



(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
USLSC501		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	
USLSC502	4	Antigen Recognition and Effector Mechanisms	2.5
		DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY I	
	1	Developmental Biology : Concepts and Tool Kit	
	2	Animal Development	
USLSC503	3	Introduction to Behavior and the Nervous System	2.5
	4	Overview of the Cellular Organization of the Nervous System	
		BIOTECHNOLOGY AND GENETIC ENGINEERING I	
	1	Fermentation Technology – Principles	
USLSC504	2	Fermentation Technology - Food and Beverage Production	2.5
	3	Gene Cloning – Principles	
	4	Gene Cloning – Technology	
		ENVIRONMENTAL BIOLOGY I	
USLSC505	1	Introduction to Fundamentals of Environmental Science	3
	2	Biodiversity and Habitats	
	3	Pest Management and Toxicology	
	4	Sustainable Development	
USLSC506		Based on USLSC503 and USLSC504 of Semester V	3

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

Course Code	Unit No	Name of the Unit	Credits
USLSC601		GENETICS AND IMMUNOLOGY II	2.5
	1	Mechanisms of Inheritance and Variation in Eukaryotes	
	2	Tools and Techniques in Molecular Biology	
	3	Hypersensitivity, Vaccines And Immunodeficiency	
	4	Transplantation, Tumour Immunology, Tolerance and Autoimmunity	
USLSC602		DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY II	2.5
	1	Cellular Aspects of Development	
	2	Applications of Developmental Biology	
	3	Introduction to Behavior and the Nervous System	
	4	Neurobiological Basis of Behavior And Diseases	
USLSCP07		Based on USLSC601 and USLSC602 of Semester VI	3
USLSC603		BIOTECHNOLOGY AND GENETIC ENGINEERING II	2.5
	1	Fermentation Technology - Enzyme And Pharmaceuticals Production	
	2	Tissue Culture Biotechnology	
	3	Genetic Engineering	
	4	Applications of Recombinant DNA Technology: And Bioinformatics	
USLSC604		ENVIRONMENTAL BIOLOGY I	2.5
	1	Environmental Degradation	
	2	Natural Resources	
	3	Environmental Impact Study	
	4	Society and Environment	
USLSCP08		Based on USLSC603 and USLSC604 of Semester VI	3

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. USLSC501 and USLSC601
2. USLSC502 and USLSC602
3. USLSC503 and USLSC603
4. USLSC504 and USLSC604

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

1. USLSC501 and USLSC601
2. USLSC502 and USLSC602

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	USLSC501	
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; and Fraenkel-Conrat and B. Singer's experiment of 1956.
1.2	Molecular aspects: Sequence complexity of DNA - Unique and repetitive sequences of DNA; Denaturation kinetics and 'CoT' value; Satellite DNA
1.3	Genomes: Structural organization of a prokaryotic genome. Structural organization of a eukaryotic genome. Higher orders of chromosome packing; 'C value paradox';
1.4	Gene regulation in eukaryotes Chromatin condensation, Modification and remodelling by acetylation and methylation, Transcriptional regulation (promoters and enhancers and Transcription initiation complex, GAL4-UAS system)
UNIT 2	Mechanisms of Inheritance and variation in Prokaryotes (15 LECTURES)
2.1	Genetic recombination in Bacteriophages: Life Cycle of lytic and lysogenic phages; Complementation in phages (Intra- and Inter-genic)
2.2	Recombination mapping Two- and three- factor crosses, Deletion Mapping; Numerical examples and problem solving.
2.3	Genetic recombination in Bacteria: The processes of: Conjugation Transformation Transduction Mapping the genome by each method. Numerical examples and problem solving.

UNIT 3	<p>Overview and cells and organs of immune system</p> <p style="text-align: right;">(15 LECTURES)</p>
3.1	<p>Overview of the Immune system - Innate Vs Adaptive Immunity</p> <p>3.1.a Innate immunity</p> <ul style="list-style-type: none"> i) Anatomical, Physiological, Phagocytic, Inflammatory barriers ii) Concept of Apoptosis vs Necrosis iii) Concept of PAMP, PRR and TLR <p>3.1.b Cells and organs of the immune system</p> <ul style="list-style-type: none"> i) Primary and secondary lymphoid organs ii) Cells -Myeloid cells, Lymphoid cells, NK cells
3.2	<p>Recognition of antigens</p> <p>3.2 a Antigen-antibody interactions</p> <ul style="list-style-type: none"> i. Antigen-Specificity, avidity, affinity, immunogenicity ii. Antibody-Structure, Functions and variations iii. Monoclonal and polyclonal antibodies (Hybridoma Technique) iv. Organization and expression of Immunoglobulin genes v. Antigen-antibody interactions –Cross reactivity, Precipitation, Immunoelectrophoresis, Agglutination, Radioimmunoassay, ELISA, Immunofluorescence
UNIT – 4	<p>Antigen recognition and Effector Mechanisms</p> <p style="text-align: right;">(15 LECTURES)</p>
4.1	<p>Recognition of antigens.</p> <p>Major Histocompatibility Complex</p> <ul style="list-style-type: none"> i) MHC-I and MHC-II molecules. ii) MHC allelic polymorphism iii) MHC restriction iv) Antigen processing and presentation-endogenous and exogenous pathways.
4.2	<p>Maturation and activation of Lymphocytes</p> <p>B- cell maturation, Activation and Differentiation</p> <p>T- cell maturation, Activation and Differentiation and T- cell receptor</p>
4.3	<p>Immune Effector Mechanisms</p> <p>Cytokines - - IL-1, IL-2, IL-4, IFNs and TNFs</p> <p>Complement</p> <ul style="list-style-type: none"> i) Classical, alternate and lectin pathways and comparison ii) Biological consequences of complement activation iii) Complement fixation tests
4.4	<p>Cell-mediated effector responses</p> <p>Cell-mediated cytotoxicity of T cells Role of TH1, TH2,TH17 and Tc cells</p>

USLSCPO 5	Practicals Based on USLSC501, Credits -1.5 (60 LECTURES)
	<p style="text-align: center;"><u>Genetics</u></p> <p><u>Experiments to be performed by students:</u> Extraction of chromosomal DNA from chicken liver / goat spleen Streak plating of saliva on two different media Viable count for enumeration of bacteria by –Bulk seed method Viable count for enumeration of bacteria by - Surface spread method Study of <i>Drosophila</i> mutants from specimen / slides / photographs Collection and observation of virgin <i>Drosophila</i> females for setting up of genetic crosses. Study of UV-Visible Spectrophotometer</p> <p style="text-align: center;"><u>Immunology</u></p> <p>I) <u>Experiments to be performed by students:</u></p> <ol style="list-style-type: none"> 1 Study of ABO Blood groups and quantitative Coomb’s Test. 2 Study of Isohemagglutinintitre in blood. 3 Quantitative Widal Test. 4. Demonstration experiments: <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; 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, 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	History and basic concepts in development Sea Urchin : Mosaic vs. Regulative Development Dictyostelium : acquisition of multicellularity Drosophila : mutation series and early development. Chick and amphibians : fate maps and chimeras. Zebra fish : in situ hybridization and trace gene expression.
1.2	Arabidopsis as the model System Life cycle of Arabidopsis – sporophytic and gametophytic generation, Fertilization and embryo development, Formation of meristems (root and shoot), Formation 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], Role of Homeotic genes specifying parts of a flower Plant genome project (Arabidopsis and rice)
UNIT 2	Animal Development (15 LECTURES)
2.1	Amphibian development- Introduction , Germ cell and Fertilization Cleavage, Morula and blastula. Gastrulation.
2.2	Chick development – Introduction, Germ cells and Fertilization, Cleavage, Morula and blastula, Gastrulation. Neurulation. - neural induction, Neural tube formation in amphibians and chick Organogenesis – Eye OR limb Neural Crest Cells
UNIT 3	Introduction to behavior and the nervous system (15 LECTURES)
3.1	Overview of animal behavior i. Innate behavior and Learned behavior (example: Aplysia). ii. Imprinting in birds, Behavioural defects – e.g. Bird songs of isolated, caged birds.)
3.2	General organization of nervous system : i. Invertebrate Nervous system: Organization of neurons in brain and ganglia of Invertebrates Nerve net, nerve plexus and ganglionated nervous system e.g. hydra, starfish and earthworm. ii. Vertebrate nervous system: Central Nervous System and Peripheral Nervous system. Functional organization of the human central nervous system
3.3	Subdivisions of the CNS – Spinal cord, the medulla, the pons, the cerebellum, the midbrain, the diencephalon, and the cerebral hemispheres.

3.4	Various lobes of the Brain- Fore brain, mid brain and spinal cord, lobes of the brain and their functional familiarization e.g. motor areas, somatosensory, emotions. Limbic System, Memory and Hypothalamo – Hypophysial Axis.
UNIT – 4	Overview of the Cellular organization of the nervous system (15 LECTURES)
4.1	Typical nerve cell Types of cells: Neuronal, Glial cells, ependymal cells and Schwann cells. Role of meninges and CSF. Chemical Basis of Neural transmission- Introduction Ionic basis of resting membrane potential: Donnan's equilibrium experiments, Nernst's potential Goldman's equation, Sodium –Potassium pump
4.2	Action Potential & propagation – Hodgkin and Huxley's model, voltage clamp experiment and the derivation and propagation of Action Potential Compound Action potential. Graded potential Synaptic potential and synaptic integration [Electrical and Chemical Synaptic Potential] Excitatory Post Synaptic Potential (EPSP), Inhibitory Post Synaptic Potential (IPSP) Neuro – muscular junctions
4.3	Synapse and synaptic transmission. Synapse: Structure, Types – chemical and electrical, Neurotransmitters – General Introduction Biosynthesis, physiological role, pharmacological significance, (examples of one agonist and one antagonist for each neurotransmitter mentioned below. a) Acetylcholine (Nicotinic and muscarinic receptors). b) Dopamine (D1 and D2 receptors). c) GABA and Glutamate d) Neuropeptide (Endorphin and Enkephalin).
USLSCPO 5	Practicals Based on USLSC502, Credits -1.5 (60 LECTURES)

	<p>Chick Developmental Biology</p> <ol style="list-style-type: none"> 1) Study of developmental stages of chick embryo- 2) Cytochrome C- oxidase activity in a developing chick embryo. <p>Demonstration experiments (any two of the following):</p> <ol style="list-style-type: none"> 1. Programmed cell death in limb bud using Janus Green B stain (in chick embryo). 2. Alizarin stain to study limb development in chick embryo/ Regeneration of cartilage / bone 3. Acid and alkaline Phosphatase in Chick embryo. <p>Plant Developmental Biology</p> <ol style="list-style-type: none"> 1. Effect of temperature on cell viability in pollen grains/yeast using Trypan blue/ acetocarmine . 2. Root and shoot development in sections of a 2 day old plant embryo. <p>Neurobiology.</p> <ol style="list-style-type: none"> 1. Dissection& display of Nervous system in invertebrates – earthworm / cockroach or any other suitable animal C,T,R Dissection & display of Nervous system in vertebrates – chick brain/goat brain or any other suitable system C,T ,R 2. Study of chick embryo for identification of fore, mid & hind brain areas (Refer above Developmental Biology Practical no.1) 3. Study of Permanent slides of: C,R <ol style="list-style-type: none"> a) Medullary nerve fibre: b) TS of Spinal cord c) Mammalian retina d) Electron micrographs of neural tissue <p>6. Demonstration Experiments (Any two of the following). Study of the Nervous system of Sepia with special reference to Giant axon and stellate ganglia T,C,R.</p>
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REFERENCES:

USLSC502: REFERENCE BOOKS

UNIT 1 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: Exploting the brain
M.F.Baer, B.W.Connors&M.A.Paradiso, William & Wilkins, Baltimore, Latest Edition (First Edition1996)

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
Internation.
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. Cembridge University Press.
25. Comparative Neurobiology
J. 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, i. Screening (primary & secondary) ii. 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
UNIT 3	Gene Cloning – Principles (15 LECTURES)
3.1	Introduction to the history of Gene cloning
3.2	Cutting and joining DNA molecules Role of Restriction enzymes, Type I, II ,III, patterns of DNA cutting by restriction enzymes. Restriction Mapping, DNA ligase, Homopolymer tailing, Adaptors, Linkers, Use of Alkaline Phosphatase
3.3	Vectors: The cloning vehicles Vectors for gene cloning (Plasmids, Bacteriophages as vectors, cosmid as vector Plasmids and other advanced vectors. pBR 322 : structure , origin and uses Expression of Insulin and somatostatin gene in <i>E.coli</i> using pBR322. Bacteriophage Lambda as vector, M13 vector.

UNIT – 4	Gene Cloning – Technology <p style="text-align: right;">(15 LECTURES)</p>
4.1	Cloning of genes i. Isolation of cloning vectors, selection of gene cloning organisms, isolation of desired DNA to be cloned ii. Identifying a specific clone with a specific probe, construction of recombinant DNA, transformation, culture and isolation of recombinant DNA from non recombinant one ii. Shot gun cloning. iv. Making genomic and cDNA libraries in E. coli
4.2	cDNA technology i. Isolation of mRNA, cDNA synthesis, cloning of double stranded cDNA in plasmid or phase vector, screening a library with nucleic acid probe to find a clone.) iii. Polymerase chain reaction : An alternative to cloning (Method , limitations of PCR, Application of PCR, Reverse transcriptase PCR)
4.3	Methods of expressing cloned genes Expression of vectors Screening and selection of the desired clone : Immunological method i) Nucleic acid hybridization method ii) Subtractive cDNA cloning Hybrid arrest and Hybrid release method (HART and HART)
USLSCPO 6	Practicals Based on USLSC503, Credits -1.5 <p style="text-align: right;">(60 LECTURES)</p>

	<ol style="list-style-type: none"> 1. Extraction of enzyme: (Amylase from sweet-potato / salivary amylase / egg white lysozyme or any other convenient enzyme) 2. Purification of enzyme : Above enzyme extract used for purifying by salting-out method 3. Determination of - i) enzyme activity ii) specific activity. 4. Determination of the effect of pH and Temperature on Enzyme activity (Amylase / any other convenient enzyme). 5. Determination of the K_m of amylase/any other convenient enzyme. 6. Immobilization of Enzyme (Amylase/any other convenient enzyme) using hen egg-white / alginate method and assay its activity. 7. Agarose gel electrophoresis of the extracted amylase using serum / egg white as a control: 8. Enzyme Activity staining / Zymogram of Amylase using starch agar plates. 9. Non-denaturing Poly Acrylamide Gel Electrophoresis of <i>E.coli</i> extract / Serum proteins / Saliva / Egg white any other suitable sample
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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>Natural resources: Sustainable development of the Biosphere How humans affect their environment: Spread of human population, Hunter gatherer population, agricultural revolution, Cultural Revolution.</p> <p>Ecosystem and Human needs: Resource depletion and pollution, Dwindling Biodiversity, consumers versus resource crunch(with suitable examples from developed and developing countries)</p> <p>Sustainable Development: As defined by United Nations World Commission on Environment and Development.</p>
1.2	<p>1.2. Ecosystem dynamics: Ecosystems and concept of biotic communities, food web food chain, Energetic of interaction between biotic and abiotic components, Energy flow, primary and secondary productivity, Ecological Pyramids.</p> <p>Chemical cycling(C, N, P, S, N fixation)</p> <p>Primary succession (soil formation) and secondary succession</p> <p>Primary succession (soil formation) and secondary succession</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.</p> <p>Wildlife management and conservation: Wild life management: Goals and Strategies., Human land-use and wildlife management, role of local communities in wildlife management initiatives., Impact of Ecotourism</p>

2.3	<p>Marine life: Open sea and coastal sea productivity and conservation issue Biodiversity conservation: Global agreements and national concerns. RAMSAR sites.* Endangered, Endemic and Extinct Species of India to be given as student assignment.</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.</p> <p>Politics and economics of Hunger, GM foods and their environmental concerns eg . <i>Bt</i> Brinjal</p> <p>International Treaty on Plant Genetic Resources for food and Agriculture (ITGR) Intellectual Property Rights (IPR), Biopiracy (e.g., Neem/Basmati), Seed Bank</p> <p>Human impact on climate: Ozone layer, green house effect, Methane, carbon dioxide. Carbon footprints.</p>
UNIT – 3	<p>Pest and pesticides</p> <p style="text-align: right;">(15 LECTURES)</p>
3.1	<p>Basic introduction about Pests,</p> <p>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</p> <p>Bioremediation of OP pesticide: using <i>Bacillus</i> Sps. (eg. Malathion Pesticide)</p> <p>Phytoremediation of Organochlorine pesticide (Chloropyrifos) using plants</p> <p>Pesticide regulation: eg. Endosulphan issue.</p>
3.2	<p>Toxicology Management.</p> <p>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.</p> <p>Limitation of Toxicological studies: Comparison of animal toxicological models and Toxicity in Humans.</p> <p>Human clinical trials: Concept of Clinical trial phases - I, 2, 3 and 4.</p> <p>Ethical issues of clinical trials: e.g. Thalidomide, Human Papillomavirus vaccine trials.</p>
UNIT – 4	<p>Sustainable Development</p>

	<p>Sustainable Development Ecological and economical growth factor for sustainable development, integrating environmental concerns in economic decisions. Economic cost of environmental degradation. Costs benefit analysis</p>
	<p>Awareness of citizen on environmental legal provisions: (i) Constitutional Provisions for environment (ii) Legislative power relating to environmental law (iii) General laws relating to environment.</p>
USLSCPO 6	<p>Practicals Based on USLSC504, Credits -1.5 (60 LECTURES)</p>
	<ol style="list-style-type: none"> 1. A visit to aquatic ecosystem and methods for water and plankton collection/ Plankton identification and quantification from river / lake water samples 2. Vegetation studies by line, quadrates and belt transect methods and their analysis. 3. 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

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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 M C (2004) "Ecology, chemistry and Management of environmental Pollution ", Mac Millan India
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7. Dolder, Willi (2009), "Endangered animals, Parragon
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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

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 Three factor crosses in maize Co-efficient of co-incidence and interference in Drosophila Co-efficient of co-incidence and interference in Drosophila
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 iii)

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</p> <p style="text-align: right;">(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 Gsubfraction 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.
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.
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 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.
Immunology: The immune system in health and disease 6thedn. C. A. Janeway, P. Travers, M. Walport, M. Shlomchik Garland Science Pub. 2005
12. Cellular and Molecular Immunology, 2nd edn. A. K. Abbas, A. H. Litchman, 2000.
13. Basic Immunology: Functions and disorders of the immune system, 2ndedn. A. K. Abbas, A. H. Litchman, 2ndedn 2004.
14. Roitt's Essential Immunology 11thedn. Blackwell publication 2006.
15. Immunology 7thInternationaledn. D. Mole, J. Bronstoff, D. Roth, I. Roitt, Mosbey Elsevier publication, 2006.
16. An Introduction to Immunology C. V. RaoNarossa Publishers 2002.

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

Internal Assessment(25marks)

Part1:ProjectWork(20Marks)

- At the beginning of the semester, students should be assigned project topics drawn from Unit 1 to Unit 4.
- Students can work in groups of not more than 8 per topic.
- Project Marks will be divided as written submission:10 Marks& Presentation & Viva: 10 marks)
- The Project/Assignment can take the form of Street-Plays/Power-Point Presentations/Poster Exhibitions and similar other modes of presentation appropriate to the topic.
- Students must submit a hardcopy of the Project before the last teaching day of the semester.

Part2: Attendance– 05marks

Semester End Examination–External Assessment(75marks)

- The duration of the paper will be two hours.
- There shall be four compulsory questions
- Q1-3 shall correspond to the three units. Q1- shall contain an internal choice (attempt any 2 of 3). Q1-3 shall carry a maximum of 20 marks
- Q4 shall be a short note fromUnit1to3. Q4 shall carry a maximum of 15marks (3x5marks) (attempt any 3of 6)

Practical Assessment (for papers with practicals)

- The duration of the practical exam will be 8 hours.
- 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.
- 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.

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) Conserved nature of developmental genes (Evo- Devoperspective Hox/Pax6 genes with respect to Drosophila)
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 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 (Arabidopsis/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 (Salamander limb) and Morphallactic (Hydra) 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 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 <p>Animal Developmental Biology</p> <ol style="list-style-type: none"> 1. Live observations of Developmental stages of. <i>C.elegans/Dictyotelum/Drosophila/zebrafish</i> Demonstration experiments: C, T (Any two of the following): 2. Imaginal discs of <i>Drosophila</i> 3. Regeneration in earthworm / any other suitable system / hydra (using permanent slide / photographs) 4. 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"> 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 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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REFERENCES:

USLSC602: 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 L. Wolpert, R. Beddington, J. Brockes, T. Jesell and P. Lawrencel 23 Oxford University Press.
4. Developmental Biology. W.A. Miller Springer – Verlag.
- 5.. Molecular Biology 3rd Ed., H.Lodish, D.Baltimore, A.Berk, S.L. Zipurski, P.Matsudaira and J. Darnell. Scientific American Book, W.H. Freeman, N.Y.
6. Molecular Biology of the Cell 3rd Edition. B. Alberts, D. Bray, J.Lewis, M. Raff, K. Roberts and J.D.Watson. Garland Publishing Inc., N T and London.
7. 5. Plant Cell and Tissue Culture I. Vasil and T.A. Thorpe. Kluwer Academic Publishers.
8. Practical Zoology 2ndEdition. K.C. Ghone and B. Manna. New Central Book Agency Publishers.
9. Developmental Biology 4thedition. S.F. Gilbert. Sinauer Associates Inc. Publishers.
10. Pollen Analysis 2ndedition. 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 2ndedition, L.W.Browder, Saunders College Publishing Co.
13. An Introduction to Embryology 5thEd 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 2nded.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).

17. Neuroscience: Exploting the brain M.F.Baer, B.W.Connors&M.A.Paradiso, William & Wilkins, Baltimore, Latest Edition (First Edition1996)
18. Neurobiology 3rdedition G.M. Shepherd Oxford University Press.
18. Principles Of Neural Science. E.R.Kandel, J.H.Schwartz and T.M. Jessel. Prentice Hall Internation.
19. Instant Notes – Neurosciences, A.Longstaff Viva Books Pvt Ltd., New Delhi, 2002

20. Text Book Of Medical Physiology A.C.Guyton and J.E.Hall Saunders College Publishers.
21. Elements Of Molecular Neurobiology C.U.M. Smith J Wiley and Sons Publishers, N.Y.
22. An Introduction to Molecular Neurobiology Z.W. Hall Sinauer Associates Inc. Publishers.
23. Ion Channels – Molecules in Action D. J. Aidley and P.R. Stanfield. 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)
UNIT 3	Genetic Engineering <p style="text-align: right;">(15 LECTURES)</p>
3.1	Manipulating DNA in Microbes, plants and Animals: a.BAC b. Cloning Other Eukaryotic vectors: <i>S. cerivisiae</i> : basic principle c. Yeast artificial chromosome d.Cloning of vectors in animal : SV 40 , Baculo virus 3.1. e.Ti plasmids to transfer genes to plants
3.2	Molecular tools for studying genes and gene activity : Molecular separations Separation of DNA by Gel electrophoresis (Agarose gel electrophoresis, Poly-acrylamode gel electrophoresis, Two-Dimensional Gel Electrophoresis) Using Nucleic acid Hybridisation Analysis of specific nucleic acids in complex mixture (Southern blotting, Northern blotting)

3.3	<p>DNA Fingerprinting and DNA typing</p> <p>Forensic uses of DNA finger printing and DNA Typing</p> <p>DNA sequencing by Sanger's, Maxam and Gilbert's methods, concept of automated gene sequencing</p> <p>Microarray</p> <p>DNA Markers SNP, VNTR, RFLP, AFLP</p> <p>In Situ hybridization</p>
3.4	<p>Chromosome walking technique, chromosome jumping technique</p> <p>Chromosome painting technique</p> <p>Protein engineering with cloned genes: Site directed mutagenesis</p>
UNIT – 4	<p>Applications of recombinant DNA technology: and Bioinformatics (15 LECTURES)</p>
4.1	<p>Knockouts , Knock in, Knock down systems(Transgenic animals) Trans genic plants :Bt cotton and weedicide resistant gene)</p> <p>Xenopus oocyte as an expression system</p> <p>Giant Mouse (MMT promoter=growth hormone fusion gene)</p>
4.2	<p>Drosophila (using p element mediated technique-enhancer trap)</p> <p>Issues on recombinant DNA technology:</p> <p>Applications in industry – Medical/pharmaceutical, agricultural</p> <p>Applications in basic research – Intellectual property rights and open source biotechnology</p> <p>Gene therapy for Parkinson disease</p> <p>Stem cell technology and Parkinson disease</p>

4.3	<p style="text-align: center;">Bioinformatics :</p> <p>Biological databases sequence annotation and comparison</p> <p style="text-align: center;">Multiple sequence alignment Phylogenetic trees.</p> <p style="text-align: center;">* to be dealt with in practicals</p>
USLSCPO 8	<p style="text-align: center;">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 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: (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

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	Ecosystem degradation: Population size and growth, population fluctuations, carrying capacity, (density and population reduction(density dependent and independent factors). competition and predation: limits on population.	
1.2	Urbanization in developing countries. Urban crisis, suburban sprawl, land use planning, urban open spaces, Morbidity caused by air pollution, diseases of future(cancer & respiratory diseases).Urban growth Challenges: water and waste management, , water shortage, using less water, pricing of water. Air pollution and mobility	
1.3	Rural environment : Availability of fresh water, use of fresh water, ground water, contamination of ground water, rural sewage management, freshwater wet lands, Impact of cities on rural environment eg; Delhi & Yamuna, Spread of air pollution, Problems at catchment areas of Dams.	
1.4	Impact of Environmental degradation on Women.	
1.5	Toxic and solid waste management: Types of waste, solid waste disposal, economics of recycling, recycling plastic,, composting and producing less waste. Toxic Waste Trading: An environmentally destructive trade activity.	
UNIT 2	Energy Resources	(15 LECTURES)
2.1	Natural resources: energy conservation and renewable energy: Reserves of non renewable energy resources: Hidden costs of using natural resources electricity, generation and storing electricity.	
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	Environmental Impact Analysis of a Development Project : Environmental audit: protocols and data collection and analysis. Case studies of any two development projects. (e.g. Solid waste Management of a Municipal corporation, and an industrial plant)
3.2	Public Participation: Methodology and approach for public participation in Environmental & development decision making. Example: Plachimada struggle, Narmada Bachao andolan, Chipko movement.
3.3	Regulatory requirements for public participation eg Jaitapur or ENRON issues. Advantages and disadvantages of Public participation. Identification of participants and conflict management. Incorporation of results in decision makings.
UNIT – 4	Society and environment (15 LECTURES)
4.1	Nuclear proliferation, environment and war : E.g. use of Agent orange in Vietnam war, cost, benefit and risks, cost benefit analysis, risk management (EIA and Environment protection agency) perception of risk and gain, setting up standards, International cooperation - Treaties, planning for future. Vision of the world 2040.
4.2	Safety, Health and Environment: Lessons after 25 years of Bhopal gas tragedy. Perspectives and concerns of citizens: Environment as the ultimate beneficiary / loser. Safety and Health Hazards : Identification of potential safety and health hazards in industrial and development projects, reduction strategies, policies and legislation, international and national perspective, safety standards and management systems, ISO 18000 (Occupational Health and Safety Management Systems)
USLSCPO 6	Practicals Based on USLSC604, Credits -1.5 (60 LECTURES)

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.
- *The film documentary/Video making for project should not be more than 10 min duration.
- Project Submission and viva

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 (25 marks)

Part 1: Test (20 marks)

- Students will be given a written test from any of the units for 20 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 05 marks, Answer in one word/sentence - 05 marks, Subjective questions- HWY, Justify, Differentiate between, Diagrammatically etc. - 10 marks).

Part 2: Attendance (05 marks)

Semester end examination (75 marks)

- The duration of the paper will be two and a half hours.
- There shall be five compulsory questions
- Q1-4 shall correspond to the four units. Q1-4 shall contain an internal choice (attempt any 2 of 3 for Part A and any 5 of 8 for Part B). Q1-4 shall carry a maximum of 15 marks (10 marks Part A and 05 marks for Part B)
- Q5 shall be from Units 1 to 4. Q5 shall carry a maximum of 15 marks (attempt any 3 of 4)

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.

