

AC 07/06/13  
Item No.

# **UNIVERSITY OF MUMBAI**



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

**(Credit Based Semester and Grading System with effect from  
the academic year 2013–2014)**

## **PREAMBLE**

**Programme: B.Sc.**

**Course : Life Sciences (USLSC)**

**(Semester –V & VI)**

With the introduction of Credit Based Semester and Grading System (CBSGS) and continuous evaluation consisting of components of Internal Assessment and External Assessment by the esteemed University, the existing syllabi of F.Y.B.Sc. and S.Y.B.Sc. Life Sciences were restructured according to the CBSGS pattern and after the approval by the concerned authorities have been implemented 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 2013-14.

For restructuring the existing syllabi of T.Y.B.Sc Life Sciences and Applied Component courses, sub-committees were formed with Dr. Sanjay Deshmukh as the convener, BOS members as co-convener 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-501 and USLSC-601
2. USLSC-502 and USLSC-602
3. USLSC-503 and USLSC-603
4. USLSC-504 and 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 Practicals (Semester V and VI) compulsory:

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

## COURSE WISE CREDIT ASSIGNMENT UNDER THE FACULTY OF SCIENCE

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

Course wise credit assignments under the faculty of science Type of Courses / Credits Assigned	First Year (Credit x No. of Courses )		Second Year (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 (Practicals)	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
<b>Total</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>120</b>

**CREDIT ASSIGNMENT FOR LIFE SCIENCES AS A SINGLE MAJOR COURSE AT 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	
		<b>62</b>		<b>30</b>		<b>12</b>		<b>8</b>	<b>8</b>		<b>120</b>

**CREDIT ASSIGNMENT FOR LIFE SCIENCES + BIOCHEMISTRY AS A DOUBLE 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		Biochemistry		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	-
		<b>46</b>		<b>46</b>		<b>12</b>		<b>8</b>	<b>8</b>		<b>120</b>

**T. Y. B. Sc. LIFE SCIENCES THEORY**

**SEMESTER V**

<b>Course code</b>	<b>Title</b>	<b>Credits and Lects/Sem</b>
<b>USLSC501</b>	<b>GENETICS AND IMMUNOLOGY I</b>	<b>2.5 credits (60 LECTURES)</b>
Unit I	THE GENETIC MATERIAL	15 lectures
Unit II	MECHANISMS OF INHERITANCE AND VARIATION IN PROKARYOTES	15 lectures
Unit III	OVERVIEW AND CELLS AND ORGANS OF IMMUNE SYSTEM	15 lectures
Unit IV	ANTIGEN RECOGNITION AND EFFECTOR MECHANISMS	15 lectures

<b>USLSC502</b>	<b>DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY I</b>	<b>2.5 credits (60 LECTURES)</b>
Unit I	DEVELOPMENTAL BIOLOGY : CONCEPTS AND TOOL KIT	15 lectures
Unit II	ANIMAL DEVELOPMENT	15 lectures
Unit III	INTRODUCTION TO BEHAVIOR AND THE NERVOUS SYSTEM	15 lectures
Unit IV	OVERVIEW OF THE CELLULAR ORGANIZATION OF THE NERVOUS SYSTEM	15 lectures
<b>USLSC503</b>	<b>BIOTECHNOLOGY AND GENETIC ENGINEERING I</b>	<b>2.5 credits (60 LECTURES)</b>
Unit I	FERMENTATION TECHNOLOGY – PRINCIPLES	15 lectures
Unit II	FERMENTATION TECHNOLOGY - FOOD AND BEVERAGE PRODUCTION	15 lectures
Unit III	GENE CLONING – PRINCIPLES	15 lectures
Unit IV	GENE CLONING – TECHNOLOGY	15 lectures

<b>USLSC504</b>	<b>ENVIRONMENTAL BIOLOGY I</b>	<b>2.5 credits (60 LECTURES)</b>
Unit I	INTRODUCTION TO FUNDAMENTALS OF ENVIRONMENTAL SCIENCE	15 lectures
Unit II	BIODIVERSITY AND HABITATS	15 lectures
Unit III	PEST MANAGEMENT AND TOXICOLOGY	15 lectures
Unit IV	SUSTAINABLE DEVELOPMENT	15 lectures

## SEMESTER VI

<b>Course code</b>	<b>Title</b>	<b>Credits and Lects/Sem</b>
<b>USLSC601</b>	<b>GENETICS AND IMMUNOLOGY II</b>	<b>2.5 (60 LECTURES)</b>
Unit I	MECHANISMS OF INHERITANCE AND VARIATION IN EUKARYOTES	15 lectures
Unit II	TOOLS AND TECHNIQUES IN MOLECULAR BIOLOGY	15 lectures
Unit III	HYPERSENSITIVITY, VACCINES AND IMMUNODEFICIENCY	15 lectures
Unit IV	TRANSPLANTATION, TUMOUR IMMUNOLOGY, TOLERANCE AND AUTOIMMUNITY	15 lectures

<b>USLSC602</b>	<b>DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY II</b>	<b>2.5 (60 LECTURES)</b>
Unit I	CELLULAR ASPECTS OF DEVELOPMENT	15 lectures
Unit II	APPLICATIONS OF DEVELOPMENTAL BIOLOGY	15 lectures
Unit III	INTRODUCTION TO BEHAVIOR AND THE NERVOUS SYSTEM	15 lectures
Unit IV	NEUROBIOLOGICAL BASIS OF BEHAVIOR AND DISEASES	15 lectures

<b>USLSC603</b>	<b>BIOTECHNOLOGY AND GENETIC ENGINEERING II</b>	<b>2.5 (60 LECTURES)</b>
Unit I	FERMENTATION TECHNOLOGY - ENZYME AND PHARMACEUTICALS PRODUCTION	15 lectures
Unit II	TISSUE CULTURE BIOTECHNOLOGY	15 lectures
Unit III	GENETIC ENGINEERING	15 lectures
Unit IV	APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY: AND BIOINFORMATICS	15 lectures

<b>USLSC 604</b>	<b>ENVIRONMENTAL BIOLOGY II</b>	<b>2.5 (60 LECTURES)</b>
Unit I	ENVIRONMENTAL DEGRADATION	15 lectures
Unit II	NATURAL RESOURCES	15 lectures
Unit III	ENVIRONMENTAL IMPACT STUDY	15 lectures
Unit IV	SOCIETY AND ENVIRONMENT	15 lectures

**T. Y. BSc. LIFE SCIENCES PRACTICAL SYLLABUS**

**SEMESTER V**

<b>Course code</b>	<b>Practical Syllabus</b>	<b>Credits &amp; lectures</b>
<b>USLSCP05</b>	<b>Based on USLSC501 and USLSC502 of Semester V</b>	<b>Credits 3 (8 periods/week)</b>
<b>USLSCP06</b>	<b>Based on USLSC503 and USLSC504 of Semester V</b>	<b>Credits 3 (8 periods/week)</b>

**SEMESTER VI**

<b>Course code</b>	<b>Practical Syllabus</b>	<b>Credits &amp; lectures</b>
<b>USLSCP07</b>	<b>Based on USLSC601 and USLSC602 of Semester VI</b>	<b>Credits 3 (8 periods/week)</b>
<b>USLSCP08</b>	<b>Based on USLSC603 and USLSC604 of Semester VI</b>	<b>Credits 3 (8 periods/week)</b>

**Each theory and practical period shall be of 48 minutes duration.**



## SEMESTER V

### Life Sciences: Detail Syllabus

Course Code	Title	Lectures
USLSC501	GENETICS AND IMMUNOLOGY 1	<b>2.5 Credits (60 Lectures)</b>
<p><b><u>UNIT – I: The Genetic material:</u></b></p> <p><b>1.1 <u>Introduction - Discovery of the genetic:</u></b> 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.</p> <p><b>1.2 <u>Molecular aspects:</u></b>  <u>Sequence complexity of DNA</u> - Unique and repetitive sequences of DNA;            Denaturation kinetics and ‘CoT’ value; Satellite DNA</p> <p><b>1.3 <u>Genomes:</u></b>            1.3.a <u>Structural organization of a prokaryotic genome</u>            1.3.b <u>Structural organization of a eukaryotic genome</u>            Higher orders of chromosome packing; ‘C value paradox’;</p> <p><b>1.4 <u>Gene regulation in eukaryotes</u></b>            1.4.a Chromatin condensation,            1.4.b Modification and remodelling by acetylation and methylation            1.4.c Transcriptional regulation (promoters and enhancers and Transcription initiation complex, GAL4-UAS system)</p>		<p><b><u>15 Lectures</u></b></p> <p><b>2 Lectures</b></p> <p><b>4 Lectures</b></p> <p><b>1 Lecture</b></p> <p><b>3 Lectures</b></p> <p><b>1 Lecture</b>  <b>2 Lectures</b>  <b>2 Lectures</b></p>

<p><b><u>UNIT – II: Mechanisms of Inheritance and variation in Prokaryotes</u></b></p> <p><b>2.1 <u>Genetic recombination in Bacteriophages:</u></b>  2.1.a Life Cycle of lytic and lysogenic phages;  2.1.b Complementation in phages (Intra- and Inter-genic);  2.1.c Recombination mapping – Two- and three- factor crosses,  2.1.d Deletion Mapping;  2.1.e Numerical examples and problem solving.</p> <p><b>2.2 <u>Genetic recombination in Bacteria:</u></b>  2.2.a The processes of:  Conjugation  Transformation  Transduction  2.2.b Mapping the genome by each method.  Numerical examples and problem solving</p>	<p><b><u>15 Lectures</u></b></p> <p><b>1 Lecture</b>  <b>2 Lectures</b>  <b>2 Lectures</b>  <b>1 Lecture</b>  <b>1 Lecture</b></p> <p><b>4 Lectures</b></p> <p><b>4 Lectures</b></p>
<p><b><u>UNIT – III Overview and cells and organs of immune system</u></b></p> <p><b>3.1. Overview of the Immune system - Innate Vs Adaptive Immunity</b>  3.1.a Innate immunity  i) Anatomical, Physiological, Phagocytic, Inflammatory barriers  ii) Concept of Apoptosis vs Necrosis  iii) Concept of PAMP, PRR and TLR</p> <p>3.1.b Cells and organs of the immune system  i) <u>Primary and secondary lymphoid organs</u>  ii) Cells Myeloid cells- structure and functions  Lymphoid cells  NK cells</p> <p><b><u>3.2 Recognition of antigens</u></b></p> <p>3.2.a <b>Antigen-antibody interactions</b>  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</p>	<p><b><u>15 Lectures</u></b></p> <p><b>4 Lectures</b></p> <p><b>4 Lectures</b></p> <p><b>1 Lecture</b>  <b>2 Lectures</b>  <b>1 Lecture</b>  <b>2 Lectures</b>  <b>1 Lecture</b></p>

<p><b><u>UNIT – IV Antigen recognition and Effector Mechanisms</u></b></p> <p><b><u>4.1 Recognition of antigens.</u></b></p> <p>4.1.a <b>Major Histocompatibility Complex</b></p> <p>i) MHC-I and MHC-II molecules.</p> <p>ii) MHC allelic polymorphism</p> <p>iii) MHC restriction</p> <p>iv) Antigen processing and presentation-endogenous and exogenous pathways</p> <p><b><u>4.2 Maturation and activation of Lymphocytes</u></b></p> <p>4.2.a B- cell maturation, Activation and Differentiation</p> <p>4.2.b T- cell maturation, Activation and Differentiation and T- cell receptor</p> <p><b><u>4.3 Immune Effector Mechanisms</u></b></p> <p>4.3.a <b>Cytokines</b> - - IL-1, IL-2, IL-4, IFNs and TNFs</p> <p>4.3.b <b>Complement</b></p> <p>i) Classical, alternate and lectin pathways and comparison</p> <p>ii) Biological consequences of complement activation</p> <p>iii) Complement fixation tests</p> <p>4.3.c <b>Cell-mediated effector responses</b></p> <p>Cell-mediated cytotoxicity of T cells</p> <p>Role of TH1, TH2, TH17 and Tc cells</p>	<p><b><u>15 Lectures</u></b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>2 Lectures</b></p> <p><b>4 Lectures</b></p> <p><b>1 Lecture</b></p> <p><b>2 Lectures</b></p> <p><b>3 Lectures</b></p>
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Course Code	Title	Lectures
<b>USLSC502</b>	<b>DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY I</b>	<b>2.5 Credits (60 Lectures)</b>
<b><u>UNIT 1 : Developmental Biology : Concepts and tool kit</u></b>		<b><u>15 Lectures</u></b>
1.1 History and basic concepts in development		<b>1 Lecture</b>
1.2 Sea Urchin : Mosaic vs. Regulative Development		<b>1 Lecture</b>
1.3 Dictyostelium : acquisition of multicellularity		<b>3 Lectures</b>
1.4 Drosophila : mutation series and early development.		<b>2 Lectures</b>
1.5 Chick and amphibians : fate maps and chimeras.		<b>2 Lectures</b>
1.6 Zebra fish : in situ hybridization and trace gene expression.		<b>1 Lecture</b>

<p><b>1.7 Arabidopsis as the model System</b></p> <p>1.7.a Life cycle of Arabidopsis – sporophytic and gametophytic generation, Fertilization and embryo development, Formation of meristems (root and shoot),</p> <p>1.7.b 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],</p> <p>1.7.c. Double fertilization, seed formation. [Eventual formation of fruit],</p> <p>1.7.d. Role of Homeotic genes specifying parts of a flower</p> <p>1.7.e Plant genome project (Arabidopsis and rice)</p>	<p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p>
<p><b><u>UNIT II : Animal Development :</u></b></p> <p>2.1.a Amphibian development- Introduction , Germ cell and Fertilization</p> <p>2.1.b Cleavage, Morula and blastula.</p> <p>2.1 .c Gastrulation.</p> <p>2.2 Chick development –</p> <p>2.2.a Introduction, Germ cells and Fertilization,</p> <p>2.2.b Cleavage, Morula and blastula,</p> <p>2.2.c Gastrulation.</p> <p>2.3.d Neurulation. - neural induction, Neural tube formation in amphibians and chick</p> <p>2.4 Organogenesis – Eye OR limb</p> <p>2.5 Neural Crest Cells</p>	<p><b><u>15 Lectures</u></b></p> <p><b>2 Lectures</b></p> <p><b>1 Lectures</b></p> <p><b>1 Lectures</b></p> <p><b>2 Lectures</b></p> <p><b>1 Lectures</b></p> <p><b>1 Lectures</b></p> <p><b>2 Lectures</b></p> <p><b>3 Lecture</b></p> <p><b>2 Lectures</b></p>
<p><b><u>UNIT III : Introduction to behavior and the nervous system:</u></b></p> <p>3.1 Overview of animal behavior</p> <p>3.1.a Innate behavior and Learned behavior (example: Aplysia).</p> <p>3.1.b Imprinting in birds, Behavioural defects – e.g. Bird songs of isolated, caged birds.)</p> <p>3.2 General organization of nervous system :</p> <p>3.2.a 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.</p> <p>3.2.b Vertebrate nervous system: Central Nervous System and Peripheral Nervous system. Functional organization of the human central nervous system</p>	<p><b><u>15 Lectures</u></b></p> <p><b>2 Lectures</b></p> <p><b>3 Lecture</b></p> <p><b>3 Lecture</b></p>

<p>3.3.c Subdivisions of the CNS – Spinal cord, the medulla, the pons, the cerebellum, the midbrain, the diencephalon, and the cerebral hemispheres.</p>	<p><b>4 Lectures</b></p>
<p>3.3.d 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.</p>	<p><b>3 Lectures</b></p>
<p><b><u>UNIT – IV Overview of the Cellular organization of the nervous system</u></b></p>	
<p>4.1 Typical nerve cell</p>	<p><b>1 Lecture</b></p>
<p>4.2 Types of cells: Neuronal, Glial cells, ependymal cells and Schwann cells.</p>	<p><b>1 Lectures</b></p>
<p>4.3 Role of meninges and CSF.</p>	<p><b>1 Lectures</b></p>
<p>4.4 Chemical Basis of Neural transmission- Introduction Ionic basis of resting membrane potential: Donann’s equilibrium experiments, Nernst’s potential Goldman’s equation, Sodium –Potassium pump.</p>	<p><b>2 Lectures</b></p>
<p><b>4.5 Action Potential &amp; propagation –</b></p>	
<p>4.5.a Hodgkin and Huxley’s model, voltage clamp experiment and the derivation and propagation of Action Potential</p>	<p><b>1 Lecture</b></p>
<p>4.5b Compound Action potential. Graded potential</p>	<p><b>1 Lecture</b></p>
<p>4.5c Synaptic potential and synaptic integration [Electrical and Chemical Synaptic Potential] Excitatory Post Synaptic Potential (EPSP), Inhibitory Post Synaptic Potential (IPSP)</p>	<p><b>1Lecture</b></p>
<p><b>4.6 Neuro – muscular junctions</b></p>	
<p><b>4.7 Synapse and synaptic transmission.</b></p>	<p><b>1 Lecture</b></p>
<p>4.7a 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.</p>	<p><b>1 Lecture</b></p>
<p>4.7.b Acetylcholine (Nicotinic and muscarinic receptors).</p>	<p><b>5 Lectures</b></p>
<p>4.7.c Dopamine (D1 and D2 receptors).</p>	
<p>4.7.d GABA and Glutamate</p>	
<p>4.8 Neuropeptide (Endorphin and Enkephalin).</p>	

Course Code	Title	Lectures
USMB503	BIOTECHNOLOGY AND GENETIC ENGINEERING 1	2.5 Credits (60 Lectures)
<b><u>Unit I</u></b> <b>Fermentation technology – Principles</b>		<b><u>15 Lectures</u></b>
1.1	History and development of Food & Fermentation Technology	1 Lecture
1.2	Fermentation technology & Instrumentation	1 Lecture
1.3.a	Principles of microbial growth,	1 Lecture
1.3.b	Screening (primary & secondary)	1 Lecture
1.3.c	Strain improvement (mutation & selection using auxotrophy & analogue resistance)	2 Lecture
1.4	The Bioreactor / Fermenter & accessories (Stirred tank & Airlift)	2 Lectures
1.5	Media design for fermentation (include molasses, corn steep liquor)	2 Lecture
1.6	Downstream processing (use ex of Penicillin and an enzyme? for cell disruption)	1 Lecture
1.7	Instrumentation: Principles and technique of Centrifugation, Spectrophotometry & Chromatography	4 Lecture
<b><u>UNIT II</u></b> <b>Fermentation technology - Food and Beverage Production</b>		<b><u>15 Lectures</u></b>
2.1	Batch vs Continuous fermentation	2 Lectures
2.2	Technological aspects of industrial production of	1 Lecture
2.2.a	Cheese	2 Lectures
2.2.b	Beer	2 Lectures
2.2.c	Vinegar	2 Lectures
2.2.d	Single Cell Protein	2 Lectures
2.2.e	Mushroom,	2 Lectures
2.2.f	Yoghurt	2 Lectures
2.2.g	Wine	2 Lectures
2.3	Food quality assurance: Regulatory & social aspects of food biotechnology	2 Lectures
<b><u>UNIT III</u></b> <b>Gene Cloning – Principles</b>		<b><u>15 Lectures</u></b>
3.1	Introduction to the history of Gene cloning	1 Lecture

<b>3.2 Methods in Molecular Biology : Molecular cloning methods</b>	
3.2.a Cutting and joining DNA molecules	<b>2 Lectures</b>
3.2.b Role of Restriction enzymes, Type I, II ,III, patterns of DNA cutting by restriction enzymes	<b>3 Lectures</b>
3.2.c Restriction Mapping, DNA ligase, Homopolymer tailing, Adaptors, Linkers, Use of Alkaline Phosphatase.	<b>2 Lectures</b>
<b>3.3. Vectors: The cloning vehicles</b>	
3.3.a Vectors for gene cloning ( Plasmids, Bacteriophages as vectors, cosmid as vector	<b>2 Lectures</b>
3.3.b Plasmids and other advanced vectors.	<b>1 Lecture</b>
3.3.c pBR 322 : structure , origin and uses	<b>2 Lectures</b>
3.3.d Expression of Insulin and somatostatin gene in <i>E.coli</i> using pBR322.Bacteriophage Lambda as vector, M13 vector	<b>2 Lectures</b>
<b><u>Unit IV</u></b>	
<b>Gene Cloning – Technology</b>	
<b><u>15 Lectures</u></b>	
<b>4.1.Cloning of genes</b>	
<b>1 Lectures</b>	
4.1.a Isolation of cloning vectors, selection of gene cloning organisms, isolation of desired DNA to be cloned	<b>2 Lectures</b>
4.1.b. Identifying a specific clone with a specific probe, construction of recombinant DNA, transformation, culture and isolation of recombinant DNA from non recombinant one	<b>2 Lectures</b>
4.1.c Shot gun cloning	<b>1 Lecture</b>
4.1.d Making genomic and cDNA libraries in <i>E. coli</i>	<b>1 Lecture</b>
<b>4.2. cDNA technology</b>	
4.2.a 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.)	<b>2 Lectures</b>
4.2.b Polymerase chain reaction : An alternative to cloning (Method , limitations of PCR, Application of PCR, Reverse transcriptase PCR)	<b>2 Lectures</b>

<b>4.3.</b> Methods of expressing cloned genes	<b>1Lectures</b>
4.3.a Expression of vectors	<b>1Lectures</b>
4.3.b Screening and selection of the desired clone :	<b>1Lectures</b>
Immunological method	<b>2 Lectures</b>
i) Nucleic acid hybridization method	
ii) Subtractive cDNA cloning	
iii) Hybrid arrest and Hybrid release method (HART and HART)	

<b>Course Code</b>	<b>Title</b>	<b>Lectures</b>
<b>USLSC504</b>	<b>ENVIRONMENTAL BIOLOGY 1</b>	<b>2.5 Credits (60 Lectures)</b>
<b>Unit I Introduction</b> to Fundamentals of environmental science		<b><u>15 Lectures</u></b>
<b>1.1 Natural resources:</b>		
1.1.a Sustainable development of the Biosphere How humans affect their environment: Spread of human population, Hunter gatherer population, agricultural revolution, Cultural Revolution		<b>3 Lectures</b>
1.1.b Ecosystem and Human needs: Resource depletion and pollution, Dwindling Biodiversity, consumers versus resource crunch(with suitable examples from developed and developing countries)		<b>2 Lectures</b>
1.1.c Sustainable Development: As defined by United Nations World Commission on Environment and Development.		<b>2 Lectures</b>
<b>1.2. Ecosystem dynamics:</b>		
1.2.a 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.		<b>3 Lectures</b>
1.2.b Chemical cycling(C, N, P, S, N fixation)		<b>3 Lectures</b>
1.2.c Primary succession (soil formation) and secondary succession		<b>2 lectures</b>



<b>UNIT II</b>	<b>15 Lectures</b>
<b>2.1. Biodiversity and Habitats:</b>	
2.1.a Biomes of the world: climate, vegetation and Geographical distribution pattern. Tropical biomes, desert, temperate, taiga and tundra biome.	<b>2 Lectures</b>
2.1.b Biological diversity of India: Indian Bio-geographic Zones, climate and its impact on biodiversity.	<b>2 Lectures</b>
<b>2.2 Indian flora and fauna</b>	
2.2.a Indian forest and vegetation types: diversity of flora and fauna. Endangered, Endemic and Extinct Species of India: Threatened species categories of IUCN, threatened species of plants and animals in India and their reasons, Red data books.	<b>2 Lectures</b>
2.2.b Environmental biotechnology: Role of biotechnology in conservation of species, in-situ and ex-situ conservation.	<b>1 Lecture</b>
2.2.c 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	<b>1 Lecture</b>
<b>2.3 Marine life:</b>	<b>2 Lectures</b>
2.3.a Open sea and coastal sea productivity and conservation issue	
2.3.b Biodiversity conservation: Global agreements and national concerns. RAMSAR sites	
* Endangered, Endemic and Extinct Species of India <b>to be given as student assignment.</b>	
<b>2.4. Population and consumption Dynamics with special reference to Human:</b>	<b>5 Lectures</b>
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.	
2.4.b Politics and economics of Hunger, GM foods and their environmental concerns eg . <i>Bt</i> Brinjal	
2.4.c International Treaty on Plant Genetic Resources for food and Agriculture (ITGR) Intellectual Property Rights (IPR), Biopiracy (e.g., Neem/Basmati), Seed Bank	
2.4.d Human impact on climate: Ozone layer, green house effect, Methane, carbon dioxide.	
2.4.e Carbon footprints.	

<p><b><u>UNIT III</u></b></p> <p><b>3.1. Pest and pesticides:</b></p> <p>3.1.a Basic introduction about Pests, Pesticides and Environment</p> <p>3.1.b Pesticide toxicity: Bioaccumulation and Biomagnification, persistence, resistance and pollution health of farmers. New methods of pest control: Biological pest control: predators parasites, and pathogens. Genetically Engineering and pest control, Integrated pest management</p> <p>3.1.c Bioremediation of OP pesticide: using Bacillus Sps. ( eg. Malathion Pesticide)</p> <p>3.1.d Phytoremedian of Organochlorine pesticide (Chloropyrifos) using plants</p> <p>3.1.e Pesticide regulation: eg. Endosulphan issue.</p> <p><b>3.2. Toxicology Management.</b></p> <p>3.2.a 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>3.2.b Limitation of Toxicological studies: Comparison of animal toxicological models and Toxicity in Humans.</p> <p>3.2.c Human clinical trials: Concept of Clinical trial phases - I, 2, 3 and 4.</p> <p>3.2.d Ethical issues of clinical trials: e.g. Thalidomide, Human Papillomavirus vaccine trials.</p>	<p><b><u>15 Lectures</u></b></p> <p><b>1 Lecture</b></p> <p><b>2 Lectures</b></p> <p><b>2 Lectures</b></p> <p><b>2 Lectures</b></p> <p><b>1 Lecture</b></p> <p><b>3 Lectures</b></p> <p><b>2 Lectures</b></p> <p><b>1 Lectures</b></p> <p><b>1 Lecture</b></p>
<p><b><u>Unit IV</u></b></p> <p><b>4.1 Sustainable Development</b></p> <p>Ecological and economical growth factor for sustainable development, integrating environmental concerns in economic decisions.</p> <p>Economic cost of environmental degradation. Costs benefit analysis</p> <p><b>4.2 Awareness of citizen on environmental legal provisions:</b></p> <p>(i) Constitutional Provisions for environment (ii) Legislative power relating to environmental law (iii) General laws relating to environment.</p>	<p><b><u>15 Lectures</u></b></p> <p><b>7 Lectures</b></p> <p><b>4 Lectures</b></p> <p><b>4 Lectures</b></p>

## Semester V

### Practicals

Course code: USLSCP05

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

#### Genetics

<u>I) Experiments to be performed by students:</u>	<u>Expected learning outcomes</u>
1. Extraction of chromosomal DNA from chicken liver / goat spleen	I, C,T,R
2. Streak plating of saliva on two different media	C,T,R
3. Viable count for enumeration of bacteria by –Bulk seed method	C,T,R
4. Viable count for enumeration of bacteria by - Surface spread method	C,T,R

#### Demonstration experiments:

5. a) Study of <i>Drosophila</i> mutants from specimen / slides / photographs	C,R
b) Collection and observation of virgin <i>Drosophila</i> females for setting up of genetic crosses.	C,R
6. Study of UV-Visible Spectrophotometer	C,R

#### Immunology

<u>I) Experiments to be performed by students:</u>	
1. Study of ABO Blood groups and quantitative Coomb's Test.	C, R.
2. Study of Isohemagglutinin titre in blood.	C, R.
3. Quantitative Widal Test.	C, R.

#### Demonstration experiments:

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

Course code: USLSCP05

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

#### Chick Developmental Biology

- 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.

### **Plant Developmental Biology**

- 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.

### **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)**

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

**Course code: USLSCP06**

**[Practical Syllabus Based on USLSC503, Credits: 1.5, Lectures: 60]**

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 *E.coli* extract / Serum proteins / Saliva / Egg white any other suitable sample

**Course Code : USLSCP 06**

**[Practical Syllabus Based on USLSC504 Semester V Credits : 1.5, Lectures : 60 ]**

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

1. A visit to aquatic ecosystem and methods for water and 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

**Semester V: Text Books and References**  
**USLSC501: References books**

**Units I and II Genetics**

1. Principles of Genetics by Snustad and Simmons 4<sup>th</sup>edn. John Wiley and sons 2006.
2. I Genetics; A Molecular approach by Peter Russel 2<sup>nd</sup>edn. Pearson 2006.
3. I Genetics; A Mendelian approach by Peter Russel 2<sup>nd</sup>edn. Pearson 2006.
4. Introduction to Genetic Analysis by Griffiths et al 8<sup>th</sup>edn Freeman 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 7<sup>th</sup>edn., Blackwell publication, 2007.
7. Concepts of Genetics W. S. Klug and M. R. Cummings 7<sup>th</sup>edn. Pearson 2003.
8. Concepts of Genetics W. S. Klug, M. R. Cummings, C. A. Spencer 8<sup>th</sup>edn. Pearson 2006.
9. Human Molecular Genetics by Tom Strachan and Andrew Read, 3<sup>rd</sup>edn. Garland Science pub. 2004.
10. Principles of Genetics by R. Tamarin 7<sup>th</sup>edn 2002

**Units III and IV Immunology**

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

**USLSC502: REFERENCE BOOKS**

**UNIT I and II Developmental Biology (Latest editions recommended)**

1. Instant Lecture Notes- Developmental Biology  
R.M. Twyman, Viva Books Private Limited, New Delhi, Latest Edition ( First Edition – 2001)
2. Developmental Biology  
T. Subramaniam, Narosa publishing Hopuse, Mumbai, Latest Edition ( First Edition- 2002)
3. Principles of Development  
L. 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 3<sup>rd</sup> 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 2<sup>nd</sup> Edition.

K.C. Ghone and B. Manna.

New Central Book Agency Publishers.

9. Developmental Biology 4<sup>th</sup> edition.

S.F. Gilbert.

Sinauer Associates Inc. Publishers.

10. Pollen Analysis 2<sup>nd</sup> 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 2<sup>nd</sup> edition,

L.W.Browder,

Saunders College Publishing Co.

13. An Introduction to Embryology 5<sup>th</sup> Ed

B. I. Ballinsky'

Saunders, College Publishing Co.

14. Developmental Biology – Patterns, Problems and Principles.

J. W. Saunders.

J. R. MacMillan Publishing Co.,

15. An Introduction To the Embryology of Angiosperms.

P. Maheshwari.

16. An Atlas Of Descriptive Embryo

logy 2<sup>nd</sup> ed.  
W.W.Mathews.  
MacMillan Publishing Co.  
15. 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: Exploring the brain  
M.F.Baer, B.W.Connors&M.A.Paradiso, William & Wilkins, Baltimore, Latest Edition  
(First Edition1996)

18. Neurobiology 3<sup>rd</sup> edition  
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



### **USLSC503: REFERENCE BOOKS**

1. Principles of gene manipulation and Genomics by Primrose and Twyman, 7<sup>th</sup> 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.

### **USLSC504: REFERENCE BOOKS**

1. Misra and Pandey (2011), "Essential environmental studies ", Ane Books
2. Martens (1998),"Health and climate change ", Earth Scan
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
6. Nayak ,Amar(2006) "Sustainable sewage water Management ",Mc Millan India
7. Dolder, Willi (2009), "Endangered animals, Parragon
8. Gupta P K (2000)," Methods in environmental Analysis ",Agrobio (India)
9. Fumento, Michael (2003),"Bioevolution : How biotechnology is changing our world" , California encounter Books
10. Kapur (2010) "Vulnerable India ", SAGE
11. Jacob, Miriam(2004) ," Silent Invaders" , Orient Longman
12. Mc Cafferty (1998) ,"Aquatic Entomology ", Jones and Barlett
13. Subramnyam (2006),"Ecology " , 2<sup>nd</sup> ed.Narosa
14. Dilip Kumar, Rajvaidya (2004)," Environmental Biotechnology ", APH
15. Sharma and Khan (2004)," Ozone Depletion and Environmental Impacts" , Pointer publishers

## SEMESTER VI

### Life Sciences: Detail Syllabus

Course Code	Title	Lectures
<b>USLSC601</b>	<b>GENETICS AND IMMUNOLOGY II</b>	<b>2.5 Credits (60 Lectures)</b>
<b><u>UNIT – I: Mechanisms of Inheritance and variation in Eukaryotes</u></b>		<b><u>15 Lectures</u></b>
<b><u>1.1 Recombination in Eukaryotes:</u></b>		
1.1.a <b>Genetic recombination in Fungi –</b> Life Cycle; recombination in <i>Neurospora</i> and mapping by Tetrad analysis.		<b>5 Lectures</b>
1.1.b <b>Genetic recombination in <i>Drosophila</i> –</b> Life Cycle; Recombination – Mapping the genome by two and three factor crosses, co-efficient of co-incidence and interference.		<b>5 Lectures</b>
1.1.c <b>Genetic recombination in Humans –</b> Somatic cell Genetics: Use of cell hybrids and hybridomas for gene mapping;		<b>1 Lecture</b>
<b><u>1.2 Mutational Variation:</u></b>		
1.2.a <u>Natural biological mutagenic agents</u> – Prokaryotic Transposable elements and their significance		<b>1 Lecture</b>
1.2.b <u>Induced mutations</u> - Site-Directed mutagenesis using Oligomers and ‘Cassette mutagenicity’; Mutagenicity testing – Ames test.		<b>3 Lectures</b>

<p><b><u>UNIT II : Tools and Techniques in Molecular Biology</u></b></p> <p><b><u>2.1 Recombinant DNA technology:</u></b></p> <p>2.1.a. i Restriction Enzymes – General nature of action, Major categories based on type of cut, two typical examples each and recognition sites ii Restriction mapping iii DNA Joining enzymes (Ligases)</p> <p>2.1.b Vectors in genetic engineering – i) Plasmids (pBR322) ii) Phages (<math>\lambda</math>)</p> <p>2.1.c Transformant screening by gene inactivation method</p> <p>2.1.d Strategy for cloning Somatostatin in <i>E. coli</i></p> <p><b><u>2.2 Applied genetics:</u></b></p> <p>2.2.a DNA Sequencing – Sanger’s Method only</p> <p>2.2.b Polymerase Chain Reaction and its applications</p> <p>2.2.c The Human Genome Project and beyond: aims, major features and applications</p> <p>2.2.d Genetically modified organisms / plants / animals / foods</p>	<p><b><u>15 Lectures</u></b></p> <p><b>3 Lectures</b></p> <p><b>3 Lectures</b></p> <p><b>1 Lecture</b> <b>1 Lectures</b></p> <p><b>7 Lectures</b></p>
<p><b><u>UNIT – III : Hypersensitivity, Vaccines and Immunodeficiency</u></b></p> <p><b><u>3.1 Hypersensitivity</u></b> Gell and Coombs classification:</p> <p>3.1.a Type I: Ag-Ab reactions viz. RIST and RAST</p> <p>3.1.b Type II: Agglutination to be included</p> <p>3.1.c Type III: Immunofluorescence, ELISA</p> <p>3.1.d Type IV: Tuberculin test</p> <p><b><u>3.2 Vaccines</u></b></p> <p>3.2.a <u>Passive immunization</u> i) Preformed antibodies and problems ii) Use of Chimera / humanized antibodies</p> <p>3.2.b <u>Active immunization</u>( Different methods used): i) Whole organisms (attenuated vs. inactivated ex. Polio) ii) Purified macromolecules (Polysaccharide, toxoid and recombinant antigen vaccines) iii) Peptide vaccines iv) DNA vaccines</p> <p><b><u>3.3 Immunodeficiency</u></b></p> <p>3.3.a B-celled- X-linked agammaglobulinemia</p> <p>3.3.b T-celled- Di George</p> <p>3.3.c Combined-SCID</p> <p>3.3.d Phagocytic- CGD</p> <p>3.3.e AIDS</p>	<p><b><u>15 Lectures</u></b></p> <p><b>4 Lectures</b></p> <p><b>2 Lectures</b></p> <p><b>4 Lectures</b></p> <p><b>5 Lectures</b></p>

<p><b><u>UNIT – IV : Transplantation, Tumour Immunology, Tolerance and Autoimmunity</u></b></p> <p><b><u>4.1 Transplantation</u></b></p> <p>4.1.a Types of grafts  4.1.b Tissue typing (serological and MLR)  4.1.c Mechanisms of graft rejection  4.1.d Graft vs. host disease w.r.t. bone marrow or cornea</p> <p><b><u>4.2 Tumor Immunology</u></b></p> <p>4.2.a Role of the immune system, Cell mediated and humoral responses,  4.2.b NK cells and macrophages,  4.2.c Tumor specific antigens,  4.2.d Immunological surveillance,  4.2.e Immunological escape and potential for therapy.</p> <p><b><u>4.3 Tolerance</u></b></p> <p>4.3.a Mechanism of T cell and B cell tolerance  4.3.b Immunology of pregnancy  4.3.c Role of T regulatory cells</p> <p><b><u>4.4 Autoimmunity</u></b></p> <p>4.4.a Mechanisms for induction(Aetiology)  4.4.b Types of Auto immune diseases-organ specific and systemic eg. Myasthenia gravis, Graves disease, SLE and Multiple sclerosis</p>	<p><b><u>15 Lectures</u></b></p> <p><b>4 Lectures</b></p> <p><b>4 Lectures</b></p> <p><b>3 Lectures</b></p> <p><b>4 Lectures</b></p>
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Course Code	Title	Lectures
<b>USLSC602</b>	<b>DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY II</b>	<b>2.5 Credits (60 Lectures)</b>
<p><b><u>UNIT – I: Cellular aspects of development:</u></b></p> <p>1.1 Totipotency e.g.. Carrot phloem, animal cell nuclei, stem cells  1.2 Pluripotency e.g. Neural crest cells or Hematopoetic cells  1.3.a Determination e.g. Drosophila imaginal disc  1.3.b Transdetermination e.g. Drosophila imaginal disc  1.4. Differentiation. E.g. Neural crest cells or hematopoietic cells  1.5.a Signaling factors (autocrine and paracrine) Explain with Hematopoiesis as example.  1.5.b Induction – e.g. Formation of lens in the eye  1.6 Molecular basis of growth and differentiation:  1.6.a Differentiation as a change in gene expression. (e.g. <math>\beta</math> globin gene</p>		<p><b><u>15 Lectures</u></b></p> <p><b>1 Lecture</b>  <b>1 Lecture</b>  <b>1 Lecture</b>  <b>1 Lecture</b>  <b>1 Lecture</b>  <b>1 Lecture</b>  <b>1 Lecture</b>  <b>2 Lectures</b></p>

<p>expression)</p> <p>1.6.b Genes in early development (with Drosophila as example) Maternal genes, Segmentation genes, Homeotic– Drosophila.</p> <p>1.7 Cell cycle and its control.</p> <p>1.8 Apoptosis</p>	<p><b>4 Lectures</b></p> <p><b>2 Lecture</b></p> <p><b>1 Lecture</b></p>
<p><b><u>UNIT II : Applications of developmental biology :</u></b></p> <p>2.1 Assisted human reproduction</p> <p>2.2 Congenital abnormalities</p> <p>2.3 Aging- Theories of Aging</p> <p>2.4 Regeneration in animal world, Regeneration of Salamander limb (dedifferentiation), Wound healing VS regeneration</p> <p>2.5 Cancer- Types of Cancer, Causes of Cancer, Oncogenes, Tumor suppressor genes, Treatment strategies for Cancer</p> <p>2.6 Fundamentals of Stem cell research</p>	<p><b><u>15 Lectures</u></b></p> <p><b>3 Lectures</b></p> <p><b>2 Lectures</b></p> <p><b>2 Lectures</b></p> <p><b>3 Lectures</b></p> <p><b>3 Lectures</b></p> <p><b>2 Lectures</b></p>
<p><b><u>UNIT – III : Sensory and motor system:</u></b></p> <p>3.1 Human Sense organs: receptors, receptor mechanisms and pathways- Introduction</p> <p>3.2 Visual system: Vision - structure of the eye, retina, photoreceptors (rods and cones), phototransduction, binocular vision, visual pathway (flow chart only – LGN to visual cortex), 1.2d light &amp; dark adaptation, colour vision.</p> <p>3.3 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>3.4 Vestibular System: Structure of the vestibular labyrinth, maculae and cristae. Mechanism of transduction.</p> <p>3.5 Chemosensory system: Olfactory and Gustatory receptors – structure.</p> <p>3.6 Skin as sense organ: somatic receptors - Types of mechano- receptors, pain reception &amp; Pain management (example analgesic effect by prostaglandin inhibition - aspirin)</p> <p>3.7 Structure of Muscle, Types of muscles, Molecular basis of Muscle contraction</p> <p>3.8 Reflexes: Simple reflex arc, mono and poly-synaptic reflexes, stretch and knee-jerk reflex, Crossed – extensor reflex, Golgi-tendon reflex.</p>	<p><b><u>15 Lectures</u></b></p> <p><b>1 Lecture</b></p> <p><b>2 Lecture</b></p> <p><b>2 Lecture</b></p> <p><b>2 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>2 Lecture</b></p> <p><b>3 Lecture</b></p> <p><b>2 Lectures</b></p>

<b><u>UNIT – IV : Neurobiological basis of behavior and Diseases:</u></b>	<b><u>15 Lectures</u></b>
4.1 Associative conditioning - Overview	<b>2 Lectures</b>
4.2 Short term memory and Long Term Memory (eg. Aplysia )	<b>2 Lectures</b>
4.3 Addiction – narcotic drugs and their effects on CNS (eg: Opiates)	<b>2 Lectures</b>
4.4 Abnormal Behaviour and the Brain	<b>2 Lectures</b>
4.5 Schizophrenia- Positive and negative sympto	<b>2 Lectures</b>
4.6 Prions and Mad cow disease	<b>1 Lecture</b>
4.7 Duchene’s muscular Dystrophy	<b>1 Lecture</b>
4.8 Alzheimer’s disease	<b>2 Lectures</b>
4.9 Huntington’s Disease	<b>1 Lecture</b>

<b>Course Code</b>	<b>Title</b>	<b>Lectures</b>
<b>USLSC603</b>	<b>BIOTECHNOLOGY &amp; GENETIC ENGINEERING II</b>	<b>2.5 Credits (60 Lectures)</b>
<b><u>Unit I</u></b> <b>Fermentation technology – Enzyme and Pharmaceuticals Production</b>		<b><u>15 Lectures</u></b>
1.1.EnzymeTechnology		
1.1.a. Enzyme production ex. Amylase (bacterial & fungal)		<b>2 Lectures</b>
1.1.b. Immobilized Biocatalyst (method of immobilization, applications – biosensors )		<b>1 Lecture</b>
1.2. Application of fermentation technology in medicine		
1.2.a.Production of antibiotics (Penicillin)		<b>2 Lectures</b>
1.2.b.Vitamins (Vit B12)		<b>2 Lectures</b>
1.2.c. Vaccines (polio, HbsAg)		<b>2 Lectures</b>
1.2.d.Monoclonal antibodies		<b>2 Lectures</b>
1.2.e.Biopharmaceuticals (Insulin / IFN- $\alpha$ )		<b>2 Lectures</b>
<b><u>UNIT II</u></b> <b>Tissue Culture biotechnology</b>		<b><u>15 Lectures</u></b>
2.1.Application of fermentation technology Agriculture		
2.1.a.Secondary metabolites from plant tissue culture		<b>2 Lectures</b>
2.1.b.Biopesticides – bacteria ( <i>B. thuringiensis</i> ), Virus (Polyhedrosis virus) and fungal ( <i>Trichoderma</i> )		<b>4 Lecture</b>

<p>2.2.Plant and Animal Tissue</p> <p>2.1.a. Animal – Laboratory setup, Media, Basic techniques (Disaggregation of tissue and primary culture, maintenance of cell lines- see also Practicals)</p> <p>2.1.b.Plant – Media, Basic techniques (callus and suspension culture, organogenesis, &amp; somatic embryogenesis, Protoplast isolation and fusion)</p>	<p><b>5 Lectures</b></p> <p><b>4 Lectures</b></p>
<p><b><u>UNIT III Genetic Engineering</u></b></p> <p><b>3.1.Manipulating DNA in Microbes, plants and Animals:</b></p> <p>3.1.a.BAC</p> <p>3.1.b.Cloning Other Eukaryotic vectors: <i>S. cerivisiae</i> : basic principle</p> <p>3.1.c. Yeast artificial chromosome</p> <p>3.1.d.Cloning of vectors in animal : SV 40 , Baculo virus</p> <p>3.1.e.Ti plasmids to transfer genes to plants</p> <p><b>3.2.Molecular tools for studying genes and gene activity :</b></p> <p><b>3.2. Molecular separations</b></p> <p>3.2.a. Separation of DNA by Gel electrophoresis (Agarose gel electrophoresis, Poly-acrylamode gel electrophoresis,Two-Dimensional Gel Electrophioresis )</p> <p>3.2.b Using Nucleic acid Hybridisation</p> <p>3.2.c Analysis of specific nucleic acids in complex mixture ( Southern blotting, Northern blotting)</p> <p>3.2.d .DNA Fingerprinting and DNA typing</p> <p>3.2.e Forensic uses of DNA finger printing and DNA Typing</p> <p>3.2.f DNA sequencing by Sanger’s, Maxam and Gilbert’s methods, concept of automated gene sequencing</p> <p>3.2.g Microarray</p> <p>3.2.h DNA Markers SNP, VNTR, RFLP, AFLP</p> <p>3.2.i In Situ hybridization</p>	<p><b><u>15 Lectures</u></b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lectures</b></p>

3.2.j Chromosome walking technique, chromosome jumping technique Chromosome painting technique	<b>1 Lecture</b>
3.2.k .Protein engineering with cloned genes: Site directed mutagenesis	<b>1 Lecture</b>
<b><u>Unit IV</u></b>	<b><u>15 Lectures</u></b>
<b>4.1.Applications of recombinant DNA technology: and Bioinformatics</b>	
4.1.a. Knockouts , Knock in, Knock down systems(Transgenic animals) Trans genic plants :Bt cotton and weedicide resistant gene)	<b>2 Lectures</b>
4.1.b.Xenopus oocyte as an expression system	<b>1 Lecture</b>
4.1.c. Giant Mouse (MMT promoter=growth hormone fusion gene)	<b>1 Lectures</b>
4.1.d.Drosophila (using p element mediated technique-enhancer trap)	<b>2 Lectures</b>
4.1.e.Issues on recombinant DNA technology:	<b>1 Lectures</b>
4.1.f.Applications in industry – Medical/pharmaceutical, agricultural	<b>1 Lectures</b>
4.1.g. Applications in basic research – Intellectual property rights and open source biotechnology	<b>1 Lectures</b>
4.1.h.Gene therapy for Parkinson disease	<b>1 Lectures</b>
4.1.i.Stem cell technology and Parkinson disease	<b>2 Lectures</b>
<b>4.2.Bioinformatics :</b>	<b>3 Lectures</b>
4.2.a. Biological databases	
4.2.b. sequence annotation and comparison	
4.2.c.Multiple sequence alignment	
Phylogenetic trees.	
* to be dealt with in practicals	



Course Code	Title	Lectures
USLSC604	ENVIRONMENTAL BIOLOGY II	2.5 Credits (60 Lectures)
<b><u>Unit I</u></b>		<b><u>15 Lectures</u></b>
<b>1.1 Ecosystem degradation:</b> Population size and growth, population fluctuations, carrying capacity, (density and population reduction( density dependent and independent factors). competition and predation: limits on population.		<b>3 lectures</b>
<b>1.2. Urbanization</b> 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		<b>2 lectures</b>
<b>1.3. Rural environment</b> : 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.		<b>4 Lectures</b>
<b>1.4. Impact of Environmental degradation on Women.</b>		<b>2 lectures</b>
<b>1.5. Toxic and solid waste management:</b> Types of waste, solid waste disposal, economics of recycling, recycling plastic,, composting and producing less waste. Toxic Waste Trading: An environmentally destructive trade activity.		<b>4 Lectures</b>
<b><u>UNIT II</u></b>		<b><u>15 Lectures</u></b>
<b>2.1. Natural resources:</b> energy conservation and renewable energy: Reserves of non renewable energy resources: Hidden costs of using natural resources electricity, generation and storing electricity.		<b>6 Lectures</b>
<b>2.2Evaluating energy resources:</b> Nuclear power, coal, Natural gas, biomass burning, gas turbines, biofuels.		<b>4 Lectures</b>
<b>2.3Alternative energy resources:</b> Geothermal, Tidal/wave power, ocean thermal energy conversions, inland solar ponds, Energy efficient buildings. Concept of carbon credit.		<b>5 Lectures</b>
<b>* Types of energy resources to be given as student assignment.</b>		

<p><b><u>Unit III</u></b></p> <p><b>3.1. Environmental Impact Analysis of a Development Project :</b></p> <p>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)</p> <p><b>3.2 Public Participation:</b> Methodology and approach for public participation in Environmental &amp; development decision making. Example: Plachimada struggle, Narmada Bachao andolan, Chipko movement</p> <p>Regulatory requirements for public participation eg Jaitapur or ENRON issues.</p> <p>Advantages and disadvantages of Public participation.</p> <p>Identification of participants and conflict management.</p> <p>Incorporation of results in decision makings.</p>	<p><b><u>15 Lectures</u></b></p> <p><b>4 Lectures</b></p> <p><b>5 Lectures</b></p> <p><b>2 Lectures</b></p> <p><b>2 Lectures</b></p> <p><b>1 Lecture</b></p> <p><b>1 Lecture</b></p>
<p><b><u>Unit IV</u></b></p> <p><b>4.1. Society and environment:</b></p> <p>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.</p> <p><b>4.2. Safety, Health and Environment:</b></p> <p>Lessons after 25 years of Bhopal gas tragedy.</p> <p>Perspectives and concerns of citizens: Environment as the ultimate beneficiary / loser.</p> <p>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)</p>	<p><b><u>15 Lectures</u></b></p> <p><b>5 Lectures</b></p> <p><b>4 Lectures</b></p> <p><b>6 Lectures</b></p>

**Semester VI  
Practicals**

**Course code: USLSCP07**

**[Practicals Based on USLSC601, Credits -1.5, Lectures- 60]**

**Genetics**

Experiments to be performed by students:

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

Demonstration experiments:

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

**Immunology**

Experiments to be performed by students:

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

Demonstration experiments:

9. Separation of Mononuclear cells using a gradient and the determination of viable count of the same C, R, T.
10. SDS- PAGE for separation of IgGsubfraction I,C,R,T
11. Qualitative ELISA using albumin I,C,R,T

**Course Code: USMBP07**

**[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

Demonstration experiments :

11) 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**

3. Live observations of Developmental stages of *C.elegans/Dictyoteliium/Drosophila/zebrafish*

Demonstration experiments :

4. Imaginal discs of *Drosophila* C,T
5. Regeneration in earthworm / any other suitable system / hydra (using permanent slide / photographs) T,C

**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 sensillae
  - g)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

1. Stroop test. C, T, R
2. Olfactory /Gustatory Behavioral study: Snail / Earthworm / insect larvae or any other suitable system. I,C,T,R.
3. Associative conditioning
4. Knee-jerk and pupillary reflex. . C,T, R
5. Testing for locating the Blind Spot in the retina

## Course Code: USLSCP08

### [Practical Syllabus Based on USLSC603 Semester VI 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.
  3. Assay of fermentation product / Substrate – Estimation of  
(a) alcohol/Acetic/lactic acid (b) Sugar
  4. Extraction of plasmid DNA& Agarose Gel Electrophoresis of plasmid DNA/Restriction Digest with costing of the experiment
  5. Bioinformatics :
    - i) Introduction to databases and: use of public domain open source database and programs for studying genomics of human / mouse, yeast/ plant/ microbes or any other relevant organism.
    - ii) Manual annotation of DNA sequence: pUC series or any convenient cloning/expression vector followed by using programmed tools
    - iii) Blast search of genome sequence , Sequence alignment – pair wise / multiple, construction of Cladogram / phylogram
- 12. Open-ended projects :** (*Any one of the following, along with its costing*)
- a) Home-Wine production / Home-Vinegar production from any convenient source & assay for fermentation products
  - b) Culturing & biomass estimation of mushroom/ *Spirulina* /*chlorella* by cell count/dry weight and estimation of percentage total protein. ,
  - c) Plant tissue culture: i) Callus production ii) Preparation of protoplasts and estimate viability by trypan blue staining
  - d) 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
  - e) Growth curve of E coli (DH5 alpha) and preparation of competent cell for transformation experiment.
  - f) Finger Printing technique using electrophoresis of protein/DNA digest

- g) SDS PAGE with suitable Protein sample for Comparison with Experiment no.3 above.
- h) Agarose Gel Electrophoresis of extracted DNA samples with & without Molecular marker ladder
- i) 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: USLSCP08**

**[Practical Syllabus Based on USLSC604 Semester VI Credits: 1.5, Lectures: 60]**

1. EC, conductivity, N/P/K/Sulphates/ Na/ Ca. / Estimation of  $\text{Co}^{2+}$  and  $\text{Ni}^{2+}$  by colorimetry / spectrophotometry / Water analysis for physico-chemical characteristics / Estimation of Heavy metal in various samples by titrimetry or spectrometry/ Potability of the given drinking water sample by MPN.  
(any three of the above) **(CTR)**
  
2. 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)**
3. Collection and Interpretation of weather data/Climatology of Mumbai city  
(Satellite images and statistical analysis of weather data).  
  
Use of computer for MS office, Excel, Power Point for analysis of data.
  
- OR
  
- Statistical methods for analysis of environmental data: diversity and similarity indices,  
for the given data. **(CT)**
  
4. Study of effect of a metal toxicity on the heart beat of Daphnia and statistical analysis of the same T Test/LC 50 **(CTR)**
  
5. Field visit to river/lake and waste water treatment plants. **(CTR)**
6. Identification of local plant species as : Ecological indicators, exotic species.  
  
(At least one example) **(CR)**
7. Environmental Project (compulsory) **(CTR)**  
  
Environmental audit of an institution eg. 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 an chosen organism in your immediate environment or its significance to the local biodiversity/Measurement of sounds by DB meter in silent, industrial, residential and commercial zones/ A Survey related to environmental issues amongst the citizens: Data to be collected and analyzed statistically with suggestions for environmental management .

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

Project Submission and viva

### **Semester V: Text Books and References**

#### **USLSC601: References books**

##### **Units I and II Genetics**

1. Principles of Genetics by Snustad and Simmons 4<sup>th</sup>edn. John Wiley and sons 2006.
2. I Genetics; A Molecular approach by Peter Russel 2<sup>nd</sup>edn. Pearson 2006.
3. I Genetics; A Mendelian approach by Peter Russel 2<sup>nd</sup>edn. Pearson 2006.
4. Introduction to Genetic Analysis by Griffiths et al 8<sup>th</sup>edn Freeman 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 7<sup>th</sup>edn., Blackwell publication, asianedn Oxford publishers 2007.
7. Concepts of Genetics W. S. Klug and M. R. Cummings 7<sup>th</sup>edn. Pearson 2003.
8. Concepts of Genetics W. S. Klug, M. R. Cummings, C. A. Spencer 8<sup>th</sup>edn. Pearson 2006.
9. Human Molecular Genetics by Tom Strachan and Andrew Read, 3<sup>rd</sup>edn. Garland Science pub. 2004.
10. Principles of Genetics by R. Tamarin 7<sup>th</sup>edn 2002

##### **Units III and IV Immunology**

11. Immunology 5<sup>th</sup>edn. R.A.Goldsky, T. J. Kindt, B. A. Osborne, J. Kuby 2003.
12. Immunology: The immune system in health and disease 6<sup>th</sup>edn. C. A. Janeway, P. Travers, M. Walport, M. Shlomchik Garland Science Pub. 2005.
13. Cellular and Molecular Immunology, 2<sup>nd</sup>edn. A. K. Abbas, A. H. Litchman, 5<sup>th</sup>edn 2000.
14. Basic Immunology: Functions and disorders of the immune system, 2<sup>nd</sup>edn. A. K. Abbas, A. H. Litchman, 2<sup>nd</sup>edn 2004.
15. Roitt's Essential Immunology 11<sup>th</sup>edn. Blackwell publication 2006.
16. Immunology 7<sup>th</sup> 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.

#### **USLSC602: 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  
L. 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 3<sup>rd</sup> 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 2<sup>nd</sup> Edition.  
K.C. Ghone and B. Manna.  
New Central Book Agency Publishers.
9. Developmental Biology 4<sup>th</sup> edition.  
S.F. Gilbert.  
Sinauer Associates Inc. Publishers.
10. Pollen Analysis 2<sup>nd</sup> 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 2<sup>nd</sup> edition,  
L.W.Browder,  
Saunders College Publishing Co.



13. An Introduction to Embryology 5<sup>th</sup> Ed

B. I. Ballinsky'

Saunders, College Publishing Co.

14. Developmental Biology – Patterns, Problems and Principles.

J. W. Saunders.

J. R. MacMillan Publishing Co.,

15. An Introduction To the Embryology of Angiosperms.

P. Maheshwari.

16. An Atlas Of Descriptive Embryo

logy 2<sup>nd</sup> ed.

W.W.Mathews.

MacMillan Publishing Co.

15. 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 3<sup>rd</sup> edition

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.  
Cambridge University Press.

24. Comparative Neurobiology  
J. P. Mill  
Edward Arnold Publishers.

25. Physiology Of the Nervous Systems  
D Ottoson, McMillan Press

### **USLSC603: REFERENCE BOOKS**

1. Principles of gene manipulation and Genomics by Primrose and Twyman, 7<sup>th</sup> 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)
4. Cell and molecular biology by sp Vyas and Mehta (2011) CBS pub and Dist Pvt Ltd.
5. Industrial Microbiology. L.E.Casida (2003) New Age International (P) Ltd.
6. Industrial Microbiology. Prescott And Dunn's (2004) Chapman & Hall.
7. Industrial Microbiology. A H PATEL (2005) Macmillan India.

### **USLSC604: REFERENCE BOOKS**

- Misra and Pandey (2011), “Essential environmental studies “, Ane Books
2. Martens (1998),”Health and climate change “, Earth Scan
  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
  6. Nayak ,Amar(2006) ”Sustainable sewage water Management “,Mc Millan India

7. Dolder, Willi (2009), "Endangered animals, Parragon
8. Gupta P K (2000)," Methods in environmental Analysis ",Agrobio (India)
9. Fumento, Michael (2003),"Bioevolution : How biotechnology is changing our world" , California encounter Books
10. Kapur (2010) "Vulnerable India ", SAGE
11. Jacob, Miriam(2004) ," Silent Invaders" , Orient Longman
12. Mc Cafferty (1998) ,"Aquatic Entomology ", Jones and Barlett
13. Subramnyam (2006),"Ecology " , 2<sup>nd</sup> ed.Narosa
14. Dilip Kumar, Rajvaidya (2004)," Environmental Biotechnology ", APH
15. Sharma and Khan (2004)," Ozone Depletion and Environmental Impacts" , Pointer publishers

#### **USLSC504: REFERENCE BOOKS**

1. Misra and Pandey (2011), "Essential environmental studies ", Ane Books
2. Martens (1998),"Health and climate change ", Earth Scan
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
6. Nayak ,Amar(2006) "Sustainable sewage water Management ",Mc Millan India
7. Dolder, Willi (2009), "Endangered animals, Parragon
8. Gupta P K (2000)," Methods in environmental Analysis ",Agrobio (India)
9. Fumento, Michael (2003),"Bioevolution : How biotechnology is changing our world" , California encounter Books
10. Kapur (2010) "Vulnerable India ", SAGE
11. Jacob, Miriam(2004) ," Silent Invaders" , Orient Longman
12. Mc Cafferty (1998) ,"Aquatic Entomology ", Jones and Barlett
13. Subramnyam (2006),"Ecology " , 2<sup>nd</sup> ed.Narosa

14. Dilip Kumar, Rajvaidya (2004),” Environmental Biotechnology “, APH

15. Sharma and Khan (2004),“ Ozone Depletion and Environmental Impacts” ,

Pointer publishers

**Modality of Assessment:**  
**Theory Examination Pattern:**

**A) Internal Assessment - 40%**  
**40 marks.**

**Theory** **40 marks**

Sr No	Evaluation type	Marks
1	One Assignment/Case study/Project	10
2	One class Test (multiple choice questions / objective)	20
3	Active participation in routine class instructional deliveries(case studies/ seminars//presentation)	05
4	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.	05

**B ) External examination - 60 %**

**Semester End Theory Assessment - 60%** **60 marks**

- i. Duration - These examinations shall be of two and half hours duration.
- ii. Theory question paper pattern :-
  1. There shall be **five** questions each of **12** marks. On each unit there will be one question & fifth one will be based on all the four units.
  2. All questions shall be compulsory with internal choice within the questions. Each question will be of **24** marks with options.
  3. Questions may be sub divided into sub questions a, b, c & d only, each carrying **six** marks **OR** a, b, c, d, e & f only each carrying **four** marks and the allocation of marks depends on the weightage of the topic.

**Practical Examination Pattern:**

**(A) Internal Examination:-**

**There will not be any internal examination/ evaluation for practicals.**

**(B) External (Semester end practical examination) :-**

<b>Sr.No.</b>	<b>Particulars</b>	<b>Marks</b>
<b>1.</b>	<b>Laboratory work</b>	<b>40</b>
<b>2.</b>	<b>Journal</b>	<b>05</b>
<b>3.</b>	<b>Viva</b>	<b>05</b>

**Semester V:**

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

**In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-ordinator of the department ; failing which the student will not be allowed to appear for the practical examination.**

**Semester VI**

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

**In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-ordinator of the department ; failing which the student will not be allowed to appear for the practical examination.**

## Overall Examination and Marks Distribution Pattern

### Semester V

Course	USLSC-501			USLSC-502			USLSC-503			USLSC-504			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
<b>Theory</b>	<b>40</b>	<b>60</b>	<b>100</b>	<b>40</b>	<b>60</b>	<b>100</b>	<b>40</b>	<b>60</b>	<b>100</b>	<b>40</b>	<b>60</b>	<b>100</b>	<b>400</b>
<b>Practicals</b>	<b>-</b>	<b>50</b>	<b>50</b>	<b>-</b>	<b>50</b>	<b>50</b>	<b>-</b>	<b>50</b>	<b>50</b>	<b>-</b>	<b>50</b>	<b>50</b>	<b>200</b>

### Semester VI

Course	USLSC-601			USLSC-602			USLSC-603			USLSC-604			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
<b>Theory</b>	<b>40</b>	<b>60</b>	<b>100</b>	<b>40</b>	<b>60</b>	<b>100</b>	<b>40</b>	<b>60</b>	<b>100</b>	<b>40</b>	<b>60</b>	<b>100</b>	<b>400</b>
<b>Practicals</b>	<b>-</b>	<b>50</b>	<b>50</b>	<b>-</b>	<b>50</b>	<b>50</b>	<b>-</b>	<b>50</b>	<b>50</b>	<b>-</b>	<b>50</b>	<b>50</b>	<b>200</b>