primary and secondary productivity, Ecological Pyramids. Soil Ecology: Soil Profile, Soil food web (components and interactions) sustainable soil management and agriculture.</p> <p>Anthropogenic, effects on Biogeochemical cycles of Carbon and Nutrient cycles (S, P and N).</p>
UNIT 2	Biodiversity and Habitats
2.1	<p>Biomes of the world: climate, vegetation and Geographical distribution pattern. Tropical biomes, desert, temperate, taiga and tundra biome.</p> <p>Biological diversity of India: Indian Bio-geographic Zones, climate and its impact on biodiversity.</p>

2.2	<p>Indian flora and fauna</p> <p>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.</p> <p>Environmental biotechnology: Role of biotechnology in conservation of species, in-situ and ex-situ conservation (concept of Gene Bank).</p> <p>Wildlife management and conservation: Wildlife management: Goals and Strategies., Human land-use and wildlife management – Elephant Corridor Vulture Conservation Centre, Haryana. (an BNHS initiative), Wildlife crossings.</p>
2.3	<p>India and Multilateral Environmental agreements</p> <p>Implications of Environmental Agreements to India: Ratification, Becoming a Signatory, Responsibilities, Obligations, expectations and challenges.</p> <p>RAMSAR Convention on Wetlands</p> <p>IUCN (International Union for Conservation of Nature and Natural Resources)</p> <p>Convention on Biological Diversity</p> <p>CMS (Convention on the Conservation of Migratory Species)</p> <p>Basel Convention on the Control of Transboundary Movement of Hazardous Waste and Their Disposal</p> <p>Kyoto Protocol</p> <p>IWC (International Whaling Commission)</p>
2.4	<p>Population and consumption Dynamics with special reference to Human:</p> <p>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.</p>
2.5	<p>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>

UNIT – 3	Pest and pesticides <p style="text-align: right;">(15 LECTURES)</p>
3.1	<p>Basic introduction about Pests, Pesticides and Environment 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 Bioremediation of OP pesticide: using Bacillus Sps. (eg. Malathion Pesticide) Phytoremedian of Organochlorine pesticide (Chloropyrifos) using plants Pesticide regulation: eg. Endosulphan issue.</p>
3.2	<p>Toxicology Management. Toxicology : Basic concepts, toxicity and its impacts, 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. Biocomposting. Limitation of Toxicological studies: Comparison of animal toxicological models and Toxicity in Humans. Human clinical trials: Concept of Clinical trial phases - I, 2, 3 and 4. Ethical issues of clinical trials: e.g. Thalidomide, and significance of Helsinki declaration.</p>
UNIT – 4	<p>Community and Environment Conservation.</p>
	<p>Case study- Amur Falcon and tribal community of Nagaland One man role in conservation A Case Study–Dr. Rajendra Singh (Water man of India) Role of local communities in wildlife management initiatives. Case study- Kokrabelur Village.</p>
	<p>Citizen Awareness and environment legal provisions: Environmental Law and Constitution of India: Constitutional Provisions: Article 21, Article 48A, Article 51A(g), Environment protection Act 1986, MoEF (1985) 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>

USLSCPO 6	Practicals Based on USLSC504, Credits -1.5 (60 LECTURES)
	<ol style="list-style-type: none"> 1. Plankton identification and quantification from river / lake water samples 2. a. Vegetation studies by line, quadrates and belt transect methods and their analysis. b. 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. 3. Preparation of media for microbial culture, Isolation and culturing of microbes from Soil / water samples (Fungal /Bacterial /Algal organism) . 4. Study of fecundity from the given sample of freshwater/marine fish 5. Isolation and culturing of Rhizobium from the given sample. 6. Analysis of soils for pH, moisture, soil types. 7. Water analysis for physicochemical characteristics: (any three) Salinity/Acidity/Alkalinity/BOD/DO/COD/Copper 8. Study of effect of a metal toxicity on the heartbeat of Daphnia and statistica lanalys is of the same T Test/LC 50 9. A visit to Mahim Nature Park/ Vikhroli Mangroves

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4. Chakraborti (2005), "Energy efficient and environment friendly technologies for rural development " ,Allied Publishers
5. Dash M C (2004) "Ecology, chemistry and Management of environmental Pollution ", Mac Millan India
6. Nayak ,Amar(2006) "Sustainable sewage water Management ", Mc Millan India
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8. Gupta P K (2000), "Methods in environmental Analysis ", Agrobio (India)
9. Fumento, Michael (2003), "Bioevolution : How biotechnology is changing our world" , California encounter Books

10. Kapur (2010) "Vulnerable India ", SAGE
11. Jacob, Miriam(2004) ," Silent Invaders" , Orient Longman
12. Mc Cafferty (1998) ,"Aquatic Entomology ", Jones and Barlett
13. Subramnyam (2006),"Ecology " , 2nd ed.Narosa
14. Dilip Kumar, Rajvaidya (2004)," Environmental Biotechnology ", APH
15. Sharma and Khan (2004)," Ozone Depletion and Environmental Impacts , Pointer publishers.
16. StateofIndia`sEnvironment2018.ADownToEarthAnnual.

SEMESTER 6

NAME OF THE COURSE	GENETICS AND IMMUNOLOGY II	
CLASS	TYBSC	
COURSE CODE	USLSC601	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	Understanding the concept of gene mapping
CO 2.	Studying the various tools and techniques involved in human genetics and recombination
CO 3.	Learning about immune mediated hypersensitivity, infectious, vaccines and importance immunodeficiency diseases
CO 4.	Introducing the concepts of transplantation, tumor immunology, tolerance and autoimmunity

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to perform gene mapping using numerical problems
CLO 2.	The learner will be able to interpret the knowledge of gene recombination and mapping in detection of polymorphism and personalized medicine
CLO 3.	The learner will be able to compare and contrast between between different tools and techniques in molecular genetics

UNIT 1	Organisms and techniques used in the understanding of Genetics (15 LECTURES)
1.1	Genetic recombination and Gene mapping (Processes and numerical problems), Bacterial Conjugation Three factor crosses in maize Co-efficient of co-incidence and interference in Drosophila Complementation analysis in Humans using Haemoglobin Life Cycle of lytic and lysogenic phages; Deletion mapping
1.2	Human Genetics 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 The Human Genome Project : aims, major features and applications(e.g. detecting polymorphism, personalized medicine)
UNIT 2	Tools and Techniques in Molecular Genetics (15 LECTURES)
2.1	Agarose gel electrophoresis (Principle, methodology, Applications) Polymerase Chain Reaction (Principle, methodology, Applications)
2.2	Restriction enzymes and Restriction mapping DNA Sequencing – Sanger’s Method, Next Gen Sequencing PCR based methods of Induced mutagenesis (Site-Directed mutagenesis, Cassette mutagenesis)
2.3	Mutagenicity testing – Ames test, Sister chromatid exchange test, mouse specific locus test (Advantages and disadvantages) Nucleic acid in situ Hybridization (FISH) and Chromosome painting Hybrid arrest and Hybrid release method (HRT and HART)
2.4	Overview of Cloning Insulin
UNIT 3	Hypersensitivity, Infectious diseases, Vaccines and Immunodeficiency (15 LECTURES)
3.1	Hypersensitivity Gell and Coombs classification: 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

3.2	<p>Infectious Diseases and Vaccines Important immune mechanisms against various infectious diseases i) Viral infections ii) Bacterial infections iii) Fungal infections iv) Parasitic infections 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 and Peptide vaccines) v) DNA vaccines</p>
3.3	<p>Immunodeficiency Primary and acquired Immunodeficiency Primary 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 Acquired Immunodeficiency Acquired Immunodeficiency Syndrome</p>
UNIT – 4	<p>Transplantation, Tumor Immunology, Tolerance and Autoimmunity (15 LECTURES)</p>
4.1	<p>Transplantation i) Types of grafts ii) Tissue typing (serological and MLR) iii) Mechanisms of graft rejection iv) Immunosuppressive therapy v) Graft vs. host disease - bone marrow transplant.</p>
4.2	<p>Tumor Immunology i) Tumour specific and associated antigens ii) Role of NK cells and macrophages iii) Tumour evasion of immune system iv) Cancer immunotherapy.</p>
4.3	<p>Tolerance and Autoimmunity Establishment and maintenance of tolerance i) Mechanisms of central tolerance ii) Mechanisms of peripheral tolerance iii) Role of T regulatory cells iv) Immunology of pregnancy Autoimmunity i) Mechanisms for induction (Aetiology) ii) Organ specific diseases – ex. Myasthenia gravis, Graves disease iii) Systemic diseases – ex. Systemic Lupus Erythematosus, Multiple sclerosis</p>

USLSCPO 7	Practicals Based on USLSC601, Credits -1.5 (60 LECTURES)
	<p>Genetics</p> <p>I) Experiments to be performed by students:</p> <ol style="list-style-type: none"> 1. Giant Chromosome preparation (<i>Drosophila / Chironomus</i>) 2. Estimation of bacteriophage titre by plaque assay 3. Effect of UV light on microorganisms - Determination of percent viability of an <i>E. coli</i> culture after U.V. exposure- in the absence of light repair 4. Isolation of antibiotic resistant / auxotrophic mutants using Replica plate technique. <p>II) Demonstration experiments:</p> <ol style="list-style-type: none"> 5. Extraction of plasmid DNA, restriction enzyme digestion and visualization by agarose gel electrophoresis. <p>Immunology</p> <p>I) Experiments to be performed by students:</p> <ol style="list-style-type: none"> 6. Ouchterlony test for Immunodiffusion – (Qualitative). 7. Mancini test – Single Radial Immunodiffusion (Qualitative) 8. Agarose slide gel electrophoresis of Serum. <p>II) Demonstration experiments:</p> <ol style="list-style-type: none"> 9. Separation of Mononuclear cells using a gradient and the determination of viable count of the same. 10. SDS- PAGE for separation of Ig G subfraction. 11. Qualitative ELISA using albumin.

REFERENCES:

Units 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.
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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 6th edn., Blackwell publication, asianedn Oxford publishers 2007.

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9. Human Molecular Genetics by Tom Strachan and Andrew Read, 3rdedn. Garland Science pub. 2004.
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Units III and IV Immunology

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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, 2nd edn. A. K. Abbas, A. H. Litchman, 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.
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17. An Introduction to Immunology C. V. RaoNarossa Publishers 2002.

SEMESTER 6

NAME OF THE COURSE	DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY II	
CLASS	TYBSC	
COURSE CODE	USLSC602	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	Explains the molecular and cellular aspects of the important genes involved in early development in plants and animals.
CO 2.	Introduction to regeneration, advances in stem cell and regenerative medicine, apoptosis and types of cancer and the treatment strategies.
CO 3.	Describes the structural and functional features of the various sensory and motor systems.
CO 4.	CO 2 Elaborates on some behavioral aspects such as sleep and memory.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to differentiate between determination and trans determination.
CLO 2.	The learner would have the knowledge of the molecules deposited by the mother and the role of Maternal genes and zygotic genes.
CLO 3.	The learner would be familiar with the plant genome project.
CLO 4.	The learner will be able to describe the sensory and motor systems.
CLO 5.	The learner will be able to deduce the neurobiological basis of behavior and diseases that arise due to malfunction of the nervous system.
CLO 6.	The learner will be able to describe the sensory and motor systems

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)
1.2	Determination and Trans determination (Imaginal Discs) Differentiation: Hematopoietic stem cells and Neural crest cells (migration and differentiation)
1.3	Molecular basis of development:- 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) Beta globin gene – as an example of change in gene expression Conserved nature of developmental genes (Evo- Devoperspective Hox/Pax6 genes with respect to <i>Drosophila</i>) Organogenesis of Eye OR Limb with references to inductive/ instructive signals, cytoplasmic determinants and gradients.
1.4	Plant Development :- Role of Homeotic genes specifying parts of a flower Plant genome project (<i>Arabidopsis</i> /rice)
UNIT 2	Applications of Developmental Biology (15 LECTURES)
2.1	Assisted human reproduction 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)

2.2	<p>Aging- Theories of Aging</p> <p>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</p> <p>Cell cycle regulation - check points in cell cycle and role of cyclins and cdks</p> <p>Apoptosis and its role in development</p> <p>Cancer- Types of Cancer, Causes of Cancer, Oncogenes, Tumour suppressor genes, Treatment strategies for Cancer (example breast cancer)</p>
UNIT 3	<p>Sensory and motor systems</p> <p>(15 LECTURES)</p>
3.1	<p>Introduction to Human Sense organs: receptors, receptor mechanisms and pathways</p> <p>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.</p> <p>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.</p> <p>Vestibular System: Structure of the vestibular labyrinth, maculae and cristae. Mechanism of transduction.</p> <p>Chemosensory system: Olfactory and Gustatory receptors – structure.</p> <p>Skin as sense organ: somatic receptors - Types of mechano- receptors, pain reception & Pain management (example analgesic effect by prostaglandin inhibition - aspirin)</p>
3.2	<p>Motor System:</p> <p>Organisation, Reflex Coordination(ascending and descending pathways diagrammatic representation only)</p> <p>Role of cerebellum in motor co-ordination</p>
3.3	<p>Types of muscles, Molecular basis of Muscle contraction</p> <p>Reflexes: Simple reflex arc, mono and poly-synaptic reflexes (one example of each)</p>
UNIT – 4	<p>Neurobiological basis of Behaviour</p> <p>(15 LECTURES)</p>
4.1	<p>Sleep, Stages of sleep – REM and non REM</p> <p>Short term memory and Long Term Memory (eg. Pathway in Aplysia and molecular events)</p>

4.2	Neurobiological basis of Diseases: Epilepsy Parkinson's disease Schizophrenia- Relevance with regard to neurotransmitters Prions associated diseases Duchene's muscular Dystrophy Alzheimer's disease
USLSCPO 7	Practicals Based on USLSC602, Credits -1.5 (60 LECTURES)
	<p>Plant Developmental Biology</p> <ol style="list-style-type: none"> 1. Effect of boron / calcium on pollen tube germination in <i>Vinca rose</i> or any other suitable sample 2. Role of GA in seed germination. 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) <p>Animal Developmental Biology</p> <ol style="list-style-type: none"> 4. Live observations of Developmental stages of. <i>C.elegans/ Dictyotelium/Drosophila/zebrafish</i> <p>Demonstration experiments: C, T (Any two of the following):</p> <ol style="list-style-type: none"> 5. Imaginal discs of <i>Drosophila</i> 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 <p>Neurobiology</p> <ol style="list-style-type: none"> 1. Differential staining of white and grey matter of vertebrate brain. 2 Temporary mounts of any three of the following: <ol style="list-style-type: none"> 2. Cornea of prawn. b) Statocyst of prawn. c) Columella of bird. d) Striated / smooth muscle fibre. 3. Methylene blue staining of earthworm nerve cord or any other suitable nerve cord or brain to observe organization of neuronal cell bodies in invertebrates 4. Olfactory & gustatory sensilla eg) Histological staining of neuronal tissue using Heamotoxilin-Eosin staining or Nessil's staining. 3) Making clay model of vertebrate brain and cranial nerves.

	<p>Demonstration Experiments – Stroop test.</p> <ol style="list-style-type: none"> 1. Olfactory /Gustatory Behavioral study: Snail / Earthworm / insect larvae 2. Associative conditioning 3. Knee-jerk and pupillary reflex. 4. Testing for locating the Blind Spot in the retina
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USLSC602: REFERENCE BOOKS

UNIT I and II Developmental Biology (Latest editions recommended)

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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.
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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 Embryo 24 logy 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).

UNIT III and IV – Neurobiology (Latest Editions Recommended).

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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. Cembridge University Press.
24. Comparative Neurobiology J. P. Mill Edward Arnold Publishers.
25. Physiology Of the Nervous Systems D Ottoson, McMillan Press

SEMESTER 6

NAME OF THE COURSE	BIOTECHNOLOGY AND GENETIC ENGINEERING II	
CLASS	TYBSC	
COURSE CODE	USLSC603	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	Familiarizing learners with the process of production of enzyme and pharmaceutical products.
CO 2.	Introducing learners to tissue culture techniques.
CO 3.	Inculcate the knowledge of transgenic animals and its applications.
CO 4.	Introduce the students to <i>in silico</i> and <i>in vitro</i> tools used in genetic engineering.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to relate the application of fermentation technology in the production of various pharmaceutically important compounds.
CLO 2.	The learner will be able to comprehend the knowledge in understanding the application of genetic engineering tools in the field of medical/pharmaceutical and agricultural biotechnology.
CLO 3.	The learner will be able to understand the ethical, legal, and social Implications of recombinant DNA technology.
CLO 4.	The learner will be able to compare and contrast between different tools used <i>in silico</i> and <i>in vitro</i> tools used in genetic engineering.
CLO 5.	The learner will be able to relate the application of fermentation technology in the production of various pharmaceutically important compounds.

UNIT 1	Fermentation technology – Enzyme and Pharmaceuticals Production (15 LECTURES)
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1.1	Enzyme Technology Enzyme production ex. Amylase (bacterial & fungal) Immobilized Biocatalyst (method of immobilization, applications – biosensors)
1.2	Application of fermentation technology in medicine a. Production of antibiotics (Penicillin) b. Vitamins (Vit B12) c. Vaccines (polio, HbsAg) d. Monoclonal antibodies e. Biopharmaceuticals (Insulin / IFN- α)
UNIT 2	Tissue Culture biotechnology <p style="text-align: right;">(15 LECTURES)</p>
2.1	Application of fermentation technology Agriculture Secondary metabolites from plant tissue culture Biopesticides – bacteria (<i>B.thuringiensis</i>), Virus (Polyhedrosis virus) and fungal (<i>Trichoderma</i>)
2.2	Plant and Animal Tissue Animal – Laboratory setup, Media, Basic techniques (Disaggregation of tissue and primary culture, maintenance of cell lines- see also Practicals) Plant – Media, Basic techniques (callus and suspension culture, organogenesis, & somatic embryogenesis, Protoplast isolation and fusion) Secondary metabolites from plant tissue culture
UNIT 3	Applications of recombinant DNA technology (15 LECTURES)
3.1	Knockouts, Knockin, Knockdown systems(Transgenic animals) Transgenic plants: Btcotton and weedcid eresistant gene(any one example) Xenopus oocyte as an expression system Giant Mouse(MMT promoter growth hormone fusion gene) Drosophila(using p element mediated technique-enhancer trap) Transformation of Plant Cells and Applications for Plant Genetic Engineering: Microinjection method Ti plasmid based Vectors(Binary vector and Co integrative vector) Applications inindustry –Medical/pharmaceutical, agricultural Gene therapy using anyone example(Parkinson disease/SCID) Ethical, Legal, and Social Implications of recombinant DNA technology Consumer awareness(Labelling of GM food)
UNIT – 4	Tools in genetic engineering, Bioinformatics: Structural and functional Genomics, Comparative Genomics <p style="text-align: right;">(15 LECTURES)</p>
4.1	Preparing genomic and cDNA libraries

4.2	<p>Screening techniques(Nucleic acid hybridization methods , Immunological methods, gene inactivation)</p> <p>Microarrays</p> <p>Brief overview of Cre- Lox system</p>
4.3	<p>Bioinformatics: Structural and functional Genomics</p> <p>Biological databases (formats:FASTAandGenBank)</p> <p>Sequence annotation and comparison</p> <p>Assigning Gene/protein Function Experimentally</p> <p>Applied genomics: Drug designing and basic concept of Docking</p>
4.4	<p>Comparative Genomics</p> <p>Sequence alignment [Pairwise alignment(BLAST), Multiple alignment (Custalw)]</p> <p>Phylogenetic trees(Rooted, Unrooted, Concept of Boot-strapping)</p> <p>Examples of Comparative Genomics Studies and Uses</p>
USLSCPO 8	<p>Practicals Based on USLSC603, Credits -1.5 (60 LECTURES)</p>

[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 TimeLine

Open-ended projects: (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. GenomicDNAextraction,purificationandestimationbyUVspectroscopyDevelopmentof cost effective method using Liquid Soap, Common Salt and Alcohol or any convenient variation.

REFERENCES:

USLSC603: REFERENCE BOOKS

1. Principles of gene manipulation and Genomics by Primrose and Twyman, 7th edition, Blackwell publishing (2006)
2. Molecular Techniques in Biochemistry and Biotechnology by S Shrivastava (2010) Pub. New central book Agency (P) Ltd
3. Molecular Biology by Robert Weaver, second edition Pub Mc Graw Hill (2003)
4. Text book of cell and Molecular Biology by Ajoy Paul Pub Books and Allied (P) Ltd. Second edition (2009)
5. Cell and molecular biology by sp Vyas and Mehta (2011) CBS pub and DistPvt Ltd.
6. Industrial Microbiology. L.E.Casida (2003) New Age International (P) Ltd.
7. Industrial Microbiology. Prescott And Dunn's (2004) Chapman & Hall.
8. Industrial Microbiology. A H PATEL (2005) Macmillan India.
9. Principals of Fermentation Technology , P.F Stanbury, Whitaker and Hall (2004) Fourth Edition

SEMESTER 6

NAME OF THE COURSE	ENVIRONMENTAL BIOLOGY II	
CLASS	TYBSC	
COURSE CODE	USLSC604	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	To comprehend 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 LEARNING OUTCOMES:

CLO 1.	The learner will be able to interpret the process of urbanization with respect to consumption of resources.
CLO 2.	The learner will be able to analyze the environmental consequences of urban transformation, waste disposal and pollution.

CLO 3. The learner will be able to interpret sustainability in relation to safety, health and environment.

UNIT 1	Ecosystem (15 LECTURES)
1.1	<p>Environmentaleffectsofurbanization: Availabilityofpublic/open and green spaces/sustainable use of urban space)</p> <p>Expansionpatternofcities- Megacities,smartcitiesandEcocities, problem of Urban sprawl.</p> <p>UrbangrowthChallenges: Drinkingwatersupply,pollutionof surface water, generation of waste and waste management.</p>
1.2	<p>Ruralenvironmentaldegredation:(a)deforestation;(b)declining soil quality (including soil desiccation); and (c) loss of biodiversity.</p> <p>Use of fresh water Resources: ground water, contamination of ground water, rural sewage management, freshwater wet lands, RuralMigration , Impact of cities on rural environment.</p>
1.3	RiverlinkingProject:KenandBetwariver.*tobegivenasStudent Assignment
1.4	Impact of Environmental degradation on Women.
1.5	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.
UNIT 2	Energy Resources (15 LECTURES)
2.1	Energy and Environment: Classification of Energy resources,Types of renewable and Non-renewable energy resources.
2.2	Evaluating energy resources: Nuclear power, coal, Natural gas, biomass burning, gas turbines, biofuels.
2.3	Alternative energy resources: Geothermal, Tidal/wave power, ocean thermal energy conversions, inland solar ponds, Energy efficient buildings. Concept of carbon credit. * Types of energy resources to be given as student assignment.
UNIT – 3	Environmental Impact Analysis (15 LECTURES)

3.1	<p>Environmental Impact Analysis of a Development Project Risk management (EIA and Environment protection agency) perception of risk and gain, setting up standards Preparation of EIA report: For e.g.: Selection of a Landfill site. For e.g.: Post Chernobyl disaster.</p>
3.2	<p>a. 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>
3.3	<p>Environmental Justice Movement: Narmada Bachao Andolan and Project Affected people. Chipko Movement, Hargila Army–Conservation efforts in Assam Bauxite Mining and Battle for Niyamgiri Hills. Plachimada struggle against destruction of groundwater</p>
UNIT – 4	<p>Sustainable Development (15 LECTURES)</p>
4.1	<p>Sustainable Development a. UNA genda for sustainable development. b. Sustainable development goals(Global goals),2030 c. War and Sustainability: Eg. Consequences of Vietnam war. Cost benefit analysis</p>
4.2	<p>Safety, Health and Environment: Safety and Health Hazards : Identification of potential safety and health hazards in industrial and development projects, reduction strategies, policies and legislation. Lessons after 25 years of Bhopal gas tragedy. International and national perspective, safety standards and management systems, ISO 18000 (Occupational Health and Safety Management Systems)</p>
4.3	<p>Consumption Dynamics with special reference to Human: Landscape 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>
USLSCPO 6	<p>Practicals Based on USLSC604, Credits -1.5 (60 LECTURES)</p>

	<ol style="list-style-type: none"> 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). 2. Estimation of CO_2^{+} and Ni^{2+}/Pb by colorimetry / spectrophotometry (any one). 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. Statistical methods for analysis of environmental data: diversity and similarity indices, for the given data. Use of EXCEL or SPSS Using a Simulated data perform the following:- 6. 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) 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. A visit to Sanjay Gandhi National Park. Identification of local plant species as : Ecological indicators, exotic species 9. Environmental Project (compulsory) 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 a 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. <p>*The film documentary/Video making for project should not be more than 10 min duration.</p> <p>Project Submission and viva</p>
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REFERENCES:

1. Misra and Pandey (2011), "Essential environmental studies," Ane Books.
2. Martens (1998), "Health and climate change", EarthScan
3. Saxena (1998), "Environmental Analysis of soil and air", Agrobotanica
4. Chakraborti (2005), "Energy efficient and environment friendly technologies for rural development", Allied Publishers
5. Dash MC (2004) "Ecology, chemistry and Management of environmental Pollution", Mac Millan India
6. Nayak, Amar (2006) "Sustainable sewage water Management", McMillan India

7. Dolder, Willi (2009), "Endangered animals, Parragon
8. Gupta PK (2000), "Methods in environmental analysis", Agrobio (India)
9. Sharan Awadhendra (2014) "In the city out of place, Nuisance, Pollution and Dwelling in Delhi"
10. Kapur (2010) "Vulnerable India", SAGE
11. Jacob, Miriam (2004), "Silent Invaders", Orient Longman
11. Subramnyam (2006), "Ecology", 2nd ed. Narosa
12. Dilip Kumar, Rajvaidya (2004), "Environmental Biotechnology", APH
13. Sharma and Khan (2004), "Ozone Depletion and Environmental Impacts", Pointer publisher
14. State of India's Environment 2018. A Down To Earth. Fortnightly on politics of development, environment and health.
15. Walker, Gordon (2012) "Environmental Justice: Concepts, Evidence & politics" Routledge, Publishers
16. Gadgil, Madhav; Guha Ramachandra (2012) This Fissured Land An Ecological History of India Oxford University Press.
17. Shah Mihir; Vijayshankar: P. S (2016) Water: Growing Understanding, Emerging Perspectives. Orient Black Swan,
18. Garg Santosh Kumar & Garg Ranjini (2018) Environmental Studies and Green Technologies. Khanna Publisher.

ASSESSMENT DETAILS: (this will be same for all the theory papers)

ASSESSMENT DETAILS:

Internal assessment (50 marks)

Three or four activities having two tests and one activity OR two tests and two activities. The best two marks will be considered for the Internal assessment total out of 50

- Test (25 marks)-Students will be given a test from any of the units for 25 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 10 marks, Answer in one word/sentence - 05 marks, Subjective questions - HWY, Justify, Differentiate between, Diagrammatically etc. - 10 marks.)
- An activity for 25 marks would be given in the form of a creative learning process. (Powerpoint presentation, Report and Viva, Model making and presentation, poster presentation, Analytical problems on higher order thinking, any other activity)

Semester end examination (50 marks)

If Online

- The question paper shall consist of two parts - Part A and B. Part A will consist of 30 marks MCQs (including both 1 and 2 mark MCQs) whereas Part B will consist of 20 marks subjective having 5 mark questions **OR** The question paper will be a 50 mark paper having MCQs of 1 and 2 marks.

If Offline

- The duration of the paper will be two hours.
- There shall be five compulsory questions.

- Q1-4 shall correspond to the four units. Q1-4 shall contain an internal choice (any two out of four). Q1-4 shall carry a maximum of 10 marks.
- Q5 shall be from Units 1 to 4. Q5 shall carry a maximum of 10 marks (attempt any 5 out of 10)

Practical Assessment

- The duration of the practical exam will be three days.
- There will be 50 marks practical per paper.
- The students are allowed to write the paper if the attendance for practicals is more than 75%.
- To appear in the practical exam, students must bring a properly certified journal.