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UNIVERSITYOFMUMBAI

Syllabus for the T.Y. B. Sc.
Program: B.Sc.
Course: Life Sciences (USLSC)

Choice Based Credit System
(Academic year2018 –2019)

PREAMBLE

Programme: B.Sc.

Course: Life Sciences(USLSC)

(Semester–V&VI)

With the introduction of Choice Based Credit System and continuous evaluation consisting of components of Internal Assessment and External Assessment by the esteemed University, the existing syllabi of F.Y.B.Sc.andS.Y.B.Sc. Life Sciences were restructured according to the CBSGS pattern and after the approval by the concerned authorities have been mplemented from the academic years 2011-12 and 2012-13 respectively.

In accordance with the CBSGS pattern, the existing syllabus of T.Y.B.Sc Life Sciences has been restructured and after the approval by the concerned authorities shall be implemented from the academic year 2018-19.

For restructuring the existing syllabi of T.Y.B.Sc Life Sciences as the convener, BOS members as co-conveners and Head/Senior teachers from affiliated colleges as members of these sub-committees.

As mentioned in the outline of the syllabus, all the 08 courses of theory and Practicals (Semester V and VI together) are compulsory to the students offering Life Sciences as a Single Major Subject (6 units pattern of the old course).

These courses are:

1. USLSC-501and USLSC-601
2. USLSC-502and USLSC-602
3. USLSC-503and USLSC-603
4. USLSC-504and USLSC-604

However, the students opting for Double Major Subject (3 Units pattern of the old course), shall have following 04 courses of theory and Practical (Semester V and VI) compulsory:

1. USLSC-501and USLSC-601
2. USLSC-502and USLSC-602

COURSEWISECREDITASSIGNMENTUNDERTHEFACULTYOF SCIENCE

Program: B.Sc.
Course: Life Sciences(USLSC)

Course wise credit assignments under the faculty of science Type of Courses/ Credits Assigned	FirstYear (Credit x No. of Courses)		SecondYear (Credit x No. of Courses)		Third Year (Credit x No. of Courses)		Total Credit Value
	First Semester	Second Semester	Third Semester	Fourth Semester	Fifth Semester	Sixth Semester	
Core Courses (Theory)	04x03	04x03	06x02	06x02	2.5x04	2.5x04	68
Core Courses (Practical's)	02x03	02x03	03x02	03x02	1.5x04	1.5x04	36
Foundation course	02x01	02x01	02x01	02x01			08
Applied Component Courses(Theory)					02x01	02x01	04
Applied Component Courses (Practical)					02x01	02x01	04
Total	20	20	20	20	20	20	120

CREDITASSIGNMENTFORLIFE SCIENCESAS ASINGLEMAJORCOURSEAT B.Sc. LEVEL

The credits earned by learner in duration of three years undergraduate programme in Life Sciences disciplines is shown in the following table assuming that student has offered Life Sciences, Chemistry, Botany and Foundation course at first year and Microbiology, Chemistry, and Foundation course in Second year and **Life Sciences as a Single Major Course** +Applied Component in Third year.

Year	**Sem**	**Life Sciences**		**Chemistry**		**Botany**		**FC**	**AC**		**Total**
		Th	Pr	Th	Pr	Th	Pr	Th	Th	Pr	
1	**I**	4	2	4	2	4	2	2			20
	II	4	2	4	2	4	2	2			20
2	**III**	6	3	6	3			2			20
	IV	6	3	6	3			2			20
3	**V**	10	6						2	2	20
	VI	10	6						2	2	20
Total		40	22	20	10	8	4	8	4	4	
		62		**30**		**12**		**8**	**8**		**120**

CREDITASSIGNMENTFORLIFE SCIENCES+ BIOCHEMISTRYAS ADOUBLE MAJOR COURSE AT B.Sc. LEVEL

The credits earned by learner in duration of three years undergraduate programme in Microbiology disciplines is shown in the following table assuming that student has offered Microbiology, Biochemistry, Botany and Foundation course at first year and Microbiology, Biochemistry, and Foundation course in second year and **Life Sciences + Biochemistry as a Double Major Course** + Applied Component in third year.

Year	**Sem**	**Life Sciences**		**Bioche-mistry**		**Botany**		**FC**	**AC**		**Total**
		Th	Pr	Th	Pr	Th	Pr	Th	Th	Pr	
1	**I**	4	2	4	2	4	2	2	-	-	20
	II	4	2	4	2	4	2	2	-	-	20
2	**III**	6	3	6	3	-	-	2	-	-	20
	IV	6	3	6	3	-	-	2	-	-	20
3	**V**	5	3	5	3	-	-	-	2	2	20
	VI	5	3	5	3	-	-	-	2	2	20
Total		30	16	30	16	8	4	8	4	4	-
		46		**46**		**12**		**8**	**8**		**120**

USLSC501	GENETICS AND IMMUNOLOGY I	2.5 credits (60Lectures)
UNITI	The Genetic material	15 lectures
UNITII	Mechanisms of Inheritance and variation	15 lectures
UNITIII	Overview and cells and organs of immune system	15 lectures
UNITIV	Antigen recognition and Effector Mechanisms	15 lectures

USLSC601	GENETICS AND IMMUNOLOGY II	2.5 credits (60Lectures)
UNITI	Organisms and techniques used in the understanding of Genetics	15 lectures
UNITII	Tools and Techniques in Molecular Genetic	15 lectures
UNITIII	Hypersensitivity, Infectious diseases, Vaccines and Immunodeficiency	15 lectures
UNITIV	Transplantation, Tumor Immunology, Tolerance and Autoimmunity	15 lectures

USLSC502	DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY I	2.5 CREDITS (60LECTURES)
UNITI	Developmental biology : concepts, model organisms and techniques	15 lectures
UNITII	Animal and plant development – basic cellular aspects	15 lectures
UNITIII	General organization of nervous system	15 lectures
UNITIV	Cellular organization of the nervous system	15 lectures

USLSC602	DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY II	2.5 CREDITS (60LECTURES)
UNITI	Animal and plant development – basic cellular and molecular aspects	15 lectures
UNITII	Applications of developmental biology	15 lectures
UNITIII	Sensory and motor systems	15 lectures
UNITIV	Neurobiological basis of behaviour	15 lectures

USLSC503	BIOTECHNOLOGY AND GENETIC ENGINEERING I	2.5 credits (60 Lectures)
UNITI	Fermentation technology – Principles	15 lectures
UNITII	Fermentation technology - Food and Beverage Production	15 lectures
UNITIII	Tools in Recombinant DNA technology	15 lectures
UNITIV	Techniques in Recombinant DNA technology and applications	15 lectures

USLSC603	BIOTECHNOLOGY AND GENETIC ENGINEERING II	2.5 credits (60Lectures)
UNIT I	Fermentation technology – Enzyme and Pharmaceuticals Production	15 lectures
UNIT II	Tissue Culture biotechnology	15 lectures
UNIT III	Applications of recombinant DNA technology	15 lectures
UNIT IV	Tools in genetic engineering , Bioinformatics: Structural and functional Genomics, Comparative Genomics	15 lectures

USLSC504	**ENVIRONMENTALBIOLOGYI**	**2.5 credits(60 Lectures)**
UNITI	Introduction to fundamentals of Environmental science	15 lectures
UNITII	Biodiversity and habitats	15 lectures
UNITIII	Pest management and toxicology	15 lectures
UNITIV	Sustainable development	15 lectures

USLSC604	**ENVIRONMENTALBIOLOGYII**	**2.5 credits(60 Lectures)**
UnitI	Environmental degradation	15 lectures
UnitII	Natural resources	15 lectures
UnitIII	Environmental impact study	15 lectures
UnitIV	Society and environment	15 lectures

T.Y. B. Sc. LIFE SCIENCESSEMESTER V

Course code	Practical Syllabus	Credits &l ectures
USLSCP05	Based on USLSC501andUSLSC502of Semester V	Credits3 (8 periods/week)
USLSCP06	Based on USLSC503andUSLSC504of Semester V	Credits3 (8 periods/week)

T.Y.B. Sc. LIFE SCIENCESSEMESTER VI

Course code	Practical Syllabus	Credits &lectures
USLSCP07	Based on USLSC601andUSLSC602 Of Semester VI	Credits3(8 periods/week)
USLSCP08	Based on USLSC603andUSLSC604 Of Semester VI	Credits3(8 periods/week)

SEMESTER V

USLSC501: Genetics I: The course is designed to give students understanding of basic principles of Genetics. Brief History of Genetics, Organization of Genome and ways in which gene expression is regulated is covered in first unit. The next unit deals with genes are inherited, and how variation is introduced in the genome.

Course Code	Title	No.of Lectures
USLSC501	**Genetics I**	**(60L)**
Unit I:The Genetic material:		**(15L)**
Discovery of the genetic: Griffith's experiment of 1928; Avery, McLeod and McCarty's experiment of1944; Hershey-Chase's experiment – (Brief review, only for short notes.)		02
1. Organization of Eukaryotic and Prokaryotic Genome : **1.1** Structural organization of Prokaryotic and Eukaryotic genome (CCC DNA, Nucleosome structure, higher orders of chromosome packaging, Solenoid model, zig-zag model)		03
1.2 Sequence complexity of DNA - Unique and repetitive sequences (SINE, LINE, Microsatellite, mini satellite DNA), Denaturation kinetics and 'CoT' value and interpretation of Cot curves; 'C value paradox';		03
2. Gene regulation in eukaryotes **2.1** Chromatin condensation (Euchromatin, heterochromatin) **2.2** Modification and remodelling by acetylation and methylation		03
2.3 Transcriptional regulation • Cis-acting regulatory sequences, promoters and enhancers. • Transcription activators and repressors		04
Unit II:1.2 Mechanisms of Inheritance and variation		**(15L)**
1. Inheritance pattern of Genetic Disorders in Humans (Prognosis, Testing, of any human genetic disorder)		02
2. Introduction to genetic recombination **2.1** Types of naturally occurring genetic recombination. (e.g Homologous/Non homologous/site directed)		02
2.2 Mechanism and proposed models for genetic recombination (e.g Holliday Model/Double strand break model)		02
2.3 Advantages of genetic recombination during meiosis		02
3. Mutational Variation: **3.1** Natural biological mutagenic agents – Prokaryotic Transposable elements and their significance		02
3.2. **A.** Types of eukaryotic transposons , their mechanism of action,(e.gAcDs system in maize,P element transposition) and inheritance		04
3.2.B. Application of transposable elements in genetics		01

USLSC501: Immunology I: This course of Immunology is formulated to provide good knowledge of the immune system, its response and involvement in health and disease. While immunology as a *science* has been defined as the "science of self/non self discrimination", it also includes our innate ability to defend against microorganisms (Innate Immunity); and its ability to recognize and respond to fight the infections through Acquired Immunity. Specific topics being covered include antigens and antibodies, antigen-antibody interactions, antibody structure and formation, Effector responses etc.

Course Code	Title	No.of Lectures
USLSC501	**Immunology I**	**(60L)**
UNIT – III Overview and cells and organs of immune system		**(15L)**
3.1. Historical Perspective - Early Vaccination studies; Infection and immunity **Overview of the Immune system -** Innate Vs Adaptive Immunity 3.1.a Innate immunity i) Anatomical, Physiological, Phagocytic, Inflammatory barrier iii) Concept of PAMP, PRR and TLR 3.1.b Cells and organs of the immune system i) Cells - structure and functions Myeloid cells - Lymphoid cells – B and T cells, NK cells ii) Primary and secondary lymphoid organs **3.2 Antigens and antibodies** 3.2.aImmunogenicity versus antigenicity i) Antigen-Specificity, avidity, affinity, cross reactivity, haptens, adjuvants, epitopes ii) Properties of immunogen contributing to immunogenicity 3.2.b Antibodies i) Basic structure of antibodies ii) Classes of antibodies and biological activity iii) Polyclonal antibodies 3.2 c. Organization and expression of Immunoglobulin genes i) Multigene organization and gene rearrangement ii) Generation of antibody diversity (Brief description) iii) class switching 3.2 d. Antigen-antibody interactions – Principles and applications Precipitation, Immunoelectrophoresis, Agglutination, Radioimmunoassay, ELISA, Immunofluorescence, Monoclonal antibodies (Hybridoma Technique)		01 02 03 01 02 03 03

	(15L)
UNIT – IV Antigen recognition and Effector Mechanisms	
4.1 Recognition of antigens. 4.1.a**Major Histocompatibility Complex** i) MHC molecules and genes ii) MHC allelic polymorphism iii) Cellular expression of MHC iv) Self MHC restriction of T cells	02
4.1 b Antigen processing and presentation i) Endogenous antigens – the cytosolic pathway ii) Exogenous antigens – the endocytic pathway	02
4.2 Maturation and activation of Lymphocytes 4.2.a B- cell Maturation, Activation and Differentiation	02
4.2.b i) T- cell receptor – Structure and role of αβ and γδ receptors ii) T cell receptor complex and accessory membrane molecules	01
4.2.cT- cell Maturation, Activation and Differentiation	02
4.3 Immune Effector Mechanisms 4.3.a**Cytokines**- - IL-1, IL-2, IL-4, IFNs and TNFs ii) Cytokine secretion by T_H1 and T_H2 cells	01
4.3.b**Complement** i) Classical, alternate and lectin pathways and comparison ii) Biological consequences of complement activation iii) Complement fixation tests	02
4.3.c**Cell-mediated effector responses** Cell-mediated cytotoxicity of T cells, NK cells,ADCC Role of T_H1, T_H2,T_H17 and Tc cells	03

USLSC502: Developmental Biology I: The course will introduce to the students the basic concepts of developmental biology, which is the process by which animals and plants grow from a single original zygote. This module describes the important model systems and technique used to understand developmental process. The early process of animal development will be explained using the amphibian and chick as examples and plant development using Arabidopsis.

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

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

Neurobiology I:

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

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

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

USLSC503: Biotechnology I: The course is designed to make students familiar with basics of fermentation techniques. Students will learn how food and beverages are produced at Industrial scale using fermentation.

Course Code	**Title**	**No. of Lectures**
USLSC503	**Biotechnology and Genetic Engineering**	**2.5 credits 60**
UNIT I: Fermentation technology – Principles		**15**
1.1. History and development of Food & Fermentation Technology		01
1.2. Fermentation technology & Instrumentation		01
1.3.a. Principles of microbial growth,		01
1.3.b. Screening (primary & secondary)		01
1.3.c. Strain improvement (mutation & selection using auxotrophy& analogue resistance		02
1.4. The Bioreactor / Fermenter & accessories (Stirred tank & Airlift)		02
1.5. Media design for fermentation (include molasses, corn steep liquor)		02

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

USLSC503: Genetic Engineering

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

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

USLSC504: ENVIRONMENTALBIOLOGY1: This syllabus is designed to understand the environment around us. It introduces the fundamental concepts of environment and the biodiversity around us. The students will understand different features of a habitat, also the problems associated with their management and conservation. The issues and problems regarding the natural resources is featured along with detailed coverage on sustainability.

CourseCode	Title	Lectures
USLSC504	**ENVIRONMENTALBIOLOGY1**	**2.5Credits (60 Lectures)**
Unit I IntroductiontoFundamentalsofenvironmentalscience		**15 Lectures**
1.1.Environmental History and Naturalresources: Definition, Scope and Importance		**1lectures**
1.1.a. Environmental History: Historical Modes of Resource Use: a) Gathering, b) Nomadic c) Settled cultivation d) Industry Controlled exploitation of natural resources: A case study of British India- timber/coal mining		**2Lectures**
1.1.b. Community Ecology: Concept of community (E.g. Forest as a community) Species Interaction, Prey Predator interaction. Food chain, Food web and Higher order interactions: Succession seral communities in secondary succession, redistribution of population after land fragmentation, loss of species (fire and succession).		**3Lectures** **2Lectures**
1.1.c. Population ecology: Population parameters- Spacing, size and density, Age composition, Survivorship curves, recruitment,Population growth- logistic, exponential, Geometric growth.		**1lectures**
Population cycles, population dynamics and models of population regulation- Competition and predation		**3Lectures**
Natality, Mortality, Biotic potential, Carrying capacity, density dependence, regulation. Improving carrying capacity and its application in wildlife management. Invasive species: example: *Lantana camara /Prosopsisjulifera*		**1Lectures**
1.2. Ecosystem dynamics:		
1.2.a. Energy flow, primary and secondary productivity, Ecological Pyramids.		**1lectures**
1.2.b. Soil Ecology: Soil Profile, Soil food web (components and interactions) sustainable soil management and agriculture.		**1lectures**
1.2.c. Anthropogenic effects on Biogeochemical cycles of Carbon and Nutrient cycles (S, P and N).		

UNITII	**15 Lectures**
2.1.BiodiversityandHabitats:	**1 Lectures**
2.1.a. Biomesoftheworld: climate,vegetationand Geographicaldistribution pattern.Tropicalbiomes,desert,temperate,taigaand tundrabiome.	**1Lectures**
2.1.b. BiologicaldiversityofIndia: IndianBio-geographicZones,climateandits impactonbiodiversity.	
2.2.Indianfloraandfauna	**2Lectures**
2.2.a. Indianforestand vegetationtypes:diversityofflora andfauna**.** Endangered, Endemicand ExtinctSpeciesofIndia: Threatened species categoriesofIUCN,threatened speciesofplantsand animalsinIndia and their reasons, Reddatabooks.	**1Lecture**
2.2.b. Environmentalbiotechnology:Roleofbiotechnologyinconservationof species,in-situand ex-situconservation. (concept of Gene Bank)	**2 Lectures**
2.2. c. Wildlife management and conservation: Wild life management: Goals and Strategies., Human land-use and wildlife management – Elephant Corridor Vulture Conservation Centre,Haryana.(an BNHS initiative),Wildlife crossings.	
2.3. India and Multilateral Environmental agreements	**4Lectures**
2.3.a. Implications of Environmental Agreements to India: Ratification, Becoming a Signatory, Responsibilities, Obligations, expectations and challenges.	
2.3.b. RAMSAR Convention on Wetlands	
2.3.c. IUCN (International Union for Conservation of Nature and Natural Resources)	
2.3.d. Convention on Biological Diversity	
2.3.e. CMS(Conventionon the Conservation of Migratory Species)	
2.3.f. Basel Convention on the Control of Trans boundary Movement of Hazardous Waste and Their Disposal	
2.3g. KyotoProtocol	
2.3h. IWC (International Whaling Commission)	**4Lectures**
2.4.Population and consumptionDynamicswithspecialreference to Human:	
2.4.a Energy and food production (grains, Livestock, aqua culture): Green revolution, Blue revolution. Nutrition: micro and macro nutrition, Ecological costs of food production. Organic Farming, Climate change and impact on Agriculture.	
2.4.b. GM foods and their environmental concerns eg .Bt Brinjal, Politics and economics of Hunger,Intellectual Property Rights (IPR), Biopiracy (e.g., Neem/Basmati) Relevance of Seed Bank.	

UNITIII	**15 Lectures**
3.1.Pestandpesticides: **3.1.a.**BasicintroductionaboutPests, Pesticidesand Environment	**1 Lecture**
3.1.b. Pesticide toxicity:Bioaccumulationand Biomagnification,persistence, resistanceand pollutionhealthoffarmers.Newmethodsofpestcontrol: Biologicalpestcontrol:predatorsparasites,and pathogens. Genetically Engineeringand pestcontrol, Integratedpestmanagement	**3Lectures**
3.1.c. BioremediationofOP pesticide: usingBacillusSps.(eg. Malathion Pesticide)	**1Lectures**
3.1.d. PhytoremediationofOrganochlorinepesticide(Chloropyrifos)usingplants	**2Lectures**
3.1.e. Pesticideregulation:eg.Endosulphanissue.	
3.2.ToxicologyManagement. **3.2.a.**Toxicology:Basicconcepts,toxicityanditsimpacts 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)	**3Lectures**
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.	**2Lectures**
3.2.b. LimitationofToxicologicalstudies: Comparisonofanimaltoxicological modelsand Toxicity inHumans.	**2Lectures**
3.2.c. Humanclinicaltrials:ConceptofClinicaltrialphases-I,2,3and Pharmacovigilance.	**1Lecture**
3.2.d. Ethicalissuesofclinicaltrials: (e.g.Thalidomide) and significance of Helsinki declaration.	

Unit IV **4.1 Community and Environment Conservation**. **4.1a.** Case study- Amur Falcon and tribal community of Nagaland **4.1b.**One man role in conservation A Case Study – Dr. Rajendra Singh (Water man of India) **4.1c.** Role of local communities in wildlife management initiatives. Case study- Kokrabellur Village. **4.2. Citizen Awareness andenvironmentallegal provisions:** Environmental Law and Constitution of India: ConstitutionalProvisions:Article 21,Article 48A, Article 51A(g), Environment protection Act1986,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	**15 Lectures** **3Lectures** **2Lectures** **2Lecture** **3Lecture** **5Lectures**

Semester VI

USLSC601: Genetics II: The course deals with organisms and techniques used in understanding molecular genetics. Students are expected to learn how genes are mapped on chromosomes. The second unit introduces principle and applications behind tools used in Genetics.

Course Code	Title	No.of Lectures
USLSC601	**Genetics II**	**(60L)**
Unit I:Organisms and techniques used in the understanding of Genetics		**(15L)**
1. Genetic recombination and Gene mapping (Processes and numerical problems)		
1.1 Bacterial Conjugation		01
1.2 Three factor crosses in maize		02
1.3 Co-efficient of co-incidence and interference in Drosophila		02
1.4 Complementation analysis in Humans using Haemoglobin		02
1.5. Life Cycle of lytic and lysogenic phages; Deletion mapping		02
2.Human Genetics		
2.1. Human Genetic Maps, Somatic cell Genetics: Use of cell hybrids and hybridomas for gene mapping; The lod Score Method for Analyzing Linkage of Human Genes		03
2.2 The Human Genome Project : aims, major features and applications(e.g. detecting polymorphism, personalized medicine)		03
Unit II: Tools and Techniques in Molecular Genetics		**(15L)**
3.1 Agarose gel electrophoresis (Principle, methodology, Applications)		02
3.2 Polymerase Chain Reaction (Principle, methodology, Applications)		02
3.3 Restriction enzymes and Restriction mapping		02
3.4 DNA Sequencing – Sanger's Method, Next Gen Sequencing		02
3.5 PCR based methods of Induced mutagenesis (Site-Directed mutagenesis , Cassette mutagenesis)		02
3.6 Mutagenicity testing – Ames test, Sister chromatid exchange test, mouse specific locus test (Advantages and disadvantages)		02
3.7 Nucleic acid in situ Hybridization (FISH) and Chromosome painting		01
3.8 Hybrid arrest and Hybrid release method (HRT and HART)		01
3.9 Overview of Cloning Insulin		01

USLSC601: Immunology II : This course mainly deals with the section of immunology which encompasses the aetiology of various diseases caused by disorders of the immune system either due to its failure (immunodeficiency), aberrant action (Hypersensitivity, autoimmunity), or malignant growth of cellular elements (Cancer) and clinical management (Vaccines).

Course Code	Title	No.of Lectures
USLSC601	**Immunology II**	**(60L)**
UNIT – III :Hypersensitivity, Infectious diseases, Vaccines and Immunodeficiency		**(15L)**
3.1 Hypersensitivity Gell and Coombs classification: 3.1. Types of hypersensitivity – Examples and methods of diagnosis i) IgE- mediated (Type I) hypersensitivity: RIST and RAST ii) Antibody-mediated(Type II) hypersensitivity : Agglutination iii) Immune complex-mediated(Type III) hypersensitivity: Immunofluorescence, ELISA iv) Delayed type hypersensitivity(Type IV) : Tuberculin test **3.2 Infectious Diseases and Vaccines** 3.2.aImportant immune mechanisms against various infectious diseases i) Viral infections ii) Bacterial infections iii) Fungal infections iv) Parasitic infections 3.2 b. Vaccines i) Passive immunization - Preformed antibodies and their disadvantages ii) Use of Chimera / humanized antibodies iii) Active immunization- Whole organisms (attenuated vs. inactivated ex. Polio) iv) Subunit Vaccines (Polysaccharide, toxoid andPeptide vaccines) v) DNA vaccines **3.3 Immunodeficiency** Primary and acquired Immunodeficiency 3.3.aPrimary immunodeficiency i) B-cell- X-linked agammaglobulinemia ii) T-cell- Di George Syndrome iii) Lymphoid deficiency - Severe Combined Immunodeficiency iv) Deficiency of myeloid lineage- Chronic Granulomatous Disease 3.3.bAcquired Immunodeficiency i) Acquired Immunodeficiency Syndrome		**05** **07** **03**

UNIT – IV : Transplantation, Tumor Immunology, Tolerance and Autoimmunity	(15L)
4.1 Transplantation i) Types of grafts ii) Tissue typing (serological and MLR) iii) Mechanisms of graft rejection iv) Immunosuppresive therapy v) Graft vs. host disease - bone marrow transplant	**04** **04**
4.2 Tumor Immunology i) Tumour specific and associated antigens ii) Role ofNK cells and macrophages iii) Tumour evasion of immune system iv)Cancer immunotherapy.	**04**
4.3 Tolerance and Autoimmunity 4.3.a 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 4.3 b. Autoimmunity i) Mechanisms for induction(Aetiology) ii) Organ specific diseases – ex. Myasthenia gravis, Graves disease iii) Systemic diseases – ex. Systemic Lupus Erythematosus, Multiple sclerosis	**03**

USLSC 602: Developmental Biology II

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

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

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

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

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

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

USLSC603: Biotechnology II: This course deals with details of applied aspects of Biology. Students will learn how fermentation technology, and plant / animal tissue culture are used for production of various pharmaceutically important compounds.

Course Code	**Title**	**No. of Lectures**
USLSC603	**Biotechnology and Genetic Engineering**	**2.5 credits 60**
Unit I Fermentation technology – Enzyme and Pharmaceuticals Production		**15**
1.1. EnzymeTechnology		
1.1.a. Enzyme production ex. Amylase (bacterial & fungal)		03
1.1.b. Immobilized Biocatalyst (method of immobilization, applications – biosensors)		02
1.2. Application of fermentation technology in medicine:		02
1.2.a.Production of antibiotics (Penicillin)		02
1.2.b.Vitamins (Vitamin B12)		02
1.2.c. Vaccines (polio, HbsAg)		02
1.2.d. Probiotics, Neutraceuticals (one example of each)		02
1.2.e. Biopharmaceuticals/Biomolecules (Insulin/IFN)		
UNIT II Tissue Culture biotechnology		**15**
2.1. Application of fermentation technology in Agriculture Biopesticides – bacteria (*B.thuringiensis*), Virus (*Polyhedrosis* virus) and fungal (*Trichoderma)*		04

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

USLSC603: Genetic Engineering II: In this course students will learn about Applications of tools and techniques in Recombinant DNA technology. They will also learn about bioinformatics and Genomics. Students should be aware of vast scope of Genetic Engineering in transforming human lives by end of this course.

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

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

USLSC604: ENVIRONMENTAL BIOLOGY II: The paper deals with the human dimension of development and its effect on environment. It aims to provide adequate insight on management of natural resources. It introduces critical issues in environmental studies, both in an Indian and global perspective. The process of urbanization is explored with respect of consumption of resources; environmental consequences of urban transformation, waste disposal and pollution.

Course Code	Title	No. of Lectures
USLSC604	ENVIRONMENTALBIOLOGYII	2.5Credits (60 Lectures)

Unit I	**15 Lectures**
1.1.Environmental effects of urbanization: Availability of public/open and green spaces/sustainable use of urban space)	**1Lectures**
1.2.Expansion pattern of cities- Megacities, smart cities and Ecocities, problem of Urban sprawl.	**2Lectures**
1.3.Urban growth Challenges: Drinking water supply, pollution of surface water, generation of waste and waste management.	**2 Lectures**
1.4.Rural environmental degradation: (a) deforestation; (b) declining soil quality (including soil desiccation); and (c) loss of biodiversity.	**2Lectures**
1.5. Use of fresh water Resources: ground water, contamination of ground water, rural sewage management, freshwater wet lands, Rural Migration , Impact of cities on rural environment. **River linking Project: Ken and Betwa river.* to be given as Student Assignment**	**3Lectures**
1.6.Impact of environmental degradation on rural women	**1Lectures**
1.7. Toxic and solid waste management: Types of waste, solid waste disposal,E-waste and toxic waste trading, economics of recycling, recycling plastic,Biocomposting and producing less waste.	**4Lectures**
UNITII	**15 Lectures**
2.1. Energy and Environment: Classification of Energy resources, Types of renewable and Non-renewable energy resources.	**2Lectures**
2.2. Evaluating energy resources: Nuclear Power, Coal, Natural Gas, Biomass burning, Gas turbines and Biofuels.	**3Lectures**
2.3. Alternative Energy Resources: Geothermal, Tidal/Wave power, Ocean Thermal Energy, Inland Solar ponds, Energy efficient buildings	**4Lectures**
2.4. Meeting the growing demands: Transportation, residential, commercial and industrial needs.	**3 Lectures**
2.5. Meeting energy efficiency: Household connected devices	**1 Lectures**
2.6. Concept of carbon credit and carbon foot print	**2 Lectures**
*Types of energy resources to be given as student assignment.	

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

Practical Syllabus

Semester V

Course code: USLSCP05

[Practical Based on USLSC501, Credits-1.5, Lectures- 60]

Genetics

I) Experiments to be performed by students:

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

II) Demonstration experiments:

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

Immunology

I)Experiments to be performed by students:

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

II) Demonstration experiments:

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

Course code: USLSCP05

[Practical Syllabus Based on USLSC502, Credits: 1.5, Lectures : 60]

Developmental Biology:

Animals:

1) Study of developmental stages of chick embryo- C, T

2) Cytochrome C- oxidase activity in a developing chick embryo. C, T

Demonstration experiments (Any two of the following):

1. Programmed cell death in limb bud using Janus Green B stain (in chick embryo).C, T,R

2. Alizarin stain to study limb development in chick embryo/ Regeneration of cartilage / bone C, T,R

3. Acid and alkaline Phosphatase in Chick embryo.

Plants :

1) Effect of temperature on cell viability in pollen grains/yeast using Trypan blue/ acetocarmine .C, T, R

2) Root and shoot development in sections of a 2-day old plant embryo. I,C,T,R.

3) Study of plant embryo and determination of seed viability using NBT I,C,T,R.

Neurobiology:

1) Dissection& display of Nervous system in invertebrates – earthworm / cockroach or any other suitable animal C,T,R

2) Dissection & display of Nervous system in vertebrates – chick brain/goat brain or any other suitable system C,T ,R

3) Study of chick embryo for identification of fore, mid & hind brain areas (Refer above Developmental Biology Practical no.1)

5) Study of Permanent slides of: C,R

a) Medullary nerve fibre b) TS of Spinal cord c) Mammalian retina

d) Electron micrographs of neural tissue

Demonstration Experiments (Any two of the following):

a)Study of the Nervous system of Sepia with special reference to Giant axon and stellate ganglia T,C,R.

b)Assignment - Bird songs and neurophysiology involved (as a group practical)

c)Understanding the principle and basic interpretation of brain imaging tests like PET (Positron Emission Tomography) and MRI (Magnetic Resonance Imaging)

Coursecode: USLSC P06

[Practical Based on USLSC503,Credits-1.5,Lectures- 60]

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

Coursecode: USLSC P06

[Practicals Based on USLSC504,Credits-1.5,Lectures- 60]

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

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

Practical
Syllabus
Semester VI

Course code: USLSC P07

[Practical Based on USLSC601, 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.
5. Extraction of DNA from epithelial cells

II) Demonstration experiments:

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

Immunology
I) Experiments to be performed by students:

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

II) Demonstration experiments:

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

Course Code: USMB P07

[Practical Syllabus Based on USLSC602 Credits: 1.5, Lectures: 60]

Plant Developmental Biology

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

Animal Developmental Biology

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

Neurobiology

1. Differential staining of white and grey matter of vertebrate brain.
2 Temporary mounts of **any three** of the following: C, T, R
a) Cornea of prawn. b) Statocyst of prawn. c) Columella of bird. d) Striated / smooth muscle fibre.
e) Methylene blue staining of earthworm nerve cord or any other suitable nerve cord or brain to observe organization of neuronal cell bodies in invertebrates
f) Olfactory & gustatory sensillaeg) Histological staining of neuronal tissue using Heamotoxilin-Eosin staining or Nessil's staining.
3) Making clay model of vertebrate brain and cranial nerves. C,T,R
Demonstration Experiments - C, T, R
1. Stroop test.
2. Olfactory /Gustatory Behavioral study: Snail / Earthworm / insect larvae
3. Associative conditioning
4. Knee-jerk and pupillary reflex.
5. Testing for locating the Blind Spot in the retina

Coursecode: USLSC P08

[Practicals Based on USLSC603,Credits-1.5,Lectures- 60]

1. Thin layer chromatography of lipids/plant alkaloids/any other suitable extract
2. Bioassay of antibiotic / plant extract / for anti-bacterial activity or B-12 assay.
3. Assay of fermentation product / Substrate – Estimation of (a) alcohol/Acetic/lactic acid (b)
4. Extraction of plasmid DNA& Agarose Gel Electrophoresis of plasmid DNA/Restriction Digest with costing of the experiment.
5. Immobilization of Enzyme (Amylase/any other convenient enzyme) using hen egg-white or alginate method and assay its activity.
6. Quality control: Probiotics or Vaccine
7. Bioinformatics :

    i) Design primers (Forward and reverse primers with matching Tm) for amplifying "x" gene of "y" species. (They will search for sequence, and design primers)

    ii) Manual annotation of DNA sequence: Prokaryotic/Eukaryotic

    iii) Sequence alignment – pair wise (For Match Score: Specify values for match, mismatch and gap penalty)

    iv) Construction of Cladogram/Phylogram with TimeLine

Open-ended projects: (Any one 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 2 hrs
5. Growth curve of E coli (DH5 alpha) and preparation of competent cell for transformation experiment.
6. Finger Printing technique using electrophoresis of protein/DNA digest 38
7. SDS PAGE with suitable Protein sample for Comparison with Experiment no.3 above.
8. Agarose Gel Electrophoresis of extracted DNA samples with & without Molecular marker ladder

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

Course Code: USLSC P08

[Practical Syllabus Based on USLSC604SemesterVICredits:1.5, Lectures: 60]

Note:I–Instrumentation,C-Conceptualunderstanding,T–Technicalskill,R–Relevance to daily life

1. EC, conductivity,N/P/K/Sulphates/Na/Ca. /EstimationofCo2+and Ni2+by colorimetry/spectrophotometry/ Water analysis for physico-chemical characteristics/EstimationofHeavymetalinvarioussamplesbytitrimetryor spectrometry/Potability of the given drinking water sample by MPN. (any three of the above) **(CTR)**

2.Estimation of Co2+ and Ni2+/Pb by colorimetry / spectrophotometry (any one) **(CTR)**

3. Remote Sensing and GIS: Principles of Remote Sensing and its application of Environmental Science. Application of GIS in Environmental Management (Use photographs and models). **(CTR)**

4.Collection and Interpretation of weather data/Climatology of Mumbai city (Satellite images and statistical analysis of weather data).
Statistical methods for analysis of environmental data: diversity and similarity indices, for the given data. Use of EXCEL or SPSS **(CT)**

5. Using a Simulated data perform the following:-
Classify the data and calculate ecological indices; Dominance index, Shannon-Wiener Index, Similarity Index, Diversity index. Evaluate and interpret each of the index values. (any two) **(CT)**

6. Estimation of stomatal index (2 different leaf types and two different micro-climatic conditions e.g. Sun loving, shade loving)/ Chlorophyll content. **(CTR)**

7.Field visit to river/lake and waste water treatment plants. **(CTR)**
A visit to Sanjay Gandhi National Park . Identification of local plant species as: Ecological indicators, exotic species **(CTR)**

8.Environmental Project (compulsory) **(CTR)**
Environmental audit of an institution Ex. Electricity and water audit and preparing a report./Make an ecological evaluation of a local sit eand 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 atleast three months./Make a report and your evaluation on environmental issue/ Project on arole of a chosen organism in your immediate environment or its significance to the local biodiversity/Measurement of sounds by DB meter in silent ,industrial, residential and commercial zones/A Survey related to environmental issues amongst the citizens: Data to be collected and analyzed statistically with suggestions for environmental management.

*The film documentary/Video making for project should notbemorethan10 min duration.
Project Submission and viva

Semester V

Text Books and References

USLSC 501
References books for
Unit I and II Genetics

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

References books for
Unit III and IV Immunology

11. Immunology 5thedn. R.A.Goldsky, T. J. Kindt, B. A. Osborne, J. Kuby 2003.
12. Immunology: The immune system in health and disease 6thedn. C. A. Janeway, P. Travers, M. Walport, M. Shlomchik Garland Science Pub. 2005.
13. Cellular and Molecular Immunology, 2 ndedn. A. K. Abbas, A. H. Litchman, 5 thedn 2000.
14. Basic Immunology: Functions and disorders of the immune system, 2ndedn. A. K. Abbas, A. H. Litchman, 2ndedn 2004.
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