



HSNC UNIVERSITY, MUMBAI
Board of Faculty of Science & Technology
Board of Studies in the Subjects of Life Sciences

1. **Name of Chairperson/Co-Chairperson/Coordinator: -**
 - a. **Dr. Sagarika Damle –Chairperson–** Professor & Head, Department of Life Sciences, sagarika.damle@kccollege.edu.in, 9820360383
2. Two to five teachers each having minimum five years teaching experience amongst the full time teachers of the Departments, in the relevant subject.
 - a. **Dr. Tejashree Shanbhag** Assistant Professor, Department of Life Science, K. C. College, tejashree.shanbhag@kccollege.edu.in ,9892370263
 - b. **Dr. Shalini Rai** Assistant Professor, Department of Life Science, K. C. College, shalini.raii@kcollege.edu.in ,9987326613
 - c. **Dr. (Ms.) Aashu Vajpai** Assistant Professor, Department of Life Science, K. C. College, aashu.vajpai@kccollege.edu.in ,97020 73377
 - d. **Dr. Suvarna Sharma** Assistant Professor, Department of Life Science, K. C. College, Suvarna.sharma@kccollege.edu.in, 9869525362
3. One Professor / Associate Professor from other Universities or professor / Associate Professor from colleges managed by Parent Body ; nominated by Parent Body;-
 - a. **Dr. Jacinta D'souza** Professor, School of Biological Sciences, UM-DAE Center for Excellence In Basic Sciences, University of Mumbai jacintad@gmail.com 9820770314
4. Four external experts from Industry / Research / eminent scholar in the field relevant to the subject nominated by the Parent Body;
 - a. **Dr. Deepak Modi** - Eminent Scholar Research Scholar Scientists- F Molecular and Cellular Biology NIRRH, Parel Mumbai, deepaknmodi@yahoo.com, 9987176249
 - b. **Dr. Seema Das** – Researcher - Head of the Department Department of Life Science & Biochemistry St. Xavier's College, Autonomous 5, Mahapalika Marg, Mumbai-400 001, seema.das@xaviers.edu, 9820384851
 - c. **Dr. Laxmikant Deshpande** – Industry expert Industry Expert Wetland Management System, Godrej & Boyce Mfg. Co. Ltd, Vikhroli, Mumbai amartd@godrej.com , 9167344890
 - d. **Dr. Ahmad Ali** – Researcher, Assistant Professor, Department of Life Sciences UDLS, Kalina Campus, Vidyanagari, Santacruz, Mumbai 400098, ahmadali@mu.ac.in , 9870941656
5. Top rankers of the Final Year Graduate and Final Year Post Graduate examination of previous year of the concerned subject as invitee members for discussions on framing or revision of syllabus of that subject or group of subjects for one year.
 - a. **Dr. Anuja Pande** - Research scholar – Alumnus, SRI International-Post Doctoral Fellow,

Virginia USA, anuja.pande@gmail.com , 001-225-610-8801

- b. **Dr. Fatema Bhinderwala**- Academician – Alumnus, Coordinator- Certificate course in Bioinformatics, Sophia college, Mumbai, fatema3010@gmail.com , 9819657642
- c. **Dr. Hitesh Goswami** - Industry Alumnus, Entrepreneur CEO- 4basecare, Bangalore, hitesh@4basecare.com , 7892138638

Part –I

Outline of Choice Based Credit System as outlined by University Grants Commission:

R. ****: The Definitions of The Key Terms Used in The Choice Based Credit System And Grading System Introduced From The Academic Year 2020-2021 Are As Under:

1. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.
2. **Elective Course:** Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.
 - 2.1 **Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).
 - 2.2 **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.
 - 2.3 **Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.
3. **Choice Base Credit System:** CBCS allows students to choose inter- disciplinary, intra-disciplinary courses, skill-oriented papers (even from other disciplines according to their learning needs, interests and aptitude) and more flexibility for students.
4. **Honors Program:** To enhance employability and entrepreneurship abilities among the learners, through aligning Inter Disciplinary / Intra Disciplinary courses with Degree Program. Honours Program will have 40 additional credits to be undertaken by the learner across three years essentially in Inter / Intra Disciplinary course.

A learner who joins Regular Undergraduate Program will have to opt for Honours Program in the first year of the Program. However, the credits for honours, though divided across three years can be completed within three years to become eligible for award of honours Degree.

5. **Program:** A Program is a set of course that are linked together in an academically meaningful way and generally ends with the award of a Degree Certificate depending on the level of knowledge attained and the total duration of study, B.Sc. Programs.
6. **Course:** A 'course' is essentially a constituent of a 'program' and may be conceived of as a composite of several learning topics taken from a certain knowledge domain, at a certain level. All the learning topics included in a course must necessarily have academic coherence, i.e. there must be a common thread linking the various components of a course. A number of linked courses considered together are in practice, a 'program'.
7. **Bridge Course:** Bridge course is visualized as Pre semester preparation by the learner before commencement of regular lectures. For each semester the topics, whose knowledge is considered as essential for effective and seamless learning of topics of the Semester, will be specified. The Bridge Course can be conducted in online mode. The Online content can be created for the Bridge Course Topics.
8. **Module and Unit:** A course which is generally an independent entity having its own separate identity, is also often referred to as a 'Module' in today's parlance, especially when we refer to a 'modular curricular structure'. A module may be studied in conjunction with other learning modules or studied independently. A topic within a course is treated as a Unit. Each course should have exactly 3 Units.
9. **Self-Learning: 20% of the topics will be marked for Self-Learning.** Topics for Self-Learning are to be learned independently by the student, in a time- bound manner, using online and offline resources including online lectures, videos, library, discussion forums, fieldwork, internships etc.

Evaluative sessions (physical/online), equivalent to the credit allocation of the Self Learning topics, shall be conducted, preferably, every week for each course. Learners are to be evaluated real time during evaluative sessions. The purpose of evaluative sessions is to assess the level of the students' learning achieved in the topics are marked for Self-Learning.

The teacher's role in these evaluative sessions will be that of a Moderator and Mentor, who will guide and navigate the discussions in the sessions, and offer concluding remarks, with proper reasoning on the aspects which may have been missed by the students, in the course of the Self-Learning process.

The modes to evaluate self-learning can be a combination of the various methods such as written reports, handouts with gaps and MCQs, objective tests, case studies and Peer learning. Groups can be formed to present self- learning topics to peer groups, followed by Question-and-Answer sessions and open discussion. The marking scheme for Self-Learning will be defined under Examination and Teaching.

The topics stipulated for self-learning can be increased or reduced as per the recommendations of the Board of Studies and Academic Council from time to time. All decisions regarding evaluation need to be taken and communicated to the stakeholders preferably before the commencement of a semester. Some

exceptions may be made in exigencies, like the current situation arising from the lockdown, but such adhoc decisions are to be kept to the minimum possible.

10. **Credit Point:** Credit Point refers to the 'Workload' of a learner and is an index of the number of learning hours deemed for a certain segment of learning. These learning hours may include a variety of learning activities like reading, reflecting, discussing, attending lectures / counseling sessions, watching especially prepared videos, writing assignments, preparing for examinations, etc. Credits assigned for a single course always pay attention to how many hours it would take for a learner to complete a single course successfully. A single course should have, by and large a course may be assigned anywhere between 2 to 8 credit points wherein 1 credit is construed as corresponding to approximately 30 to 40 learning hours.
11. **Credit Completion and Credit Accumulation:** Credit completion or Credit acquisition shall be considered to take place after the learner has successfully cleared all the evaluation criteria with respect to a single course. Thus, a learner who successfully completes a 4 CP (Credit Point) course may be considered to have collected or acquired 4 credits. learner level of performance above the minimum prescribed level (viz. grades / marks obtained) has no bearing on the number of credits collected or acquired. A learner keeps on adding more and more credits as he completes successfully more and more courses. Thus, the learner 'accumulates' course wise credits.
12. **Credit Bank:** A Credit Bank in simple terms refers to stored and dynamically updated information regarding the number of Credits obtained by any given learner along with details regarding the course/s for which Credit has been given, the course-level, nature, etc. In addition, all the information regarding the number of Credits transferred to different programs or credit exemptions given may also be stored with the individual's history.
13. **Credit Transfer:** (performance transfer) When a learner successfully completes a program, he/she is allowed to transfer his/her past performance to another academic program having some common courses and Performance transfer is said to have taken place.
14. **Course Exemption:** Occasionally, when two academic programs offered by a single university or by more than one university, may have some common or equivalent course-content, the learner who has already completed one of these academic programs is allowed to skip these 'equivalent' courses while registering for the new program. The Learner is 'exempted' from 'relearning' the common or equivalent content area and from re-appearing for the concerned examinations. It is thus taken for granted that the learner has already collected in the past the credits corresponding to the exempted courses.

Part-II

O*** The fees for transfer of credits or performance will be based on number of credits that a learner has to complete for award of the degree.**

The Scheme of Teaching and Examination:

The performance of the learners shall be evaluated in two components: Internal Assessment with 40% marks by way of continuous evaluation and by Semester End Examination with 60% marks by conducting the theory examination.

INTERNAL ASSESSMENT: - It is defined as the assessment of the learners on the basis of continuous evaluation as envisaged in the credit-based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.

A). Internal Assessment – 40% 40 marks

Practical's (internal Components of the Practical Course**1. For Theory Courses**

Sr. No.	Particulars	Marks
1	ONE class test / online examination to be conducted in the given semester	15 Marks
2	One assignment based on curriculum (to be assessed by the teacher Concerned	10 Marks
3	Self-Learning Evaluation	10 Marks
4	Active participation in routine class instructional deliveries	05 Marks

2. For Courses with Practicals

Each practical course can be conducted out of 50 marks with 20 marks for internal and 30 marks for external

Practical's (Internal component of the Practical Course)

Sr. No	Evaluation type	Marks
1	Two Best Practicals /Assignments/Presentation /Preparation of models/ Exhibits Or One Assignment/ project with class presentation to be assessed by teacher concerned	10
2	Journal	05
3	Viva	05

The semester end examination (external component) of 60 % for each course will be as follows:

i) Duration – 2 Hours ii) Theory Question Paper

Pattern: -

1. There shall be Five questions each of 12 marks. First question will be based on all four units. Followed by one question from each unit.
2. All questions shall be compulsory with internal choice within the questions. (Each question will be of 20 to 23 marks with options.)
3. Question may be subdivided into sub-questions a, b, c... and the allocation of marks depend on the weightage of the topic.

The marks will be given for all examinations and they will be converted into grade (quality) points. The semester-end, final grade sheets and transcripts will have only credits, grades, grade points, SGPA and CGPA.

3. Project and Assignment:

Project or Assignment, which can in the following forms

- Case Studies
- Videos
- Blogs
- Research paper (Presented in Seminar/Conference)
- Field Visit Report
- Presentations related to the subject (Moot Court, Youth Parliament, etc.)
- Internships (Exposition of theory into practice)
- Open Book Test
- any other innovative methods adopted with the prior approval of Director Board of Examination and Evaluation.

4. Self-Learning Evaluation

- **20% OF THE TOPICS OF CURRICULUM ARE LEARNED BY THE STUDENT THROUGH SELF LEARNING USING ONLINE / OFFLINE ACADEMIC RESOURCE SPECIFIED IN THE CURRICULUM.**
- **HENCE 20% OF THE LECTURES SHALL BE ALLOCATED FOR EVALUATION OF STUDENTS ON SELF LEARNING TOPICS**
- The identified topics in the syllabus shall be learnt independently by the students in a time bound manner preferably from online resources. Evaluative sessions shall be conducted by the teachers and will carry 10 Marks.
- CLUB The self-learning topics into 3-4 GROUPS OF TOPICS ONLY FOR EVALUATION.
- **PRESCRIBE TIME DURATION (IN DAYS) FOR COMPLETION OF EACH GROUP OF TOPIC AND EARMARK SELF LEARNING EVALUATION LECTURES IN THE**

TIMETABLE. HENCE EACH GROUP OF TOPIC CAN BE ASSIGNED 3 REGULAR LECTURES FOR THIS EVALUATION FOR ENTIRE CLASS

3 Sub Topics

Each evaluative session shall carry 3 Marks (3 x 3 Units = 9 Marks). Students who participate in all evaluative sessions shall be awarded 1 additional Mark.

4 Sub Topics

Each evaluative session shall carry 2.5 Marks (2.5 x 4 Units = 10 Marks)

- **EVALUATION OF SELF LEARNING TOPICS CAN COMMENCE IN REGULAR LECTURES ASSIGNED FOR SELF LEARNING EVALUATION IN THE TIMETABLE**

3 Evaluative sessions

Each evaluative session shall carry 3 Marks (3 x 3 = 9 Marks). Students who participate in all evaluative sessions shall be awarded 1 additional Mark

4 Evaluative sessions

Each evaluative session shall carry 2.5 Marks (2.5 x 4 = 10 Marks).

Methods for Evaluation of Self-learning topics:

- Seminars/presentation (PPT or poster), followed by Q&A – Objective questions /Quiz / Framing of MCQ questions.
- Debates
- Group discussion
- You-Tube videos (Marks shall be based on the quality and viewership)
- Improvisation of videos
- Role Play followed by question-answers

TEACHERS CAN FRAME OTHER METHODS OF EVALUATION ALSO PROVIDED THAT THE METHOD, DULY APPROVED BY THE COLLEGE EXAMINATION COMMITTEE, IS NOTIFIED TO THE STUDENTS AT LEAST 7 DAYS BEFORE THE COMMENCEMENT OF THE EVALUATION SESSION AND IS FORWARDED FOR INFORMATION AND NECESSARY ACTION AT LEAST 3 DAYS BEFORE THE COMMENCEMENT OF THE EVALUATION SESSION

- Viva Voce
- Any other innovative method

SEMESTER END EXAMINATION: - It is defined as the examination of the learners on the basis of performance in the semester end theory / written examinations.

B. Semester End Examination- 60 %

60 Marks

- 1) Duration – These examinations shall be of 2 Hours duration.
- 2) Question Paper Pattern: -
 - i. There shall be Five questions each of 12 marks each.
 - ii. All questions shall be compulsory with internal choice within the questions.

- iii. Question may be sub-divided into sub-questions a, b, c, d & e only and the allocation of marks depends on the weightage of the topic.

THE MARKS OF THE INTERNAL ASSESSMENT SHOULD NOT BE DISCLOSED TO THE STUDENTS TILL THE RESULTS OF THE CORRESPONDING SEMESTER IS DECLARED.



HSNC University, Mumbai
(2022 - 2023)

Ordinances and Regulations
With Respect to
Choice Based Credit System (CBCS)

For the Programmes Under
The Faculty of Science and Technology

For the Course
Life Sciences

Curriculum – Third Year Undergraduate Programmes
Semester - V and Semester - VI

2022 - 2023

Section C
T.Y.B.Sc. Life Sciences
 Part 1: Preamble

The basic concepts of Genetics are introduced to students at higher school education level and then at undergraduate level. The role of genetic material of all living organisms, its functional and regulatory aspects are important to understand. The organization and complexity of genetic material of plants and animals provide insights to study the same in Human and in other complex Eukaryotes. The mechanism of Genetic inheritance, the techniques used to analyze the complexity and its application in Research and Disease management is of significance in the current era. Immunology is a branch of the biology involved with the study of the immune system, components of the immune system, its biological processes, the physiological functioning of the immune system, types, its disorder and lot more. The immune system consists of factors that provide innate and acquired immunity, and has evolved to become more specific, complex, efficient, and regulated. The immune system, if dysregulated, can react to self-antigens to cause autoimmune diseases or fail to defend against infections.

Developmental Biology is one of the rapidly evolving and exciting fields in biology, creating a framework that integrates Molecular biology, Physiology, Cell biology, Anatomy, Cancer biology, Immunology, Ecology, and Evolutionary biology. The study of development has become essential for understanding any other area of biology hence will make student develop a holistic approach towards the understanding of biology. Neurobiology is the branch of biology that deals with nervous system functions and structures. More specifically, neurobiology focusses on the cells and tissues of the nervous system and ways in which they can form structures and circuits (pathways) for controlling the body. This system includes common structures, such as the brain and spinal cord, and nerves. To develop the holistic approach of learning microorganisms, plant and animals, the curriculum is designed with the above sections as units for the syllabus.

1. Course objective:

Paper I: This paper is divided into two sub sections of Genetics and Immunology. The syllabus is designed with the following objectives:

- The learner would understand Genetics as a scientific discipline which is of central importance in understanding the blueprint of all Life processes. It provides a thorough understanding of genetic regulation of these processes and its normal and abnormal manifestations into different phenotypes. The basic understanding of the genome is augmented with molecular techniques which would help the learner to understand the applications of these techniques in Research and Industry.
- Section two of the paper is Immunology which is formulated to provide good knowledge of the immune system, its response and involvement in health and disease. While immunology as a science has been defined as the ‘Science of Self/Non-self-Discrimination’, it also includes our innate ability to defend against microorganisms (Innate Immunity); and its ability to recognize and respond to fight the infections through Acquired Immunity. Specific topics being covered include Antigens and Antibodies, Antigen-Antibody interactions, Antibody structure and formation, Effector responses etc.

Paper II:

This divided in two sections Developmental biology and Neurobiology.

- The units of the paper will facilitate the learner to understand the basic concept of animal development starting from embryology along with modern concept of processes and mechanisms that control and influence the development and growth of organisms especially from a Molecular, Cellular, or Genetic and Evolutionary perspective, with the help of animal models from unicellular to evolved systems. The early processes of animal development shall be explained using the amphibian and avian system as examples and plant development using *Arabidopsis*.
- This sub section explains the Molecular and Cellular aspects of various processes of growth and differentiation along-with the important genes involved in early development in *Drosophila*. It also focusses on applications of Developmental Biology in Assisted Human Reproductive Techniques (ART)

and its role in elucidating the concept of Aging, manifestation of Congenital Abnormalities. This paper also highlights the Regulation of Cell cycle, Cancer and Apoptosis with examples/case studies in the said field.

- The units in Semester V under the section of Neurobiology describe the anatomical organization of the Nervous system and its early development. It also explains the cellular basis of nerve conduction within a Neuron and transmission across synapses including the description of the Neurotransmitters. It will elucidate the cellular and molecular processes that contribute to the development, maintenance and modification of Neural circuitry. Further part of the topic describes the structural and functional features of the various Sensory and Motor systems. It elaborates on some behavioral aspects such as sleep and memory. Examples of diseases that arise due to malfunction of the Nervous system are described. Understanding the Cellular and Molecular mechanisms that underlie the neuronal signaling of various Sensory systems are part of this unit.
- This syllabus is framed with an objective of helping the students to qualify at various entrance examinations to make them eligible for the post graduate field in the subject of Life Sciences and allied subjects.

2. Process adopted for Curriculum Designing:

- This curriculum for the Third Year Students of Life Sciences has been developed by maintaining a student centric learning pedagogical approach, which has been further aimed at being outcome-oriented and curiosity-driven.
- Using creative and Bloom-based approach, rote-learning has been avoided and imaginative abilities of the students have been fostered. The curriculum has been designed to be more inclined towards understanding and assimilation of concepts.
- Feedback from the stakeholders, including the students, subject experts, alumni and industry partners has been referred to in the up-dation of the syllabus.
- Modifications and changes have been done in the syllabus with respect to the current trends and requirements of the Research and Industrial sectors of the subject.

3. Relevance of Revised Curriculum: Salient features

Paper I:

Semester V

- A systematic development of concepts regarding discovery of Genetic material in Prokaryotes and Eukaryotes followed by the sequence complexity and regulating mechanism of genetic systems. This would help students in strengthening the basic concepts in classical and molecular Genetics
- Genetic recombination and Bio-techniques such as Gene cloning, Next-Gen Sequencing supported by hands-on practical for the students to design and carry out experiments
- Topics in Immunology designed for the learner to understand the concept and role of innate and adaptive immunity and the factors contributing to immunity
- Providing learners understanding of the structure-function relationship of Immunoglobulins
- Focus on the Ontogeny and Differentiation of B and T cells, the role of the MHC molecules in adaptive immunity and the hypersensitivity as the main component of applied immunology

Semester VI

- Techniques in Genetic crosses and Gene Mapping from Prokaryotes to Humans that equip students with basic and latest concepts in Gene Mapping

- Current techniques of Animal and Plant tissue culture added as a new component would help the graduates to design experiments for their projects during the coursework and also in finding openings in pharmaceutical and health industry.
- The learner will be facilitated with the knowledge of various disorders related to the immune systems.
- Introduction to the concept of Tolerance and the mechanism associated with Transplantation
- Knowledge about Autoimmune disorders and Complement activation will support the learner to understand the causes, complete etiology and diagnosis of immune related disorders.

Paper II:

Semester V

- Strengthening of concepts related to Model organisms and various Evo-developmental relevance
- Insights on comparative developmental process through Embryonic development in Avian (chick), Amphibian (*Xenopus*) and Plant (*Arabidopsis*) systems
- Learning the structural and functional organization of the nervous system helps in understanding the cellular and molecular mechanisms that underlie the Neuronal signaling
- Elucidating the Cellular and Molecular processes that contribute to the development, maintenance and modification of Neural circuitry
- A better understanding of the role of Neurotransmitters with respect to Biosynthesis, Physiological role and Pharmacological significance

Semester VI

- Cellular and Molecular mechanisms controlling development in *Drosophila* aims in understanding the complete developmental process
- Facilitation of molecular and genetic understanding of the regulation of developmental gene functions and mutations
- Introduction of the role of environmental agents in teratogenesis in elucidating the anthropogenic factors affecting the development of organism
- Comprehension of the Structure-function relationships in the Sensory components of the Nervous system
- To enhance understanding of the Neurological basis of Behavior

4. Learning Outcomes:

- A Comparative approach to Genetics regulation and Developmental Biology in plants and Animals and their effect on Coordination would make the learners more interested in these topics. This knowledge can be extrapolated to Model systems for an in-depth study in the subject.
- Learners will develop an ability to relate various interrelated physiological and metabolic events of any biological system.
- The students will learn the use of Molecular techniques in Biological research problems.
- Since most of the theory topics are supported by the laboratory experiments, learners will be able to develop good experimental and quantitative skills encompassing preparation of laboratory reagents, conducting experiments, analysis of data and interpretation of results.
- Learners would develop a keen interest and aptitude to work safely and effectively in a laboratory.
- Acquiring application-based knowledge of the four components, viz Genetics, Immunology, Developmental Biology and Neurobiology, would motivate the learners to take up projects in these areas.
- Learners will develop an ability to critically evaluate a problem and find a solution based on scientific concepts.
- Learners will be aware of the current trends in different disciplines of Biological Sciences, avenues for research and strive for higher academic achievements in Life Sciences.

5. Input from stakeholders (Which Sections have been modified) with relevant introduction:

- Suggestions received from the members of the Board of Studies provide a holistic learning approach towards upgrading their knowledge regarding concepts of Life Sciences.
- More training and application-based approach needs to be introduced which will help learners to apply their knowledge in their studies and research work.
- Inclusion of additional hands-on, skill-based and in-silico techniques in both Papers to align the syllabus with current trends in Research and Industry.
- Orienting students to maintain digital records of specimen data *in lieu* of ethics.
- Modifying of syllabus to make learners aspire for Higher education, confident of clearing entrance exams, be industry oriented and employable after Graduation.
- Helping the learners to develop generic skills, self-employment and entrepreneurship.

HSNC, UNIVERSITY, MUMBAI
KISHINCHAND CHELLARAM COLLEGE
THIRD YEAR B.Sc. LIFE SCIENCES SYLLABUS
Academic Year 2022 - 2023

Sr. No.	Choice Based Credit System		Subject Code	Remarks	
1	Core Course (Life Sciences)		US - TLSC - 501 US - TLSC - 502 US - TLSC - 5P1 And 5P2	NIL	
2	Elective Course	Discipline Specific Elective (DSE) Course			-
		2.1	Interdisciplinary Specific Elective (IDSE) Course		-
		2.2	Dissertation/Project		-
		2.3	Generic Elective (GE) Course		-
3	Ability Enhancement Courses (AEC) (Applied Component)		US - TEVS - AC - 501		
	Skill Enhancement Courses (SEC)		-		

Third Year Semester V Internal and External Assessment Details: (60-40 pattern)

Sr. No.	Subject Code	Subject Title	Periods Per Week				Credit	Seasonal Evaluation Scheme				Total Marks	
			Units	S. L.	L	T		P	SL E	C T	TA		SEE
1	US-TLSC-501		4	20%*	4	0	0	2.5	10	20	10	60	100
2	US-TLSC-502		4	20%*	4	0	0	2.5	10	20	10	60	100
3	US-TLSC-P501 & P502		-	-	0	0	2	3	-	-	-	50 (30+20)	100
Total Hours / Credit							08	Total Marks				300	

*Three lectures/Unit to be taken for CONTINUOUS self-learning Evaluation.

SEMESTER V
US - TLSC - 501 – PAPER I – THEORY
GENETICS AND IMMUNOLOGY - I

	GENETICS - I	(30L)
UNIT I	The Genetic material 1. Discovery of Genetic material 1.1 Griffith's experiment of 1928- Bacteria 1.2 Avery, McLeod and McCarty experiment of 1944- Bacteria 1.3 Hershey Chase experiment of 1952 – Bacteriophage 1.4 Frankel, Conrat and B. Singer's Experiment of 1957 – Plant Virus 2. Organisation of Prokaryotic and Eukaryotic Genome 2.1 Plasmid Genome, Phage Genome 2.2 Eukaryotic genome: Sequence complexity of DNA - Unique and repetitive sequences (SINE, LINE, Microsatellite, mini satellite DNA), Denaturation kinetics and 'CoT' value and interpretation of Cot curves; 'C value paradox'; 3. Overview of Genetic regulation in Eukaryotes 3.1 Modification and remodeling by Acetylation and methylation system 3.2 Transcriptional Gene regulation- Operon in <i>C. elegans</i> 3.3 Gene regulation in Drosophila – Gal4	(4L) (3L) (5L) (1L) (1L) (1L)
UNIT II	Mechanism of Inheritance and Variation 1 Inheritance pattern of Genetic Disorders in Humans (Prognosis, Testing, of any Human Genetic disorder) 2 Introduction to Genetic recombination 2.1 Types of naturally occurring Genetic recombination. (e.g Homologous/ Non homologous/ site directed) 2.2 Mechanism and proposed models for Genetic recombination (e.g Holliday Model/Double strand break model) 2.3 Advantages of genetic recombination during meiosis 3 Mutational Variation: 3.1 Natural Biological mutagenic agents – Prokaryotic Transposable elements and their significance 3.2 Types of Eukaryotic transposons, their mechanism of action, (e.g AcDs system in Maize, P element transposition) and Inheritance pattern 4 Techniques in detection of variation in Genetic material 4.1 Gene cloning 4.2 Nucleic Acid blotting techniques Southern and Northern 4.3 LOD score using Pedigree charts	(2L) (1L) (2L) (2L) (1L) (4L) (1L) (1L) (1L)
	IMMUNOLOGY I	(30L)
UNIT III	Overview and cells and organs of immune system 1. Historical Perspective - Early Vaccination studies; Infection and immunity 2. Overview of the Immune system - Innate Vs Adaptive Immunity 2.1. Innate immunity 2.1.1. Anatomical, Physiological, Phagocytic, Inflammatory barrier 2.1.2. Concept of PAMP, PRR and TLR 2.2. Cells and organs of the immune system	 (1L) (2L) (3L)

	<p>2.2.1. Lymphoid cells – B and T cells, NK cells, Mast cells, Macrophages, Dendritic cells</p> <p>2.2.2. Primary: Bone Marrow and Thymus</p> <p>2.2.3. Secondary lymphoid organs: Lymph nodes, spleen, Peyers's patches, MALT AND GALT, Adenoids and Tonsils</p> <p>3. Antigens and antibodies</p> <p>3.1. Immunogenicity versus antigenicity</p> <p>3.1.1. Antigen-Specificity, avidity, affinity, cross reactivity, haptens, adjuvants, epitopes</p> <p>3.1.2. Properties of immunogen contributing to immunogenicity</p> <p>3.2. Antibodies</p> <p>3.2.1. Basic structure of antibodies</p> <p>3.2.2. Classes of antibodies and biological activity</p> <p>3.2.3. Polyclonal antibodies</p> <p>4. Organization and expression of immunoglobulin genes</p> <p>4.1. Multigene organization and gene rearrangement</p> <p>4.1.1. Generation of antibody diversity - Heavy and Light Chain gene re-arrangement</p> <p>4.1.2. Class switching</p> <p>4.2. Antigen-antibody interactions – Principles and applications Precipitation, Immunoelectrophoresis, Agglutination, Radioimmunoassay, ELISA, Immunofluorescence, Monoclonal antibodies (Hybridoma Technique) Flow Cytometry, Western Blotting</p>	<p>(1L)</p> <p>(2L)</p> <p>(2L)</p> <p>(3L)</p> <p>(3L)</p>
UNIT IV	<p>Antigen recognition and Effector Mechanisms</p> <p>1 Recognition of antigens.</p> <p>1.1 Major Histocompatibility Complex</p> <p>1.1.1 MHC molecules and genes</p> <p>1.1.2 MHC allelic polymorphism</p> <p>1.1.3 Cellular expression of MHC</p> <p>1.1.4 Self MHC restriction of T cells</p> <p>1.2 Antigen processing and presentation</p> <p>1.2.1 Endogenous antigens - the cytosolic pathway</p> <p>1.2.2 Exogenous antigens - the endocytic pathway</p> <p>1.2.3 Role of MHC in Transplantation and Grafting</p> <p>2 Maturation and activation of Lymphocytes</p> <p>2.1 B- cell Maturation, Activation and Differentiation</p> <p>2.2 T - cell receptor – Structure and role of $\alpha\beta$ and $\gamma\delta$ receptors</p> <p>2.3 T cell receptor complex and accessory membrane molecules \</p> <p>2.4 T - cell Maturation, Activation and Differentiation</p> <p>3 Immune Effector Mechanisms</p> <p>3.1 Cytokines- - IL-1, IL-2, IL-4, IFNs and TNFs</p> <p>3.1.1 Cytokine secretion by T_H1 and T_H2 cells</p> <p>3.2 Complement</p> <p>3.2.1 Classical, alternate and lectin pathways and comparison</p> <p>3.2.2 Biological consequences of complement activation</p> <p>3.2.3 Complement fixation tests</p> <p>3.3 Cell-mediated effector responses</p> <p>3.3.1 Cell-mediated cytotoxicity of T cells, NK cells, ADCC Role of TH1, TH2, TH17 and Tc cells</p>	<p>(3L)</p> <p>(3L)</p> <p>(2L)</p> <p>(2L)</p> <p>(3L)</p> <p>(2L)</p>

Unit	SELF LEARNING EVALUATION	SUGGESTED LINKS
GENETICS - I		
I	<ol style="list-style-type: none"> Gene Cloning—Genes coding for Enzymes and Human Diseases Regulatory Sequences in Transcription and Translation in Prokaryotic and Eukaryotic system 	<ul style="list-style-type: none"> https://onlinecourses.nptel.ac.in/noc22nb01/preview https://www.bio.iitb.se.in/academics/courses/
II	<ol style="list-style-type: none"> Knock-out Mice Crisper-CAS9 Recombination Scores using Pedigree Examples Research initiatives across National and International laboratories 	<ul style="list-style-type: none"> https://onlinecourses.nptel.ac.in/noc22nb01/preview https://www.bio.iitb.se.in/academics/courses/
IMMUNOLOGY - I		
III	<ol style="list-style-type: none"> Cells and organs of Immune System and their role. Types of Antibodies and their role in humoral immune system Diagnostic test-based case study-to understand abnormal/pathogenic/disease conditions. 	<ul style="list-style-type: none"> https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/11%3A_Immunology/11.01%3A_Overview_of_Immunity/11.1A%3A_Cells_and_Organs_of_the_Immune_System https://www.ncbi.nlm.nih.gov/books/NBK10752/ https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3502310/
IV	<ol style="list-style-type: none"> Role of MHC as important tool for transplantation and transfusion. Cytokines and their role in overall immune system. 	<ul style="list-style-type: none"> https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6769817/ https://medcraveonline.com/MOJI/cytokines-and-their-role-in-health-and-disease-a-brief-overview.html

US – TLSC – 502 – PAPER II – THEORY
DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY-I

	DEVELOPMENTAL BIOLOGY I	(15L)
UNIT I	<p>Concepts, Model Organisms and Techniques</p> <ol style="list-style-type: none"> 1. Historical perspective of Developmental Biology 2. Some basic concepts of developmental biology: Overview: Development is a gradual process by which a complex multicellular organism arises from a single cell (the zygote). <ol style="list-style-type: none"> 2.1 Growth: increase in size 2.2. Cell division: increase in number 2.3. Differentiation: diversification of cell types 2.4. Embryonic induction 2.5. Concept of morphogens 2.6. Mosaic and regulative development 2.7. Fate map 2.8. Pattern formation: organization 2.9. Morphogenesis: generation of shapes and structures 3. Life Histories of Model Organisms highlighting some important concepts: <ol style="list-style-type: none"> 3.1. <i>Dictyostelium</i>- cell signalling and morphogenetic gradient 3.2. <i>C.elegans</i>: Overview and Cell differentiation 3.3. Drosophila: Overview of invertebrate body plan (Life Cycle and body plan) 3.4. Zebrafish: Overview of vertebrate body plan (Life Cycle and body plan) 3.5. Chlamydomonas: Life cycle and important developmental concept 	<p>(1L)</p> <p>(6L)</p> <p>(8L)</p>
UNIT II	<p>Animal and Plant Development- Basic Cellular Aspects</p> <ol style="list-style-type: none"> 1. Comparative Approach of Development in Animals: - <ol style="list-style-type: none"> 1.1. Germ cells: Types of eggs, its structure, structure of Sperm. 1.2. Fertilization: Cell signaling and Factors affecting fertilization (prevention of Polyspermy); <ol style="list-style-type: none"> 1.2.1. Cleavage, Morula and blastula: Concept of potency and regulatory development 1.2.2. Gastrulation: Spemann's Organizer; Three germ layers and origins of organs. 1.2.3. Fate Map lineage tracing 1.2.4. Neurulation: Neural tube Induction and formation of neural tube 2. Development in Plants: - <ol style="list-style-type: none"> 2.1. Overview of Plant development: Unicellular to multicellular 2.2. Life cycle of Arabidopsis–Sporophytic and Gametophytic generation, Fertilization and embryo development, 2.3. Development of meristems (root and shoot) 2.4. Development of different organs – leaf, flower, androecium [including development of anthers, pollen grain, pollen tube etc.] and gynoecium 2.5. Development of pistil - up to formation of embryo sac 2.6. Double fertilization, seed formation and Eventual formation of fruit. 	<p>(8L)</p> <p>(7L)</p>

NEUROBIOLOGY I		
UNIT III	<p>General organization of nervous system</p> <ol style="list-style-type: none"> 1. Development of the vertebrate nervous system: <ol style="list-style-type: none"> 1.1. Neurulation: formation of neuroectoderm, neural tube and neural crest cells and their derivatives, induction as the basis of neurulation (2L) (5L) 1.2. Differentiation into neuronal and glial cell types, neuronal migration and axon guidance, synapse formation, synapse competition, maturation and cell death (1L) 1.3. Circuit formation: critical periods in development, effect of neuronal activity in development of neural circuits (1L) 2. Comparative overview of vertebrate and invertebrate nervous system (1L) <ol style="list-style-type: none"> 2.1. Vertebrate nervous system: - Anatomy and functional features of CNS (cerebral hemispheres, cerebellum, diencephalon, medulla, pons, midbrain and spinal cord), PNS (autonomous, somatosensory, cranial, spinal, plexii) (2L) 2.2. Role of meninges and CSF, concept of blood brain barrier. (1L) 2.3. Limbic System (emotions and memory) (1L) 2.4. Hypothalamus – Hypophysial Axis (stress) (1L) 	
UNIT IV	<p>Cellular organization of the nervous system</p> <ol style="list-style-type: none"> 1. Typical nerve cell, Types of cells: Neurons, Glial cells (1L) 2. Chemical Basis of Neural transmission- Introduction Ionic basis of resting membrane potential: types of ion channels, Donnan's equilibrium, Nernst's potential, Goldman's equation, Sodium –Potassium pump (2L) 3. Action Potential & propagation: Hodgkin and Huxley's model, voltage clamp experiment and the generation and propagation of Action Potential, Graded potential (2L) 4. Synaptic potential and synaptic integration [Electrical and Chemical Synaptic Potential], Excitatory Post Synaptic Potential (EPSP), Inhibitory Post Synaptic Potential (IPSP) (3L) 5. Synapse and synaptic transmission: Synapse: Structure, Types – Electrical and chemical; Neuro – muscular junctions; miniature endplate potentials (MEPPs) (3L) 6. Neurotransmitters – General Introduction Biosynthesis, physiological role, pharmacological significance, (examples of one agonist and one antagonist for each neurotransmitter mentioned below. Acetylcholine (Nicotinic and muscarinic receptors). Dopamine (D1 and D2 receptors). GABA and Glutamate Neuropeptide (Endorphin and Enkephalin) (4L) 	

Unit	SELF LEARNING EVALUATION	SUGGESTED LINKS
DEVELOPMENTAL BIOLOGY - I		
I	<ol style="list-style-type: none"> 1. Mutations and large-scale mutagenesis screens (<i>Drosophila</i>) 2. Transgenic techniques and gene silencing (<i>Zebra fish/ mice</i>) 3. Plant Genome Project 	<ul style="list-style-type: none"> • https://www.sdbonline.org/sites/fly/aimain/1aahome.htm • http://www.biology.arizona.edu/developmental_bio/problem_sets/Developmental_Mechanisms/developmental_mechanisms.html
II	<ol style="list-style-type: none"> 1. Cytoplasmic state of the egg in <i>Xenopus/Frog</i>. 2. Salamander development 3. Effect of Environmental factors affecting the germ cell formation in <i>Xenopus/Frog</i>. 4. Patterning of flower in <i>Arabidopsis</i>. 5. Overview of Development in Multicellular algae: e.g. <i>Spirullina</i> 	<ul style="list-style-type: none"> • https://darchive.mblwhoilib.org/handle/1912/1165 • https://www.ncbi.nlm.nih.gov/books/NBK10113/ • https://www.xenbase.org/anatomy/intro.do#:~:text=Introduction%20to%20Xenopus%2C%20the%20frog.and%20to%20model%20human%20diseases • https://www-tc.pbs.org/wgbh/evolution/library/04/2/pdf/l_042_03.pdf • https://www.nsf.gov/pubs/2002/bio0202/model.htm • https://pubmed.ncbi.nlm.nih.gov/19030813/ • https://pubmed.ncbi.nlm.nih.gov/15576916
NEUROBIOLOGY I		
III	<ol style="list-style-type: none"> 1. Evolution of Nervous system 2. Nervous system of Vertebrates 3. Neuro-muscular junctions –miniature end plate potentials (MEPPs) 4. Control and Coordination in Plant: Responses to stimuli - Case studies 	<ul style="list-style-type: none"> • https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5647789/ • https://www.ncbi.nlm.nih.gov/pmc/articles/PMC493862/ • https://www.pnas.org/doi/10.1073/pnas.2016025117
IV	<ol style="list-style-type: none"> 1. Hodgkin and Huxley's voltage clamp experiment 2. Voltage clamp experiment to explain resting Membrane Potential 3. Evolution of Nervous system 	<ul style="list-style-type: none"> • https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3424716/ • https://openbooks.lib.msu.edu/neuroscience/chapter/voltage-clamp/ • https://www.medicalnewstoday.com/articles/326649 • https://www.kenhub.com/en/library/anatomy/neurotransmitters

REFERENCES

Semester V- US – TLSC - 502

References books for Genetics

Unit I and II

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

References books for Immunology

Unit III and IV

11. Immunology 5th edn. R.A. Goldsby, T. J. Kindt, B. A. Osborne, J. Kuby 2003.
12. Immunology: The immune system in health and disease 6th edn. C. A. Janeway, P. Travers, M. Walport, M. Shlomchik Garland Science Pub. 2005.
13. Cellular and Molecular Immunology, 2nd edn. A. K. Abbas, A. H. Litchman, 5th edn 2000.
14. Basic Immunology: Functions and disorders of the immune system, 2nd edn. A. K. Abbas, A. H. Litchman, 2nd edn 2004.
15. Roitt's Essential Immunology 11th edn. 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. USLSC502:

SEMESTER V- US – TLSC - 502

Reference books for Developmental Biology

UNIT I and II

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. Jessell and P. Lawrence 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. Plant Cell and Tissue Culture I. Vasil and T.A. Thorpe. Kluwer Academic Publishers.
8. Practical Zoology 2nd Edition. K.C. Ghone and B. Manna. New Central Book Agency Publishers.
9. Developmental Biology 4th edition. S.F. Gilbert. Sinauer Associates Inc. Publishers.
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 Embryo 24 logy 2nd ed. W.W.Mathews. MacMillan Publishing Co.
16. Essential Developmental Biology – A Practical Approach Ed C.D. Stern and P.W.H. Holland. Oxford University Press UNIT III and IV – Neurobiology (Latest Editions Recommended).

Reference books for NEUROBIOLOGY
UNIT III and IV

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 25
- 1.**

PRACTICAL – US – TLSC – P501
(Based on paper I)

Note: C, R, T, I □ Concept, Relevance, Technique, Instrumentation

<p>A. Instrumentation / Technique (I/T)</p> <p>B. Process / Concept and immediate Relevance (C, R)</p> <p>a. Extraction, Purification techniques</p> <p>b. Analysis / Estimation</p> <p>c. GLP (Good Laboratory practices) incorporated into every practical</p> <p>C. Practical aspect of the paper will also be supported by Research papers to understand the application of the learned techniques and advantages in the field.</p> <p>D. Evaluation and internal assessment can be made by ATP (Alternative to Practical) questions.</p>	
<p>Genetics:</p> <p>I) Performance Experiments:</p> <p>1. Extraction of Chromosomal DNA from suitable sample. (Chicken/goat/any other suitable source) (1) (C, T, R, I)</p> <p>2. Viable count for enumeration of bacteria by - Bulk seed/ Pour plate method. (C, R, T) (1)</p> <p>3. Effect of UV Radiation on viability of E. coli- under the conditions of Dark and Light Repair (C, R, T, I) (1)</p> <p>4. Antibiotic Sensitivity using Agar Cup/Agar Ditch. (C, R, T) (1)</p> <p>II) Demonstration Experiments: (1)</p> <p>5. Study of UV-Visible Spectrophotometer using DNA/ Protein from suitable sample, checking purity of sample. (C, R, T, I) (2)</p> <p>6. Project: Culturing of Drosophila and Study of Wild type of Drosophila flies.</p> <p>a. Collection and observation of virgin Drosophila females for setting up of genetic crosses.</p> <p>b. Study of Drosophila mutants from specimen / slides / photographs.</p>	
<p>Immunology:</p> <p>I) Performance Experiments: (1)</p> <p>1. Western Blotting Technique (C, R, T, I) (1)</p> <p>2. Study of Is Hemagglutinin titer in blood. (C, R, T) (1)</p> <p>3. Quantitative Widal Test. (C, R, T) (3)</p> <p>II) Demonstration experiments:</p> <p>4. Study of Tissues:</p> <p>a. Dissect and expose the Lymphoid organs of rat / photograph</p> <p>b. Study of Thymus, Spleen, and Lymph node tissue sections</p> <p>c. Observation of Blast cells in bone marrow of any Mammal from slides / photographs</p>	

PRACTICAL – US – TLSC – P502 (Based on paper II)

Note: C, R, T, I □ Concept, Relevance, Technique, Instrumentation

<p>A. Instrumentation / Technique (I /T)</p> <p>B. Process / Concept and immediate Relevance (C, R)</p> <ol style="list-style-type: none"> i. Extraction, Purification techniques ii. Analysis / Estimation iii. GLP (Good Laboratory practices) incorporated into every practical <p>C. Practical aspect of the paper will also be supported by Research papers to understand the application of the learned techniques and advantages in the field.</p> <p>D. Evaluation and internal assessment can be made by ATP (Alternative to Practical) questions.</p>	
Developmental Biology:	
<p>Animals:</p> <ol style="list-style-type: none"> 1. Study of developmental stages of chick embryo- C, T 2. Cytochrome C- oxidase activity in a developing chick embryo. C, T 3. Demonstration experiments (Any two of the following): <ol style="list-style-type: none"> a. Programmed cell death in limb bud using Janus Green B stain (in chick embryo).C, T,R b. Acid and alkaline Phosphatase activity using Hydra as a model <p>Plants:</p> <ol style="list-style-type: none"> 4. Effect of temperature on cell viability in pollen grains/yeast using Trypan blue/ acetocarmine C, T, R 5. Observation of different developmental stages of plant embryo using suitable plants. 6. Study of seed viability using NBT I,C,T,R. 	<p>(1)</p> <p>(1)</p> <p>(2)</p> <p>(1)</p> <p>(1)</p> <p>(1)</p>
Neurobiology	
<ol style="list-style-type: none"> 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) 4. Study of Permanent slides of: C, R <ol style="list-style-type: none"> a) Medullary nerve fiber b) Neuro-muscular junctions c) TS of Spinal cord d) Mammalian retina e) Electron micrographs of neural tissue 5. Differential staining of Brain (Mulligan’s Staining) 6. Demonstration Experiments: <ol style="list-style-type: none"> a) Study of the Nervous system of Sepia with special reference to Giant axon and stellate ganglia b) Understanding the principle and basic interpretation of brain imaging tests like PET (Positron Emission Tomography) and MRI (Magnetic Resonance Imaging)- Using images understanding physiopathology 	<p>(1)</p> <p>(1)</p> <p>(1)</p> <p>(2)</p> <p>(1)</p> <p>(1)</p> <p>(1)</p> <p>(1)</p>

HSNC, UNIVERSITY, MUMBAI
KISHINCHAND CHELLARAM COLLEGE
THIRD YEAR B.Sc. LIFE SCIENCES SYLLABUS
Academic Year 2022 - 2023

Sr. No.	Choice Based Credit System		Subject Code	Remarks	
1	Core Course (Life Sciences)		US - TLSC - 601 US - TLSC - 602 US - TLSC - 6P1 And 6P2	NIL	
2	Elective Course	Discipline Specific Elective (DSE) Course			-
		2.1	Interdisciplinary Specific Elective (IDSE) Course		-
		2.2	Dissertation/Project		-
		2.3	Generic Elective (GE) Course		-
3	Ability Enhancement Courses (AEC) (Applied Component)		US - TEVS - AC - 601		
	Skill Enhancement Courses (SEC)		-		

Third Year Semester VI Internal and External Assessment Details: (60-40 pattern)

Sr. No.	Subject Code	Subject Title	Periods Per Week						Credit	Seasonal Evaluation Scheme				Total Marks
			Units	S. L.	L	T	P	SL E		C T	TA	SEE		
1	US-TLSC-601		4	20%*	4	0	0	2.5	10	20	10	60	100	
2	US-TLSC-602		4	20%*	4	0	0	2.5	10	20	10	60	100	
3	US-TLSC-P601 & P602		-	-	0	0	2	3	-	-	-	50 (30+20)	100	
Total Hours / Credit									08	Total Marks				300

*Three lectures/Unit to be taken for CONTINUOUS self-learning Evaluation.

SEMESTER VI
US - TLSC - 601 – PAPER I – THEORY-
GENETICS AND IMMUNOLOGY II

GENETICS - II		(30L)
UNIT I	Techniques in Gene Mapping 1. Genetic Recombination and Gene Mapping 1.1. Prokaryotic Mapping- Transformation Mapping 1.2. Bacterial Conjugation - Jacob and Wollman’s Method 1.3. Phage - Transduction, Deletion and Recombination Mapping 2. Eukaryotic Mapping 2.1. Drosophila 3 factor cross with Co-efficient of co-incidence and interference in Drosophila and Maize 2.2. Neurospora Mapping 2.3. Human Genome Mapping 2.3.1. Contig mapping 2.3.2. RFLP and SNP Mapping 2.4. Somatic Cell Genetics and Use of Cell Hybrids for Gene Mapping	(2L) (1L) (2L) (4L) (2L) (2L) (2L)
UNIT II	Tools and Techniques in Molecular Genetics 1. Restriction Enzymes and Mapping 2. DNA Next Gen Sequencing 3. Animal and Plant Tissue Culture 3.1. Ti Plasmid 3.2. Protoplast culture 3.3. Transgenic Plants and Animals 4. Non-Radioactive DNA Hybridization Techniques 4.1. Chemiluminiscence 4.2. Fluorescence 5. PCR based methods of Induced Mutagenicity 5.1. Site- directed 5.2. Mutagenicity tests AMES 6. DNA-DNA Hybridization techniques 6.1. FISH 6.2. HRT and HART	(2L) (1L) (2L) (1L) (1L) (2L) (1L) (1L) (2L) (2L)
IMMUNOLOGY - II		30L
UNIT III	Hypersensitivity, Infectious diseases, Vaccines and Immunodeficiency 1. Hypersensitivity Gell and Coombs classification: 1.1. Types of hypersensitivity – Examples and methods of diagnosis 1.1.1. IgE- mediated (Type I) hypersensitivity: RIST and RAST 1.1.2. Antibody-mediated (Type II) hypersensitivity: Agglutination 1.1.3. Immune complex-mediated (Type III) hypersensitivity: 1.1.4. Immunofluorescence, ELISA 1.1.5. Delayed type hypersensitivity (Type IV): Tuberculin test	 (5L)

	<p>2. Infectious Diseases and Vaccines</p> <p>2.1. Important immune mechanisms against various infectious diseases</p> <p>2.1.1. Viral infections</p> <p>2.1.2. Bacterial infections</p> <p>2.1.3. Fungal infections</p> <p>2.1.4. Parasitic infections</p> <p>3. Vaccines</p> <p>3.1. Passive immunization - Preformed antibodies and their disadvantages</p> <p>3.2. Use of Chimera / humanized antibodies</p> <p>3.3. Active immunization- Whole organisms (attenuated vs. inactivated ex. Polio, COVID)</p> <p>3.4. Subunit Vaccines (Polysaccharide, toxoid and Peptide vaccines)</p> <p>3.5. DNA vaccines</p> <p>4. Immunodeficiency</p> <p>4.1. Primary and acquired Immunodeficiency</p> <p>4.2. Primary immunodeficiency</p> <p>4.2.1. B-cell- X-linked agammaglobulinemia</p> <p>4.2.2. T-cell- Di George Syndrome</p> <p>4.2.3. Lymphoid deficiency - Severe Combined Immunodeficiency</p> <p>4.2.4. Deficiency of myeloid lineage- Chronic Granulomatous Disease</p> <p>4.3. Acquired Immunodeficiency</p> <p>4.3.1. Acquired Immunodeficiency Syndrome</p>	<p>(7L)</p> <p>(3L)</p>
<p>UNIT IV</p>	<p>Transplantation, Tumor Immunology, Tolerance and Autoimmunity</p> <p>1. Transplantation</p> <p>1.1. Types of grafts</p> <p>1.2. Tissue typing (serological and MLR)</p> <p>1.3. Mechanisms of graft rejection</p> <p>1.4. Immunosuppressive therapy</p> <p>1.5. Graft vs. host disease - bone marrow transplant</p> <p>2. Tumor Immunology</p> <p>2.1. Tumour specific and associated antigens</p> <p>2.2. Role of NK cells and macrophages</p> <p>2.3. Tumour evasion of immune system</p> <p>2.4. Cancer immunotherapy.</p> <p>3. Tolerance and Autoimmunity</p> <p>3.1. Establishment and maintenance of tolerance</p> <p>3.1.1. Mechanisms of central tolerance</p> <p>3.1.2. Mechanisms of peripheral tolerance</p> <p>3.1.3. Role of T regulatory cells</p> <p>3.1.4. Immunomodulation during Pregnancy</p> <p>3.2. Autoimmunity</p> <p>3.2.1. Mechanisms of induction (Aetiology)</p> <p>3.2.2. Organ specific diseases – ex. Myasthenia gravis, Graves' disease</p> <p>3.2.3. Systemic diseases – ex. Systemic Lupus Erythematosus, Multiple sclerosis</p>	<p>(4L)</p> <p>(4L)</p> <p>(4L)</p> <p>(3L)</p>

Unit	SELF LEARNING EVALUATION	SUGGESTED LINKS
GENETICS - II		
I	<ol style="list-style-type: none"> Human Genome Sequencing - Advances in Personalized Medicines In-vivo and In-vitro Gene Therapy 	<ul style="list-style-type: none"> https://nptel.ac.in/courses/102104056 https://nptel.ac.in/courses/102104052 https://onlinecourses.nptel.ac.in/noc22_bt07/preview
II	<ol style="list-style-type: none"> Current advances in Transgenic Animals and Plants Nutraceuticals and its applications Current trends in Plant Vaccines production and its advantages. 	<ul style="list-style-type: none"> https://nptel.ac.in/courses/126105015 https://onlinecourses.swayam2.ac.in/ugc19_hs33/preview
IMMUNOLOGY - II		
III	<ol style="list-style-type: none"> Understanding child immunization. Immunodeficiency diseases (any 3 other than prescribed in syllabus) 	<ul style="list-style-type: none"> https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4981642/ https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2718064/
IV	<ol style="list-style-type: none"> Tissue typing in transplantation. GVHD and bone marrow transplantation. Sex based immunological Disorders/Diseases 	<ul style="list-style-type: none"> https://www.sciencedirect.com/topics/medicine-and-dentistry/tissue-typing https://www.ncbi.nlm.nih.gov/books/NBK538235/ https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3022636/

US - TLSC - 602 - PAPER II - THEORY
DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY-II

DEVELOPMENTAL BIOLOGY II		30 L
UNIT I	<p>Animal and plant development – basic cellular and molecular aspects:</p> <ol style="list-style-type: none"> 1. Potency: <ol style="list-style-type: none"> 1.1. Totipotency (Carrot Root Phloem, Animal Nuclei) 1.2. Pluripotency (Embryonic stem Cell) 1.3. Oligopotency (Hematopoietic stem cell/Neural crest cell) 2. Determination and Trans-determination (Imaginal Discs in <i>Drosophila</i>) 3. Differentiation: Hematopoietic stem cells and Neural crest cells (migration and differentiation) 4. Molecular developmental basis of Sex Determination 5. Molecular basis of development in <i>Drosophila</i>:-Genes in early development <ol style="list-style-type: none"> 5.1. Anterior- posterior and Dorso-ventral axis : Maternal genes Zygotic, Segmentation genes, Homeotic genes and Realisator genes 6. Organogenesis of Eye OR Limb with references to inductive/ instructive signals/ cytoplasmic determinants and gradients 7. Plant Development: <ol style="list-style-type: none"> 7.1. Role of Homeotic genes specifying parts of a flower 	<p style="text-align: right;">(3L)</p> <p style="text-align: right;">(2L)</p> <p style="text-align: right;">(2L)</p> <p style="text-align: right;">(6L)</p> <p style="text-align: right;">(2L)</p>
UNIT II	<p>Applications of Developmental Biology</p> <ol style="list-style-type: none"> 1. Overview of Assisted human reproduction 2. Regeneration <ol style="list-style-type: none"> 2.1. Examples in animal world (vertebrates and invertebrates) Epimorphic (Salamander limb) and Morphallactic (Hydra) 2.2. Compensatory regeneration (mammalian liver) 3. Developmental Concept of Aging <ol style="list-style-type: none"> 3.1 Theories of Aging 3.2 Causes- Intracellular and Extracellular 4. Congenital abnormalities: sensitive periods during development and causes of congenital abnormalities with special references to the following <ol style="list-style-type: none"> 4.1. Infection mediated: Zika virus 4.2. Nutrition and Genetic: Spina bifida 4.3. Environmentally mediated: Teratogenesis 5. Cell cycle regulation - check points in cell cycle and role of cyclins and cdks 6. Apoptosis and its role in development 7. Developmental biology and Cancer: an overview 8. Types of Cancer, Causes of Cancer, Oncogenes, Tumour suppressor genes, Treatment strategies for Cancer (Ex. Breast cancer; Prostrate cancer) 	<p style="text-align: right;">(1L)</p> <p style="text-align: right;">(3L)</p> <p style="text-align: right;">(2L)</p> <p style="text-align: right;">(3L)</p> <p style="text-align: right;">(1L)</p> <p style="text-align: right;">(1L)</p> <p style="text-align: right;">(1L)</p> <p style="text-align: right;">(3L)</p>
NEUROBIOLOGY II		(30L)
UNIT III	<p>Signal transduction and processing in the Sensory Nervous System:</p> <ol style="list-style-type: none"> 1. Introduction to Human Sense organs: receptors, receptor mechanisms and pathways <ol style="list-style-type: none"> 1.1. 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, color vision. 	<p style="text-align: right;">(1L)</p> <p style="text-align: right;">(2L)</p>

	<p>1.2. 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. (2L)</p> <p>1.3. Vestibular System: Structure of the vestibular labyrinth, maculae, and cristae. Mechanism of transduction. (2L)</p> <p>1.4. Chemosensory system: Olfactory and Gustatory receptors – structure. (2L)</p> <p>1.5. Skin as sense organ: somatic receptors - Types of mechano- receptors, pain reception & Pain management (example analgesic effect by prostaglandin inhibition - aspirin). (2L)</p> <p>2. Motor System:</p> <p>2.1. Organisation, Reflex Coordination (ascending and descending pathways diagrammatic representation only). (1L)</p> <p>2.2. Role of cerebellum in motor co-ordination (1L)</p> <p>2.3. Types of muscles, Molecular basis of Muscle contraction. (1L)</p> <p>2.4. Reflexes: Simple reflex arc, mono and poly-synaptic reflexes (one example of each). (1L)</p>	
UNIT IV	<p>Neurobiological basis of Behavior</p> <p>1. Sleep, Stages of sleep – REM and non-REM (4L)</p> <p>2. Short term memory and Long-Term Memory (eg. Pathway in Aplysia and molecular events) (4L)</p> <p>3. Neurobiological basis of Diseases: (7L)</p> <p>3.1. Epilepsy</p> <p>3.2. Parkinson's disease</p> <p>3.3. Schizophrenia- Relevance with regard to neurotransmitters</p> <p>3.4. Prions associated diseases</p> <p>3.5. Duchene's muscular Dystrophy</p> <p>3.6. Alzheimer's disease</p>	

Unit	SELF LEARNING EVALUATION	SUGGESTED LINKS
DEVELOPMENTAL BIOLOGY - II		
I	<ol style="list-style-type: none"> Beta globin gene as an example of Gene expression with developmental perspective. Conserved nature of developmental genes (Evo-Devo perspective Hox/Pax6 genes with respect to Drosophila) Cytoplasmic determinants and gradients in Animal development Plant genome project (Arabidopsis/rice) 	<ul style="list-style-type: none"> http://www.biology.arizona.edu/developmental_bio/problem_sets/Developmental_Mechanisms/developmental_mechanisms.html https://genomebiology.biomedcentral.com/articles/10.1186/gb-2009-10-5-107
II	<ol style="list-style-type: none"> Challenges in Assisted Reproduction – Physiological, Somatic and Social. Recent advances in stem cells and regenerative medicine. Effect of Pesticide as endocrine disruptors. Evolutionary significance of developmental biology. 	<ul style="list-style-type: none"> https://www.sciencedirect.com/topics/medicine-and-dentistry/assisted-reproduction https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6354001/ https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NHEERL&dirEntryId=212273
NEUROBIOLOGY II		
III	<ol style="list-style-type: none"> Epilepsy Parkinson's disease Alzheimer's disease Prions associated diseases Duchene's muscular Dystrophy Memory 	<ul style="list-style-type: none"> https://www.ninds.nih.gov/ https://www.webmd.com/vaccines/covid-19-vaccine/news/20211026/uk-study-links-covid-vaccines-to-neurological-disorders https://journals.sagepub.com/home/tan https://journals.sagepub.com/home/tan
IV	<ol style="list-style-type: none"> Sleep disorders Epilepsy Parkinson's disease Stress related neural disorders 	<ul style="list-style-type: none"> https://www.nhlbi.nih.gov/science/sleep-science-and-sleep-disorders https://jamanetwork.com/journals/jamaneurology/fullarticle/2762514 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5573220/

REFERENCES

REFERENCES BOOKS FOR SEMESTER VI

PAPER I – GENETICS

UNIT I AND II – US – TLSC - 601

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

References books for Unit III and IV Immunology

1. Immunology 5thedn. R.A.Goldsky, T. J. Kindt, B. A. Osborne, J. Kuby 2003.
2. Immunology: The immune system in health and disease 6thedn. C. A. Janeway, P. Travers, M. Walport, M. Shlomchik Garland Science Pub. 2005.
3. Cellular and Molecular Immunology, 2ndedn. A. K. Abbas, A. H. Litchman, 5thedn 2000.
4. Basic Immunology: Functions and disorders of the immune system, 2ndedn. A. K. Abbas, A. H. Litchman, 2ndedn 2004.
5. Roitt's Essential Immunology 11thedn. Blackwell publication 2006.
7. Immunology 7th International edn. D. Mole, J. Bronstoff, D. Roth, I. Roitt, Mosbey Elsevier publication, 2006.
8. An Introduction to Immunology C. V. Rao Narossa Publishers 2002

Developmental Biology Reference books for PAPER II UNIT I and II – US – TLSC - 602

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.
7. 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.
8. Plant Cell and Tissue Culture I. Vasil and T.A. Thorpe. Kluwer Academic Publishers.
9. Practical Zoology 2nd Edition. K.C. Ghone and B. Manna. New Central Book Agency Publishers.
10. Developmental Biology 4th edition. S.F. Gilbert. Sinauer Associates Inc. Publishers.
11. Pollen Analysis 2nd edition. P.D.Moore, J.A.Webb and M.E. Collinson Blackwell Scientific Publishers.
12. Pollen Biology – A laboratory manual (1992) K.R. Shivanna and N.S. Rangaswamy, Narosa Publishing, Calcutta.
13. Developmental Biology 2nd edition, L.W.Browder, Saunders College Publishing Co.

14. An Introduction to Embryology 5th Ed B. I. Ballinsky^{**} Saunders, College Publishing Co.
15. Developmental Biology – Patterns, Problems and Principles. J. W. Saunders. J. R. MacMillan Publishing Co.,
16. 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).

Reference books for PAPER II UNIT III and IV Neurobiology

1. Neuroscience: Exploring the brain M.F.Baer, B.W.Connors&M.A.Paradiso, William & Wilkins, Baltimore, Latest Edition (First Edition1996)
2. Neurobiology 3rd edition G.M. Shepherd Oxford University Press.
3. Principles Of Neural Science. E.R.Kandel, J.H.Schwartz and T.M. Jessel. Prentice Hall International.
4. Instant Notes – Neurosciences, A.Longstaff Viva Books Pvt Ltd., New Delhi, 2002
5. Text Book Of Medical Physiology A.C.Guyton and J.E.Hall Saunders College Publishers.
6. Elements Of Molecular Neurobiology C.U.M. Smith J Wiley and Sons Publishers, N.Y.
7. An Introduction to Molecular Neurobiology Z.W. Hall Sinauer Associates Inc. Publishers.
8. Ion Channels – Molecules in Action D. J. Aidley and P.R. Stanfield. Cambridge University Press.
9. Comparative Neurobiology J. P. Mill Edward Arnold Publishers.
10. Physiology Of the Nervous Systems D Ottoson, McMillan Press 25

Practical Syllabus Semester VI Course code: US – TLSC – P601**[Practical Based on USLSC601, Credits-1.5, Lectures- 60]**

Note: C, R, T, I □ Concept, Relevance, Technique, Instrumentation

<p>A. Instrumentation / Technique (I /T)</p> <p>B. Process / Concept and immediate Relevance (C, R)</p> <p>a. Extraction, Purification techniques</p> <p>b. Analysis / Estimation</p> <p>c. GLP (Good Laboratory practices) incorporated into every practical</p> <p>C. Practical aspect of the paper will also be supported by Research papers to understand the application of the learned techniques and advantages in the field.</p> <p>D. Evaluation and internal assessment can be made by ATP (Alternative to Practical) questions.</p>	
Genetics:	
I) Performance Experiments:	
1. Giant Chromosome preparation (Drosophila / Chironomus larva) (C, R, T)	(1)
2. Isolation of antibiotic resistant / auxotrophic mutants using Replica plate technique. (C, R, T, I)	(1)
3. Estimation of Bacteriophage titre by Plaque assay. (C, R, T)	(1)
4. Primer Designing/ Primer T _m calculation using suitable Online software	(1)
II) Demonstration experiments:	
5. Extraction of plasmid DNA, Restriction enzyme digestion and visualization by Agarose Gel Electrophoresis. (C, R, T, I)	(1)
6. Southern Blotting technique	(1)
Immunology: Experiments to be performed by students:	
7. Ouchterlony test for Immunodiffusion – (Qualitative). (C, R, T,I)	(1)
8. Mancini test – Single Radial Immunodiffusion (Qualitative). (C, R, T,I)	(1)
9. AGE using Serum sample. (C, R, T,I)	(1)
Demonstration experiments:	
10. Separation of Mononuclear cells using a gradient and the determination of viable count of the same.	(1)
11. SDS- PAGE for separation of Ig G subfraction. (C, R, T,I)	(1)
12. Qualitative and Quantitative ELISA. (C, R, T,I)	(2)

Practical Syllabus Semester VI Course code: US – TLSC – P602
[Practical Based on US – TLSC - 602, Credits-1.5, Lectures- 60]

<p>Animal Developmental Biology</p> <p>1. Live observations of Developmental stages of. <i>C.elegans/ Dictyoteliium/ Drosophila/ zebrafish</i> (2)</p> <p>2. Observation of live developmental stages</p> <p>Experiments: C, T (Any two of the following):</p> <p>3. Imaginal discs of Drosophila (1)</p> <p>4. Regeneration in earthworm / any other suitable system /Hydra (using permanent slide / photographs) (1)</p> <p>5. Animal Cell Culture /Assays: Cell proliferation assay/ Cell migration assay/ Cell adhesion assay (Demonstration) - (3)</p> <p>a. Industry Training</p> <p>b. Project Based Learning:</p> <p>c. Drosophila development: (Understanding culturing and maintenance and basic experimentation) (4)</p> <p>d. Effect of Temperature/ Media on developmental</p> <p>e. Understanding Hydra culturing, maintenance and basic experiments on regeneration.</p> <p>Plant Developmental Biology</p> <p>6. Effect of boron / and calcium on pollen tube germination in Vinca rose or any other suitable sample I, C.T,R (2)</p> <p>7. Role of GA and other hormones in seed germination. C,T</p> <p>Project Based learning:</p> <p>8. Plant Tissue Culture: Initiation of plant tissue culture from suitable explant/ any other suitable source: (project to be performed in groups of 4-5 students) C, T,R</p>	
<p>Neurobiology</p> <p>1. Temporary mounts of the following: C, T, R (2)</p> <p>a. Cornea of prawn</p> <p>b. Statocyst of prawn</p> <p>c. Striated / smooth muscle fiber.</p> <p>d. Methylene blue staining of earthworm nerve cord or any other suitable nerve cord or brain to observe organization of neuronal cell bodies in invertebrates</p> <p>e. Olfactory/ gustatory sensillae behavior using suitable model organism</p> <p>2. Understanding the evolutionary aspect of vertebrate brain via Making clay model/Or any other suitable material of vertebrate brain and cranial nerves (Compulsory). C,T,R (1)</p> <p>3. Histological staining of neuronal tissue using Hematoxylin-Eosin staining or Nessel's staining. (2)</p> <p>4. Demonstration Experiments - C, T, R</p> <p>a. Stroop test. (1)</p> <p>b. Olfactory /Gustatory Behavioral study: Snail / Earthworm / insect larvae (3)</p> <p>c. Associative conditioning</p> <p>d. Knee-jerk and pupillary reflex.</p> <p>5. Testing for locating the Blind Spot in the retina</p> <p>6. Study of neurobiology of Vision: Illusion based study/ Hearing ability detection using a suitable app or software (1)</p> <p>7. Assignment-Bird song and neurophysiology involved (group practical assignment using suitable software - comparison in urban and in national parks, remote/rural of specific species (1)</p>	