Central University of South Bihar
Department of Life Science

Minutes of Life Science Board of Studies

The Board of Studies (BoS) meeting of the Department of Life Science was held in hybrid mode on 4th March 2025 (Tuesday) at 10:00 AM in the conference room of the Administration Building, Central University of South Bihar – Gaya, to review and approve course structure and syllabi of Integrated UG-PG in Life Science with specialization in Zoology/Botany and its fee structure.

The following BoS members attended the meeting:

1	**Prof. Ram Pratap Singh** Professor & Head, Dept. of Life Science Central University of South Bihar, Gaya	Chairperson
2	**Prof. A.K. Singh** Professor, Dept. of Zoology Banaras Hindu University, Varanasi	External Member online
3	**Prof. Shalie Malik** Professor, Dept. of Zoology Lucknow University, Lucknow	External Member online
4	**Prof. Venktesh Singh** Professor, Dept. of Physics Central University of South Bihar, Gaya	Cognate Member
5	**Prof. Rakesh Kumar** Professor, Dept. of Biotechnology Central University of South Bihar, Gaya	Cognate Member
6	**Dr. Gautam Kumar** Assistant Professor, Dept. of Life Science, Central Univesity of South Bihar, Gaya	Member
7	**Dr. Amrita Srivastava** Assistant Professor, Dept. of Life Science, Central Univesity of South Bihar, Gaya	Member
8	**Dr. Tara Kashav** Assistant Professor, Dept. of Life Science, Central Univesity of South Bihar, Gaya	Member
9	**Dr. Manoj Panchal** Assistant Professor, Dept. of Life Science, Central Univesity of South Bihar, Gaya	Member

In addition, Dr. Naveen Kumar Singh and Dr. Sanjay Kumar from Dept. of Life Science also attended the BoS meeting as special invitees.

Dr. Ram Pratap Singh, Chairman welcomed all members, and briefed about the need of new Integrated UG-PG programme in Life Science with specialization in Zoology/Botany as per the Ordinance Governing Five- Year Programme: Science, Arts and Commerce – 2024. Following agendas were discussed:

Agenda 1:- Integrated UG-PG course structure & syllabus

Recommendation: -

1) The Integrated UG-PG course structure and syllabi were placed before the BoS members for their suggestions.
2) Members of BoS thoroughly reviewed the proposed syllabi provided inputs wherever needed and approved the proposed overall course structure and syllabi of the UG-PG programme in Life Science with specialization in Zoology/Botany in the present form (Annexure – I)
3) The feedback received from different stack holders were discussed and considered by BoS.
4) Members empowered the department committee to adopt/modify the course coding and pattern of question paper based on the UG-PG ordinance.
5) Any further change in the BoS related documents shall be communicated through email to the experts for approval, if required.

Agenda 2:- Fee for Integrated UG-PG in Life Science with specialization in Zoology/Botany

Recommendation: The fee as provided in the Annexure – 2 is recommended.

The meeting ended with vote of the thanks to external, cognate and other members for all the efforts to improve/update the syllabus.

Prof. Ram Pratap Singh (Chairperson)	**Prof. A. K. Singh** (External Member)	**Prof. Shalie Malik** (External Member)
Prof. Venktesh Singh (Cognate Member)	**Prof. Rakesh Kumar** (Cognate Member)	**Dr. Gautam Kumar** (Member)
Dr. Amrita Srivastava (Member)	**Dr. Tara Kashav** (Member)	**Dr. Manoj Panchal** (Member)

CENTRAL UNIVERSITY OF SOUTH BIHAR

Course Structure and Syllabus
for
Five Year Integrated UG-PG Programme in Life Science
(with specialization in Zoology/Botany)
(Effective from Academic Session 2025-2026)

Department of Life Science
School of Earth, Biological and Environmental Sciences

About the program: The Department of Life Science offers Five Year Integrated UG-PG Programme in Life Science with specialization in Zoology/Botany with having an option of lateral entry and exit at various levels. The curriculum broadly includes theory, practical, skill based, vocational and IKS courses. In addition, the curriculum also provides an opportunity to conduct research twice during the entire program that can be done within the department or from any other University/Institute of national repute. The programme is of 200 credits including theory, practical and project work credits. The program offers multiple entry and exit options after 2nd, 4th, 6th, and 10th semester. Students have options to choose Zoology/Botany specific elective courses at semesters 2nd, 3rd, 6th, 8th, 9th and 10th to earn specialization in Zoology/Botany.

The aim of integrated BSc-MSc program is to create a highly skilled human resource in the field of Life Science with specialization in Zoology/Botany having sound fundamental knowledge base along with hands on laboratory skills to deal with local/ National and International needs, and provide solutions for a variety of ongoing and emerging issues using scientific interventions. The program contains basic physics, chemistry, mathematics and statistics courses along with subject specific skill enhancement, value added and ability enhancement courses up to third semester. Courses related to different life forms and their biology along with evolution are the main subjects of this program. Students will carry out mini project of 12 credit in the 8th semester. In the 10th semester students will carry out project work in the areas of botany or zoology as per their specialization. The UG and/or PG degree in Life Science with specialization in Zoology/Botany shall be equivalent to UG and/or PG degree in Zoology/Botany.

1. Qualification descriptors for the graduates:

Knowledge and Understanding

- To provide in-depth knowledge and understanding of different life forms and their diversity.
- To provide in-depth knowledge and understanding of origin and evolution, structural and functional aspects of ecosystem on the whole.
- To strengthen theoretical basis of biological processes at molecular, cellular and organismal level.
- To provide in-depth knowledge and understanding of animal and plant taxonomy.

Skill and Technique

- To offer hands on experience relevant in the field of life science for employment opportunities and societal benefit.
- To train graduates in pathology, molecular biology and biotechnology related techniques.
- To train graduates in taxonomy, animal husbandry, economic botany and zoology related skills.
- To make graduates capable to conduct independent research, analyze data, and draw meaningful conclusions.

Competence

- Graduates shall be competent to critically think and provide solutions for societal problems using biological science.
- Graduates will be able to communicate effectively and maintain professional standards and ethical principles.

- Graduates will be competent to contribute to academia, industry and the society.

2. **Graduates Attributes**
   - Graduates having comprehensive knowledge and understanding of life sciences.
   - Graduates having hand on experience in the related areas and skill for academia, industry and self-employment.
   - Graduates having skills to develop Bharat as VIKSIT @ 2047 through scientific and technological interventions.
3. **Programme Outcome (POs):**
   - PO1: Graduates shall gain in-depth knowledge and understanding of origin, evolution and diversity of different life forms.
   - PO2: Graduates shall gain understanding of ecology and structural & functional aspects of ecosystem on the whole.
   - PO3: Graduates shall strengthen theoretical basis of biological processes at molecular, cellular and organismal level.
   - PO4: Graduates shall develop research skills for taking up challenges in solving local, regional, national and global problems through technological interventions.
   - PO5: Graduates shall gain communication skills for better science communication required to disseminate life sciences knowledge.
   - PO6: Graduates shall gain knowledge and confidence to participate as a member of a multidisciplinary team with ethical values and social responsibility.

3. Minimum Eligibility for admission: Eligibility criteria for the M.Sc. integrated course is given below:-

I. The student should have passed class 12 from a recognized board

II. Biology must be one of the subjects studied by the student in class 12.

III. Candidates must appear in CUET in the following subject/domain combination:

a) Graduate aptitude test, and

b) Domain specific: Physics + Chemistry + Biology/Biological Sciences

IV. Only those students having CGPA more than 7.5 throughout the previous semesters may undertake Research Project of 12 credits.

4. Different levels of Multiple Entry and Exit System and its credit requirements.

Admission through a multiple-level entry

Sl. No.	Entry Points	Basic Eligibility	Mode of Entrance
1	Semester 1	Std. 12 Certificate (Biology/ Biological Sciences)	Common University Entrance Test
2	Semester 3	40 Credits with a UG Certificate (Life Science with specialization in Zoology/Botany/Biology/Biological	Counselling-cum-interaction comprising 100 marks

		Sciences) and 4 credits of skill enhancement Course	
3	Semester 5	80 Credits with a UG Diploma (Life Science with specialization in Zoology/Botany/Biology/Biological Sciences) and 4 credits of skill enhancement Course	Counselling-cum-interaction comprising 100 marks
4	Semester 7	120 Credits with a Degree of Bachelor in Science (Life Science with specialization in Zoology/Botany/ Biology/Biological Sciences) and 4 credits of skill enhancement Course	Counselling-cum-interaction comprising 100 marks
5	Semester 9	160 Credits with a Degree of Bachelor (Honours/Research in (Life Science with specialization in Zoology/Botany/ Biology/ Biological Sciences) and 4 credits of skill enhancement Course	Counselling-cum-interaction comprising 100 marks

Award of Certificate/ Diploma/ Degree along with multiple Exit Options

Sl. No.	Exit Points	Qualification Title	NHEQF Level
1	After completion of Semesters 1 & 2	UG Certificate in Life Science (specialization in Zoology/Botany)	Level 4.5
2	After completion of Semesters 1,2,3 & 4	UG Diploma in Life Science (specialization in Zoology/Botany)	Level 5
3	After completion of Semester 1,2,3,4,5 & 6	Bachelor of Science in Life Science (specialization in Zoology/Botany)	Level 5.5
4	After completion of Semesters 1,2,3,4,5,6,7 & 8	Bachelor of Science (Honours/Research) in Life Science (specialization in Zoology/Botany)	Level 6
5	After completion of Semesters 1,2,3,4,5,6,7,8,9 & 10	Master of Science (Integrated) in Life Science (specialization in Zoology/Botany)	Level 6.5

Course Structure and Syllabus of Five Years Integrated UG- PG in Life Science with specialization in Zoology/Botany
(BSc-MSc in Life Science with specialization in Zoology/Botany)
Total Credits: 200 Cr.

UG Certificate in Life Science with specialization in Zoology/Botany				
Course Type	**Course Code**	**Name of the Course**	**Credits**	**(L+T+P)**
Semester I				
Major - Departmental Core	LSC5MJ00104	Diversity of Life Forms I	4	3+0+1
Minor - other departments				
Skill Enhancement Course	LSC5SE00203	Mushroom Farming	3	1+1+1
Minor - Interdisciplinary Courses		Minor from other department within discipline (Biotechnology/Bioinformatics/Environmental Science/Agriculture)	4	
Minor - Multidisciplinary Courses		Minor from other department from different discipline (Chemistry/Physics/Math/Statistics/Others)	3	
Ability Enhancement Course (AE)		English, Hindi (Ability Enhancement Course)	2	
Value added Course (VA) - I		Yoga, Sports, EVS, SWAYAM (choose two Value added Courses)	2	
Value added Course (VA) - II		Yoga, Sports, EVS, SWAYAM (choose two Value added Courses)	2	
Total Credits			**20**	
Semester II				
Major - Departmental Core	LSC5MJ00304	Diversity of Life Forms II	4	3+0+1
Minor - other departments				
Skill Enhancement	LSCZ5SE00403	Applied Zoology	3	1+ 1+ 1

- (Zoology)				
Skill Enhancement - (Botany)	LSCB5SE00503	Nursery and Gardening	3	1+1+1
Minor - Interdisciplinary Courses		Minor from other department within discipline (Biotechnology/Bioinformatics/Environmental Science/Agriculture)	4	
Minor - Multidisciplinary Courses		Minor from other department from different discipline (Chemistry/Physics/Math/Statistics/Others)	3	
Ability Enhancement Course (AE)		English, Hindi (Ability Enhancement Course)	2	
Value added Course (VA) - I		Yoga, Sports, EVS, SWAYAM (choose two Value added Courses)	2	
Value added Course (VA) - I		Yoga, Sports, EVS, SWAYAM (choose two Value added Courses)	2	
Total Credits			**20**	
Eligible for Certificate in Life Science with specialization in Zoology/Botany, only if completes the summer internship/field work				
Summer Internship/field work			4	

UG Diploma in Life Science with Specialization in Zoology/Botany				
Course Type	**Course Code**	**Name of the Course**	**Credit**	**(L+T+P)**
Semester III				
Major - Departmental Core	LSC6MJ00604	Evolutionary Biology	4	3+0+1
Minor - other departments				
Major - Departmental Elective (Zoology)	LSCZ6MJ00704	Animal Taxonomy	4	3+0+1
Major - Departmental Elective (Botany)	LSCB6MJ 00804	Plant Taxonomy	4	3+0+1

Skill Enhancement Course	LSC6SE00903	Medical Diagnostics	3	1+1+1
Minor - Interdisciplinary Courses		Minor from other department within discipline (Biotechnology/Bioinformatics/Environmental Science/Agriculture)	4	
Minor - Multidisciplinary Courses		Minor from other department from different discipline (Chemistry/Physics/Math/Statistics/Others)	3	
Ability Enhancement Course (AE)		English, Hindi (Ability Enhancement Course)	2	
Total Credits			**20**	
Semester IV				
Major - Departmental Core	LSC6MJ01004	Cell Biology	4	3+0+1
Major - Departmental Core	LSC6MJ01104	Molecules of Life - I	4	3+0+1
Major - Departmental Core	LSC6MJ01204	Genetics	4	3+0+1
Major - Departmental Core	LSC6MJ01302	Principles of Pathology	2	2+0+0
Minor - Interdisciplinary Courses		Minor from other department within discipline (Biotechnology/Bioinformatics/Environmental Science/Agriculture)	4	
Ability Enhancement Course (AE)		English, Hindi (Ability Enhancement Course)	2	
Total Credits			**20**	
Eligible for Diploma in Life Science with specialization in Zoology/Botany only if completes the summer internship/field work				
Summer Internship/field work			4	

B.Sc Degree in Life Science with Specialization in Zoology/Botany				
Course Type	**Course Code**	**Name of the Course**	**Credit**	**(L+T+P)**
Semester V				

VII

Major - Departmental Core	LSC7MJ01402	Basics of Molecular Biology	2	2+0+0
Major - Departmental Core	LSC7MJ01504	Metabolism and Integration	4	3+0+1
Major - Departmental Core	LSC7MJ01604	Microbiology	4	3+0+1
Major - Departmental Core	LSC7MJ01704	Molecules of Life - II	4	3+0+1
Skill Enhancement Course	LSC7MJ01802	Internship (within department)	2	0+0+2
Minor - Interdisciplinary Courses		Minor from other department within discipline (Biotechnology/Bioinformatics/Environmental Science/Agriculture)	4	
Total Credits			**20**	
Semester VI				
Major - Departmental Core	LSC7MJ01904	System Physiology	4	3+0+1
Major - Departmental Core	LSC7MJ02004	Fundamentals of Ecology	4	3+0+1
Major - Departmental Core	LSC7MJ02104	Research Methodology	4	3+0+1
Major - Departmental Elective (Zoology)	LSCZ7MJ02104	Comparative Anatomy and Developmental Biology of Animals	4	3+0+1
Major - Departmental Elective (Botany)	LSCB7MJ02104	Comparative Anatomy and Developmental Biology of Plants	4	3+0+1
Minor - Interdisciplinary Courses		Minor from other department within discipline (Biotechnology/Bioinformatics/Environmental Science/Agriculture)	4	
Total Credits			**20**	
Eligible for UG Degree in Life Science with specialization in Zoology/Botany (equivalent to Zoology/Boatny) on securing 120 Credits				

UG Degree (Honours) in Life Science with specialization in Zoology/Botany

Course Type	Course Code	Name of the Course	Credit	(L+T+P)
Semester VII				
Major - Departmental Core	LSC8MJ02204	Enzymology	4	3+0+1
Major - Departmental Core	LSC8MJ02304	Advanced Molecular Biology	4	3+0+1
Major - Departmental Core	LSC8MJ02404	Recombinant DNA Technology	4	3+0+1
Major - Departmental Core	LSC8MJ02504	Instrumentation and applications	4	3+0+1
Minor - Interdisciplinary Courses		Minor from other department within discipline (Biotechnology/Bioinformatics/Environmental Science/Agriculture)	4	
Total Credits			**20**	
Semester VIII				
Major - Departmental Core	LSC8MJ 02604	Defense Mechanism	4	3+0+1
Major - Departmental Core	LSC8MJ 02704	Indian Knowledge System in Traditional Medicine	4	3+0+1
Major - Departmental Elective (Zoology)	LSCZ8MJ 02804	Vocational Training in Animal Research	4	0+1+3
Major - Departmental Elective (Zoology)	LSCZ8MJ 02904	Insects, Vectors and Animal Diseases	4	3+0+1
Major - Departmental Elective (Botany)	LSCB8MJ 03004	Plant Pathology	4	3+0+1
Major - Departmental Elective (Botany)	LSCB8MJ 03104	Vocational Training in Plant Research	4	0+1+3
Minor - Interdisciplinary Courses		Minor from other department within discipline (Biotechnology/Bioinformatics/Environmental Science/Agriculture)	4	
Total Credits			**20**	
Eligible for UG Degree Honours in Life Science with specialization in Zoology/Botany (equivalent to Zoology/Beatny) on securing 160 Credits				

UG Degree Honours with Research in Life Science with specialization in Zoology/Botany				
Course Type	**Course Code**	**Name of the Course**	**Credit**	**(L+T+P)**
Semester VII				
Major - Departmental Core	LSC8MJ02204	Enzymology	4	3+0+1
Major - Departmental Core	LSC8MJ02304	Advanced Molecular Biology	4	3+0+1
Major - Departmental Core	LSC8MJ02404	Recombinant DNA Technology	4	3+0+1
Major - Departmental Core	LSC8MJ02504	Instrumentation and applications	4	3+0+1
Minor - Interdisciplinary Courses		Minor from other department within discipline (Biotechnology/Bioinformatics/Environmental Science/Agriculture)	4	
	Total Credits		**20**	
Semester VIII				
Major - Departmental Core	LSC8MJ02604	Defense Mechanism	4	3+0+1
Major - Departmental Elective (Zoology)	LSCZ8MJ032012	Research Project	12	0+0+12
Major - Departmental Elective (Botany)	LSCB8MJ032012			
Minor - Interdisciplinary Courses		Minor from other department within discipline (Biotechnology/Bioinformatics/Environmental Science/Agriculture)	4	
Total Credits			**20**	
Eligible for UG Degree Honours with Research in Life Science with specialization in Zoology/Botany (equivalent to Zoology/Boatny) on securing 160 Credits				

Integrated PG Degree in Life Science with Specialization in Zoology/Botany				
Course Type	**Course Code**	**Name of the Course**	**Credit**	**(L+T+P)**
Semester IX				
Major - Departmental Core	LSC9MJ03304	Biosafety and IPR	4	3+1+0
Major - Departmental Elective (Zoology)	LSC9MJ 03304	Animal Physiology & Endocrinology	4	3+0+1
Major - Departmental Elective (Zoology)	LSCZ9MJ 03404	Animal Biotechnology	4	3+0+1
Major - Departmental Elective (Zoology)	LSCZ9MJ 03504	Animal Behavior	4	3+0+1
Major - Departmental Elective (Zoology)	LSCZ9MJ 03604	Techniques in Animal Research	4	3+0+1
Major - Departmental Elective (Botany)	LSCB9MJ 03604	Plant Physiology	4	3+0+1
Major - Departmental Elective (Botany)	LSCB9MJ 03804	Plant Biotechnology	4	3+0+1
Major - Departmental Elective (Botany)	LSCB9MJ 03904	Plant Breeding and Genetic Engineering	4	3+0+1
Major - Departmental Elective (Botany)	LSCB9MJ 04004	Economic Botany	4	2+1+1
Total Credits			**20**	
Semester X				
Major - Departmental Core	LSC9MJ04104	Wildlife Conservation	4	3+0+1
Major - Departmental Core	LSC9MJ04204	Nanobiotechnology	4	3+0+1
Major - Departmental Core	LSC9MJ04304	Protein Structural Biology	4	3+0+1

Major - Departmental Core	LSC9MJ04404	Cellular Stress Biology	4	3+1+0
Major - Departmental Core	LSC9MJ04504	Natural Resource Management	4	3+0+1
Total Credits			**20**	
Eligible for PG Degree in Life Science with specialization in Zoology/Botany (equivalent to Zoology/Boatny) on securing 200 Credits				

Integrated MSc Degree with Research in Life Science with specialized in Zoology/Botany (equivalent to Zoology/Boatny)				
Course Type	**Course Code**	**Name of the Course**	**Credit**	**(L+T+P)**
Option – 1 (Earn 20 Credit from courses and 20 Credit from project work, provided student has CGPA >7.5				
Semester IX				
Major - Departmental Core	LSC9MJ03304	Biosafety and IPR	4	3+1+0
Major - Departmental Elective (Zoology)	LSC9MJ 03304	Animal Physiology & Endocrinology	4	3+0+1
Major - Departmental Elective (Zoology)	LSCZ9MJ 03404	Animal Biotechnology	4	3+0+1
Major - Departmental Elective (Zoology)	LSCZ9MJ 03504	Animal Behavior	4	3+0+1
Major - Departmental Elective (Zoology)	LSCZ9MJ 03604	Techniques in Animal Research	4	3+0+1
Major - Departmental Elective (Botany)	LSCB9MJ03604	Plant Physiology	4	3+0+1
Major - Departmental Elective (Botany)	LSCB9MJ03804	Plant Biotechnology	4	3+0+1
Major - Departmental Elective (Botany)	LSCB9MJ03904	Plant Breeding and Genetic Engineering	4	3+0+1
Major - Departmental	LSCB9MJ04004	Economic Botany	4	2+0+2

Elective (Botany)				
Total Credits			**20**	
Semester X				
Major - Departmental Elective (Zoology)	LSCZ9MJ04620	Research Project	20	0+0+20
Major - Departmental Elective (Zoology)	LSCB9MJ04620			
Total Credits			**20**	
Option – II (Earn all 40 Credit from project work, provided student has CGPA >7.5				
Semester IX				
Major - Departmental Elective (Zoology)	LSCZ9MJ04720	Research Project - I	20	0+0+20
Major - Departmental Elective (Botany)	LSCB9MJ04720			
Semester X				
Major - Departmental Elective (Zoology)	LSCZ9MJ04820	Research Project - II	20	0+0+20
Major - Departmental Elective (Botany)	LSCB9MJ04820			
Eligible for PG Degree with research in Life Science with specialization in Zoology/Botany (equivalent to Zoology/Botany) on securing 200 Credits				

Note:

1. *Minor and multidisciplinary course will be suggested by Department of Life Science*
2. *Specialization shall be awarded based on the zoology/Botany specific electives and project work.*
3. *Zoology/Botany specific Department Based Core Elective are the courses for specialization specific students.*
4. *Department will notify students in the beginning of the semester about offered Internship/Field work based courses by the faculty members.*
5. *Research Project work (9th & 10th Semester) can be carried within the Life Science Department or outside the department in any Central University/Research Institution within India.*
   i. *The number of students allotted to one faculty member shall be decided based*

on the formula (No of students allotted to one faculty = total number of specialization students/total no of specialization specific faculty members

ii. *Dissertation within the department: Allotment of supervisor/mentor will be done based on students' choice in the given area of specialization.*

iii. *In case of difficulty in allotment, CGPA/SGPA shall be used to allot supervisor/mentor.*

iv. *Dissertation outside the department: The student will have to identify the University/Research Institution for dissertation work outside the department and apply for the same through HoD. CUSB will not provide any financial support for dissertation work conducted outside the department.*

v. *No internal supervisor shall be allotted to student opted to conduct dissertation work outside the department.*

vi. *In case of any unforeseen issue with student conducting dissertation research outside the department, DC shall resolve the issue keeping student's interest on priority.*

6. *DC authorized to revise course codes, if required.*
7. *Equivalence in any other biological science subject except Zoology/Botany shall not be awarded.*

Semester I

Course Title: Diversity of Life Forms I			
Course Code	LSC5MJ00104	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	I	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course (DBCC)		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Foundational course which is to be compulsorily studied by a student as a core requirement of integrated UG – PG program in Life Science.		
Methods of Content Interaction	Lecture, group discussion, field projects, laboratory-work and assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective: This course equips students with the skills needed to recognize and classify taxonomically distinct lineages of living organisms. Students will learn to identify and understand the relationships between the structure and function of various species. The course also delves into the evolutionary history of plants and animals, enabling students to trace their development and understand the mechanisms that have shaped biodiversity over time. By the end of the course, students will be able to analyze the evolutionary connections between organisms, providing a comprehensive understanding of the diversity of life.

Course Learning Outcomes:

- Ability to understand different life forms.
- Ability to identify bacteria, viruses, algae, fungi, and invertebrates

Course Content

Unit I:	No. of classes
• General Introduction: Introduction to living organisms: plant, animal, microbes • **Viruses**: Discovery, general structure, DNA viruses, RNA viruses, replication (general account), lytic and lysogenic cycle, retroviruses • **Bacteria**: Discovery, General characteristics and cell structure; Gram-positive and Gram-negative bacteria • **Archaea**: Discovery, General characteristics and cell structure, extremophiles • **Algae**: General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles, Economic importance of algae	22

• **Fungi**: Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle; Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance	
Unit 2: • **Protista and Cnidaria**: General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa; Porifera: General characters and classification up to classes; Canal System in *Sycon*. General characters and classification up to classes; Polymorphism in Hydrozoa • **Platyhelminthes**: General characters and classification up to classes; Life history of *Taenia solium* • **Nemathelminthes**: General characters and classification up to classes; Parasitic adaptations • **Annelida**: General characters and classification up to classes; Metamerism in Annelida • **Arthropoda**: General characters and classification up to classes; Metamorphosis in Insects • **Mollusca**: General characters and classification up to classes; Torsion in gastropods • **Echinodermata**: General characters and classification up to classes; Water-vascular system in Asteroidea • **Hemichordata:** General characteristic features	23
List of Practical (Tentative): 1. Demonstration using permanent slides of members of cyanobacteria, protists, green algae from natural surroundings. 2. Demonstration using slides of different classes of fungi. 3. Collection and observation of mushroom. 4. Specimen demonstration of algae. 5. Specimen/photograph-based demonstration of type specimens of porifera, Platyhelminthes, annelida, arthopoda, mollusca and echinodermata.	30 hrs
Suggested Readings*: • Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco. • Raven, P.H et al (2006) Biology 7th edition Tata McGrawHill Publications, New Delhi • Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition. • Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 12. 2nd edition.	

- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
- Kingsley J. Text Book of Vertebrate Zoology Publisher: Nabu Press ISBN: 9781171586524, 1171586523
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science • Young, J. Z. (2004).

Course Title: Mushroom Farming			
Course Code	LSC5SE00203	**Credits**	3
L + T + P	1+1+1	**Course Duration**	One Semester
Semester	I	**Contact Hours**	15 (L) + 15 (T) + 30 (P) Hours
Course Type	Skill Enhancement Course (SEC)		
Nature of the Course	Theory and Hands-on training for skill development		
Special Nature/ Category of the Course (*if applicable*)	Skill Based course that can be followed up by advanced training for entrepreneurship. It is model for circular bioeconomy and can be aligned with Zero hunger (SDG 2), Responsible consumption and production (SDG 12), Climate action (SDG 13), Sustainable cities and communities (SDG 11), Life on Earth (SDG 15). Govt of India is offering financial assistance funding to farmers/entrepreneurs through National Horticulture Board (NHB) and Mission for Integrated Development of Horticulture (MIDH) for mushroom farming in India.		
Methods of Content Interaction	Lecture, Tutorials, Practical, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field-based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objectives: The course aims to:

1. Introduce the students to mushrooms and help in understand the economic value of mushroom production.
2. Gain knowledge on the selection of mushroom varieties as per the local environment.
3. Know the challenges faced in setting up a mushroom cultivation center and the availability of various govt. funding resources will be discussed.

Course Learning Outcomes:

After completion of the course the students shall have an understanding of:

- The students will be able to understand the basics of mushroom cultivation, the criterion to choose a particular species, and various methods of cultivation.

- They will develop an understanding of setting up a govt. funded or self-funded production center, challenges, and success stories related to same.

Course Contents

Unit 1: Introduction to mushroom farming Overview of mushrooms, classification of mushrooms, mushroom hunting, mushroom statistics, Science and art of mushroom cultivation, Differences in mushroom production and pattern, world mushroom market, Types of mushrooms, economically important and medicinal mushroom, selecting a mushroom species	Number of classes: **9 (5L+4T)**
Unit 2: Methods of cultivation for shitake mushroom, oyster mushroom, button mushroom, and milky mushroom. mushroom diseases, post-harvest handling.	**11 (5L+6T)**
Unit3: Mushroom growing unit/house, Waste disposal of various mushrooms, Setting-up of mushroom cultivation center, Government aided financial support for setting-up of mushroom cultivation center, and discussion on success stories of mushroom production and sustainable development.	**10 (5L+5T)**
List of Practical (Tentative): 1. Identification of edible and poisonous mushroom 2. Bed preparation for mushroom cultivation. 3. Spawn inoculation, storage of culture and maintenance of cultures 4. Harvesting process and Processing of mushroom. 5. Visit to a mushroom farm 6. Value added recipes preparation	30 hrs

Suggested Readings*:

- B.C. Suman, V.P. Sharma. 2007. Mushroom Cultivation in India
- R. Gogoi, Y. Rathaiah, T.R. Borah. 2019. Mushroom Cultivation Technology
- Reviews: Arpita Das, Chiao-Ming Chen, Shu-Chi Mu, Shu-Hui Yang , Yu-Ming Ju , Sing-Chung Li. 2022. Medicinal Components in Edible Mushrooms on Diabetes Mellitus Treatment. Pharmaceutics. Feb 17;14(2):436. doi: 10.3390/pharmaceutics14020436.
- Patel et al, 2021. Mushroom-Derived Bioactive Molecules as Immunotherapeutic Agents: A Review. Molecules. Mar 4;26(5):1359. doi: 10.3390/molecules26051359.

Please refer to latest editions available

Semester II

Course Title: Diversity of Life Form-II			
Course Code	LSC5MJ00304	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	**II**	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course		
Nature of the Course	Theory and practical		
Special Nature/ Category of the Course (*if applicable*)	A foundation course that is to be studied by a student as a requirement to gain knowledge about diversity of different life forms.		
Methods of Content Interaction	Lecture, group discussion, laboratory-work, assignments, field work, seminar, presentations, individual and group drills		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective:

To provide a comprehensive understanding of plant and animal diversity, emphasizing their classification, morphology, anatomy, reproduction, and evolutionary adaptations. Students will also develop essential skills for identification and comparative morphological studies through microscopy and specimen analysis.

Course Learning Outcomes:

Upon completion of this course, students will be able to:

- Explain the classification, characteristics, and adaptations of Bryophytes, Pteridophytes, and Gymnosperms.
- Analyse the morphology and anatomy of key plant genera.
- Describe evolutionary developments like heterospory, seed habit, and stelar evolution.
- Assess the ecological and economic importance of non-flowering plants.
- Understand palaeobotany concepts, including plant fossils and fossilization.
- Understand different classes of chordates, level of organization and evolutionary relationship between different phyla.
- Study about diversity in animals making students understand about their distinguishing features.
- Comprehend the circulatory, nervous and skeletal system of chordates.
- Know about the habit and habitat of chordates in marine, freshwater and terrestrial ecosystems.

Course Content

Unit I: Bryophytes and Pteridophytes	Number of classes
• **Bryophytes**: General characteristics, adaptations to land habit, Classification, Range of thallus organization. morphology, anatomy and	**12**

reproduction of *Marchantia* and *Funaria*. Ecology and economic importance. • **Pteridophytes:** General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Morphology, anatomy and reproduction of *Selaginella, Equisetum* and *Pteris*. Heterospory and seed habit, stelar evolution. Ecological and economical importance.	
Unit II: Gymnosperm and elementary palaeobotany • **Gymnosperm:** General characteristics, classification. Morphology, anatomy and reproduction of Cycas and Pinus. Ecological and economical importance. • **Elementary palaeobotany:** Geological Time Scale, Types of Plant fossils, Process of Fossilization, Important Fossils in India	**11**
Unit III: Protochordate • General characteristic features of Urochordata and Cephalochordata. • Study of larval forms in protochordates, Retrogressive metamorphosis in Urochordata.	**07**
Unit IV: Chordate • General characteristic features of fishes, amphibia, reptiles, aves, and mammals. • Parental care in chordates • Food catching, digestive, respiratory, reproductive, and circulatory system in *Rana tigrina*. • Poisonous and non-poisonous snakes • Flight adaptations and migration of birds. • Classification of mammals (Prototheria, Metatheria, and Eutheria).	**15**
Tentative List of Practical 1. *Marchantia*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides). 2. *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores; showing antheridial and archegonial heads, l.s. capsule and protonema (permanent slides) 3. *Selaginella*- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll, l.s. strobilus (permanent slide) 4. *Equisetum*- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores; t.s rhizome (permanent slide). 5. *Pteris*- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores, t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide). 6. *Cycas*- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores, l.s. ovule, t.s. root (permanent slide). 7. *Pinus*- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarf shoot, t.s. needle, t.s. stem, l.s./t.s. male cone, w.m.	**30**

microsporophyll, w.m. microspores l.s. female cone, t.l.s. & r.l.s. stem (permanent slide). 8. General morphological features of *Hyla* and *Alytes*. 9. Difference between poisonous and non-poisonous snake. 10. Permanent slide of *Herdmania* and *Balanoglossus*. 11. Power point presentation on study of any two animals from two different classes by students.	

Suggested readings*:

1. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
2. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
3. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
4. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
5. Singh, G. (2004) Plant Systematics: Theory and Practice 2nd edition. Oxford & IBH Publishing Co. Delhi.
6. Mauseth, J. D. (2003) Botany, An Introduction to Plant Biology 3rd edition. Jones and Barlett Publishers.
7. Young, J. Z. (2004). The Life of Vertebrates. III Edition, Oxford university press.
8. Parker T.J. and Haswell W.A. (1972). Textbook of Zoology Vertebrates.VII Edition, Volume II
9. Pough H. (2018). Vertebrate life X Edition, Pearson International.
10. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
11. R. L Kotpal (2010) Modern text book of zoology [animal diversity- II] Rastogi publications.

**Refer to latest edition available*

Course Title: Applied Zoology			
Course Code	LSCZ5SE00403	**Credits**	3
L + T + P	1+1+1	**Course Duration**	One Semester
Semester	II	**Contact Hours**	15 (L) + 15 (T) + 30 (P) Hours
Course Type	Skill Enhancement Course (SEC)		
Nature of the Course	Theory and Hands-on Skill Development		
Special Nature/ Category of the Course (*if applicable*)	A skill enhancement course that is to be studied by a student as a requirement to enhance their skills early in the program.		
Methods of Content Interaction	Lecture, group discussion, field projects, laboratory-work and assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective: To equip students with a comprehensive understanding of application of zoological knowledge for economic benefit to the society. Enabling them to analyze and solve real-world problems related to Aquaculture & Pisciculture, Sericulture, Apiculture and Animal husbandry.

Course Learning Outcomes:

- Understand the economic importance of Aquaculture & Pisciculture, Sericulture, Apiculture and Animal husbandry.
- Develop form understanding of Aquaculture & Pisciculture, Sericulture, Apiculture and Animal husbandry.
- Develop practical solutions to challenges in Aquaculture & Pisciculture, Sericulture, Apiculture and animal husbandry.
- Evaluate the ethical implications of applied zoological practices.

Course Content

Unit 1: Aquaculture & Pisciculture • Definition, scope, and significance of Aquaculture, Prawn culture, Pearl culture, Edible Oyster culture. • Basic concept on mono and composite fish culture (Carp culture); Fish diseases caused by *Ichthyophthirius multifilis, Trichodinia* sp. and *Ichthyobodo* sp., symptoms and control; Maintenance of aquarium.	Number of classes: **06 (3L+3T)**
Unit 2: Sericulture • Different species and economic importance of silkworm, Mulberry and Non-mulberry Sericulture (Eri, Muga, Tussar), Sericulture techniques.	**04 (2L+2T)**

Unit 3: Apiculture • Different species of Honeybee, types of beehives - Newton and Langstroth, Bee Keeping equipment, Methods of extraction of honey (Indigenous and Modern) and its processing, Products of apiculture industry (Honey, Bees Wax, Propolis, Royal jelly, Pollen etc.) and their uses	**10 (5L+5T)**
Unit 4: Animal Husbandry – Dairy, Goatry and Poultry • Introduction to animal husbandry, contribution of animal husbandry in Indian GDP, different breeds of cattle and buffalo, preservation and artificial insemination in cattle; Induction of early puberty and synchronization of estrus in cattle. • Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs. • Introduction to goat farming, Management of goats, and Artificial insemination in Goats.	**10 (5L+5T)**
List of Practical (Tentative): 1. Study of aquatic organisms - prawns, oysters and fishes (any three) through photographs/museum specimens in the laboratory with details on their classification, distribution and specialized features. 2. Study of different species of aquarium fishes (Goldfish, Guppy, Swordtail fish) through photographs/museum specimens in the laboratory. 3. Study of *Bombyx mori*, its life cycle and economic importance. 4. Study of the life history of honeybee, *Apis cerana indica* and *Apis mellifera* from specimen/ photographs - egg, larva, pupa, adult (queen, drone, worker) 5. Study of artificial hive (Langstroth/Newton), its various parts and beekeeping equipment. 6. Field study/lab visit to an apiary/honey processing unit/sericulture Institute /aquarium shop/fish farm/pisciculture unit. 7. Visit to poultry farm or animal breeding centre. Submission of visit report	**30**

Suggested Readings*:

- Shukla, G.S. and Upadhyay, V.B. (2002). Economic Zoology, 4e, Rastogi Publications.
- D. B. Tembhare. (2017) Modern Entomology, Himalaya Publishing House (ISO 9001: 2008 Certified).
- Dawes, J. A. (1984). The Freshwater Aquarium, Roberts Royee Ltd. London.
- Richard A. Jones (2010). Collins Beekeeper's Bible, Collins.
- Michael Bush (2011). Practical Beekeeper: Beekeeping Naturally, X-Star Publishing Company.
- Dokuhon, Z.S. (1998). Illustrated Textbook on Sericulture, Oxford & IBH Publishing Co., Pvt. Ltd. Calcutta.
- G. C. Banerjee (2019). A Text Book of Animal Husbandry, Oxford publication
- Hafez, E. S. E. (1962). Reproduction in Farm Animals. Lea & Fabiger Publisher
- Dunham R.A. (2004). Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications, U.K.

Course Title: Nursery and Gardening			
Course Code	LSCB5SE00503	**Credits**	3
L + T + P	1+ 1+ 1	**Course Duration**	One Semester
Semester	II	**Contact Hours**	15 (L) + 15 (T) + 30(P) Hours
Course Type	Skill Enhancement Course (SEC)		
Nature of the Course	Theory and Hands-on training for skill development		
Special Nature/ Category of the Course (*if applicable*)	A skill enhancement course that is to be studied by a student as a requirement to enhance their skills early in the program. The methods of teachings for garden designing program will be a combination of several approaches such as illustrated lecture, group discussion, demonstration, guided practice, practical experiences, fieldwork and other independent learning.		
Methods of Content Interaction	Lecture, Feedback or hand note preparation, group and individual self/laboratory based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objective: The skill enhancement course aims to provide additional learner centric graded skill oriented technical training, with the primary objective of' improving the employability skills of students. The main objectives of the program are:

- ✓ To provide basic knowledge about tools, equipment and growing plot preparation used in nursery for plant production.
- ✓ To impart basic knowledge and develop skills about propagating different types of plants by seed, cuttings, budding and grafting, separation, division, layering as well as micro-propagation in commercially viable ways.
- ✓ To impart knowledge on establishment of commercial plant tissue culture unit.
- ✓ To provide an opportunity to students to develop inter-disciplinary skills.

Course Learning Outcome: On successful completion of this course, the students will be able to perform soil and plant nutrient management activities, make compost, perform nursery planning and management activities, perform plant protection activities, be familiar with various gardens, perform garden development activities, maintain garden and garden plants, propagate the plant, arrange and decorate house plants, prepare and maintain the lawn, market plants, perform communication and professionalism development activities, and perform entrepreneurship development activities

Unit 1:	Number of classes
• **Nursery:** Definition, objectives and scope and building up of infrastructure for nursery, Necessities for nursery, Nursery beds, Growing media, nursery tools and implements, and containers, Sowing methods of seeds and planting material, planning and seasonal activities- planting, direct seedling and transplants	

• **Nursery management** – watering, weeding and nutrients; pests and diseases. Economics of nursery development, pricing and record maintenance, Online nursery information and sales systems. • **Seed:** Structure and types- Seed dormancy, causes and methods or breaking dormancy- Seed storage: Seed banks, factors affecting seed viability, Seed production technology- seed testing and certification.	**10 (5L+5T)**
Unit 2: • **Vegetative Propagation:** air- layering, cutting, selection of cutting, collection, season, treatment of cutting, rooting medium and planning of cuttings, sexual (seed propagation), Scope and limitations. • Hardening of plants- greenhouse- mist chamber, shed root, shade house and glasshouse. • Hydroponics and Airoponics: Crop plant propagation and nursery production	**6 (3L+3T)**
Unit 3: • **Gardening:** Definition, objectives and scope- a different type of gardening — landscape and home gardening- parks and its components- plant materials and designing- computer application in landscaping- Gardening operation: soil, laying, manuring, watering management of pests and diseases and harvesting. Application of manure, fertilizers, nutrients and PGRs; • Weed control; biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding) • Landscaping and garden design: Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.	**8 (4L+4T)**
Unit 4: • **Sowing/raising of seed and seedlings**: Transplanting of seedlings- a study of cultivation of different vegetables and fruits: cabbage, Brinjal, Ladyfinger, Onion, Garlic, Lemon, Papaya, Guava, Coconut etc. Storage and marketing procedure.	**6 (3L+3T)**
List of Practical (Tentative): 1. Demonstration of nursery bed making 2. Planning and layout for commercial nursery. 3. Hands on training on vegetative propagation techniques of grafting, budding, cutting and layering, anatomical studies of rooting cuttings and grafting union. 4. Sample seed testing, use of plant growth regulators in propagation 5. Sterilization of equipment's and laboratory 6. Different type of media preparation, selection and preparation of explants , meristem culture and micro- grafting, 7. Planning and layout of experiments on various aspects of propagation. 8. Visit to tissue culture labs and agriculture/horticulture /forest nursery.	**30 hrs**

Suggested Readings*:

- ✓ **T.K. Bose and D Mukherjee:** Gardening in India, Oxford & IBH Publishing Co. New Delhi.
- ✓ **M.K. Sandhu:** Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
- ✓ **N. Kumar:** introduction to Horticulture, Rajlaxmi Publications, Nagercoil.
- ✓ **Edmond Musser & Andres:** Fundamentals of Horticultures, McGraw Hill Book Co., New Delhi.
- ✓ **P.K. Agrawal:** Handbook of seed technology. Deptt. of Agriculture and Co- operation, National Seed Corporation Ltd., New Delhi.
- ✓ **Janick Jules:** Horticultural Science (3rd Ed.), W.H. Freeman and Co. Sari Francisco.

**Please refer to latest editions available*

Semester III

Course Title: Evolutionary Biology			
Course Code	LSC6MJ00604	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Intermediate level course which is to be compulsorily studied by a student as a core requirement to complete the requirement of integrated UG-PG course in Life Science.		
Methods of Content Interaction	Lecture, group discussion, field projects, laboratory-work and assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective: This course covers key patterns and processes that drive the diversity of life and the adaptation of species over time. Major topics include, but are not limited to, natural selection, genetic drift, gene flow, speciation, and the molecular foundations of evolution. Emphasis will be placed on how organisms adapt to their environments, the emergence of new species, and the role of genetic variation in evolutionary change.

Course Learning Outcomes:

- To have a broad understanding of the concepts and theories in evolutionary biology
- To understand principles of natural and sexual selection, basic population genetics, molecular evolution, phylogenetics, speciation and diversification
- Evaluate the role co-evolution, life history evolution, and evolutionary developmental biology have played in the formulation of evolutionary thought

Course Content

Unit 1: Beginning of Life and Early Evolutionary Concepts ***Origin of Life*** - Chemogeny – An overview of pre-biotic conditions and events; experimental proofs to abiotic origin of micro- and macro-molecules. Current concept of chemogeny – RNA first hypothesis. Biogeny – Cellular evolution based on proto-cell models (coacervates and proteinoid micro-spheres). Origin of photosynthesis – Evolution of oxygen and ozone buildup. Endosymbiotic theory – Evolution of Eukaryotes from Prokaryotes ***Theories of Evolution*** - Pre-Darwinian ideas – List of contributors influencing Darwin indicated as a timeline. Lamarckism – Merits and demerits. Darwinism – Merits and demerits, Post-Darwinian era – Modern synthetic theory; Neo-Darwinism ***Evidences of Evolution*** - Paleobiological – Concept of Stratigraphy and	Number of classes: 7

geological timescale; fossil study (types, formation and dating methods). Anatomical – Vestigial organs; Homologous and Analogous organs	
Unit 2: Evolutionary Genetics Population genetics – Gene pool; gene/allele frequency; genotypic frequency; phenotypic frequency (simple problems for calculation). Conservation of gene frequencies (when selection does not operate) – Hardy-Weinberg's Law of Genetic Equilibrium. Alterations in gene frequency (when selection operates) – Calculation based on Selection Coefficient and Fitness). Fluctuations in gene frequency (when drift operates) – Calculation based on standard deviation, molecular markers	12
Unit 3: Forces of Evolution ***Variations as Raw Materials of Change*** Types of variations; heritable and non-heritable. Gene mutation; chromosomal aberrations; recombination and random assortment (basis of sexual reproduction); gene regulation. Concept of micro- and macro-evolution – A brief comparison Natural selection as a guiding force. Colouration, camouflage and mimicry, brief mention of drug, pesticide, antibiotic and herbicide resistance in various organisms. Modes of selection, Polymorphism, Heterosis and Balanced lethal systems. Genetic Drift (Sewall Wright effect) as a stochastic/random force – Its attributes and action.	14
Unit 4: Speciation & Extinction Concept of species as a real entity, Mechanisms of speciation – Allopatric; sympatric; peripatric, Patterns of speciation – Anagenesis and Cladogenesis; Phyletic Gradualism and Punctuated Equilibrium (Quantum Evolution), Basis of speciation – Isolating mechanisms Periodic extinctions , Mass-scale extinctions – Causes and events	10
Unit 5: Human Evolution as a case Study Primate characteristics and unique Hominin characteristics. Primate phylogeny leading to Hominin line. Human migration – Theories. Brief reference to molecular analysis of human origin – Mitochondrial DNA and Y-chromosome studies	2
List of Practical (Tentative): 1. Study of types of fossils (e.g. trails, casts and moulds and others) and Index fossils of Palaeozoic era 2. Connecting links/transitional forms - Eg. *Euglena, Neopilina, Balanoglossus, Chimaera, Tiktaalik, Archaeopteryx, Ornithorhynchus* 3. Living fossils - Eg. *Limulus, Peripatus, Latimeria, Sphaenodon* 4. Vestigial, Analogous and Homologous organs using photographs, models or specimen 5. Sampling of human height, weight and BMI for continuous variation 6. Calculations of genotypic, phenotypic and allelic frequencies from the data provided	30 hrs

Suggested Readings*:

1. Ridley, M. (2004) Evolution. III Edn. Blackwell
2. Hall, B. K. and Hallgrimson, B. (2008) Strickberger's Evolution. IV Edn. Jones and Barlett
3. Zimmer, C. and Emlen, D. J. (2013) Evolution: Making Sense of Life. Roberts & Co.
4. Futuyma, D. (1998) Evolutionary Biology. III Edn. Sinauer Assoc. Inc.
5. Barton, Briggs, Eisen, Goldstein and Patel. (2007) Evolution. Cold Spring Harbor Laboratory Press

Course Title: Animal Taxonomy			
Course Code	LSCZ6MJ00704	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline based core course		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Intermediate level course that is to be studied by a student as a requirement to gain knowledge about classification of animals.		
Methods of Content Interaction	Lecture, Practical, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field-based assignments followed by workshops.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objectives:

The course aims to –

1. Introduce the students to taxonomic classification of animal kingdom
2. Understand the importance of classification and systematics.
3. Provide a knowledge on taxonomic characters, keys, evolutionary relationships.

Course Learning Outcomes:

After completion of the course the students shall have an understanding of –

- Gain a basic grasp on the rules and philosophy of nomenclature.
- Comprehend the basic concepts of animal taxonomy and zoological nomenclature
- Evaluate the significance of museum specimens
- Analyze the implications of biometrics, numerical taxonomy and cladistics

Course Contents

Unit I	**Number of classes:**
Definition and basic concepts of biosystematics taxonomy and classification. History and theories of biological Classification, Nomenclature, Classification based upon Body symmetry, Body cavities (coelom), and Body opening- Protostomes and Deuterostomes. Systematics and taxonomy. Classification: morphological and evolutionary (molecular). Relationship of taxa:	11

phylogenetics and cladistics, paraphyly, monophyly, apomorphy, plesiomorphy and phenoplasticity.	
Unit II Taxonomic keys, different types of keys, their merits, and demerits, international code of Zoological Nomenclature (ICZN): Operative principles, interpretation, and application of important rules: Formation of Scientific names of various Taxa, Synonyms, homonyms and tautonomy.	11
Unit III Taxonomic Characters and different kinds, Origin of reproductive isolation, animal hybridization, biological mechanism of genetic incompatibility, Taxonomic procedures: Taxonomic collections, preservation, curetting, process of identification. Importance of collections/ museum specimens of the world and India	12
Unit IV Molecular Taxonomy: Genetic polymorphism, electrophoretic variations, amino acid sequencing for variety of proteins, DNA-DNA hybridization, DNA bar coding for identification of species, e-DNA based identification, Trends in biosystematics: Chemotaxonomy, cytotaxonomy and molecular taxonomy, Dimensions of speciation. Species concepts: Typological, Nominalistic and Biological species concepts. Subspecies and other infra-specific categories.	11
Tentative List of Practical 1. General discussion, distinguishing characters and classification of selected animals 2. Preparation of identification keys for select specimens of non-chordate (e.g., insects) and chordates (e.g., birds) 3. Identification and taxonomic divisions of type animals representing respective phylum from available slides/specimen of Protozoa, Porifera, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata, hemichordata 4. An "Animal album" containing photographs, with identifying features and classification up to order needs to be prepared.	30 hrs
Suggested Readings*: 1. Dalela & Sharma: Animal Taxonomy and Museology (1976, Jai PrakashNath). 2. Kapoor: Theory and Practicals of Animal Taxonomy (1988, Oxford & IBH). 3. Simpson: Principles of Animal Taxonomy (1962, Oxford). 4. Roymahoney: Laboratory Techniques in Zoology (1966, Butterworths). **Please refer to latest editions available*	

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Course Title: Plant Taxonomy			
Course Code	LSCB6MJ00804	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course		
Nature of the Course	Theory and practical		
Special Nature/ Category of the Course (*if applicable*)	Intermediate level course that is to be studied by a student as a requirement to gain knowledge about classification of plants		
Methods of Content Interaction	Lecture, group discussion, laboratory-work, assignments, field work, seminar, presentations		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective:

The course provides an in-depth understanding of plant taxonomy, focusing on classification systems, nomenclature, and identification techniques. It covers taxonomic evidence from various disciplines and introduces modern methods like cladistics and numerical taxonomy for plant classification and systematics.

Course Learning Outcomes:

By the end of this course, students will be able to:

- Understand key concepts in plant taxonomy
- Apply classification systems
- Utilize taxonomic evidence to analyse and interpret taxonomic data
- Understand and apply methods of numerical taxonomy and cluster analysis, phenograms, and cladograms
- Understand phylogenetic tree construction

Course Content

Unit I: Introduction to plant taxonomy and Identification • Identification, Classification, Nomenclature. • Difference in Systematics and Taxonomy, Principles and Procedures of plant systematics, Sources of data for plant systematics. • Functions of Herbarium, important herbaria and botanical gardens of the world and India • Documentation: Flora, Keys: single access and multi-access	Number of classes **10**
Unit II: Types of classification and Taxonomic evidences • Classification based on morphology, Natural and phylogenetic. • Bentham and Hooker (upto series), Engler and Prantl (upto series).	**12**

• Taxonomic evidences from palynology, cytology, phytochemistry and molecular data.	
Unit III: Taxonomic hierarchy and Botanical nomenclature • Ranks, categories and taxonomic groups, • Principles and rules (ICN); ranks and names • Binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.	**08**
Unit IV: Biometrics, numerical taxonomy and cladistics • Characters; variations; OTUs, character weighting and coding; • Cluster analysis; phenograms, cladograms • Apomorphic and plesiomorphic characters, homologous vs. analogous; • Phylogenetic Trees - monophyletic, polyphyletic and paraphyletic; rooted and unrooted. • Phylogenetic-algorithmic (UPGMA and Neighbour joining) and tree-searching (Parsimony, Maximum Likelihood and Bayesian).	**15**
List of Practical (Tentative): 1. Comparative study of monocot, dicot primitive and advanced characters 2. Examination of root, stem, leaf, flower, fruit, and seed structures 3. Identification of leaf arrangements, phyllotaxy, venation, and placentation types 4. Collection of specimens from the field and preparation of herbarium 5. Study of floral characters of the following families for their identification according to Bentham & Hooker's system of classification: • Solanaceae: *Solanum* / *Withania* • Brassicaceae: *Brassica* / Alyssum • Asteraceae: *Calendula* / Helianthus • Poaceae: *Triticum* / *Avena*	**30 hrs**

Suggested readings:

1. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
2. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
3. Mauseth, J.D. Botany: An Introduction to plant Biology. Jones and Barlett publishers
4. Lawrence, G.H.M., 1967: Taxonomy of Vascular Plants, Oxford & IBH Publishing Co., New Delhi

**Please refer to latest editions available*

Course Title: Medical Diagnostics			
Course Code	LSC6SE00903	**Credits**	3
L + T + P	1 + 1 + 1	**Course Duration**	One Semester
Semester	III	**Contact Hours**	15 (L) +15(T)+30 (P) Hours
Course Type	Skill Enhancement Courses (SEC)		
Nature of Course	Theory & Practical		
Special Nature/ Category of the course *(if applicable)*	A skill Enhancement Course that is to learn diagnostic methods to enable students in the field of Medical Diagnosis		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative innature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objective:

- To enable the students to provide an understanding for the significance and scope of medical diagnostics.
- To provide information about biological fluids analysis.
- To acquaint students with diagnostic methods of specific infectious and non-infectious disease

Course Learning Outcomes:

- Students will have knowledge about the diagnostic methods, their significance and goals.
- Students will get an idea about the Quality assurance and safety procedures that need to be followed in the diagnostic lab.

Course Contents

Unit 1: Introduction to Medical Diagnostics and its Importance	**Number of classes 4 (2L+2T)**
Unit 2: Diagnostics Methods Used for Analysis of Blood Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell	**10 (5L+5T)**

Volume (P.C.V.)	
Unit 3: Diagnostic Methods Used for Urine Analysis Urine Analysis: Physical characteristics; Abnormal constituents	**4 (2L+2T)**
Unit 4: Non-infectious Diseases Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit	**8 (4L+4T)**
Unit 5: Infectious Diseases Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis	**4 (2L+2T)**
List of Practical (tentative) 1. Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain 2. Testing of blood glucose using Glucometer/Kit 3. Measurement of blood pressure	**30 hrs**

Suggested Readings*:

- Park, K. (2007), Preventive and Social Medicine, B.B. Publishers
- Godkar P.B. and Godkar D.P. Textbook of Medical Laboratory Technology, II Edition, Bhalani Publishing House
- Cheesbrough M., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses
- Guyton A.C. and Hall J.E. Textbook of Medical Physiology, Saunders
- Robbins and Cortan, Pathologic Basis of Disease, VIIIEdition, Saunders
- Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd.

Semester-IV

Course Title: Cell Biology			
Course Code	LSC6MJ01004	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	IV	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Intermediate level course that is to be compulsorily studied by a student as a core requirement to complete the discipline of study at integrated UG-PG level.		
Methods of Content Interaction	Lecture, Feedback or hand note preparation, group and individual self/laboratory-work and assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objective: This course is designed to understand basic structure and function of both pro and eukaryotic cell and their organelles. Also, the fundamentals of cell signaling and cell cycle are explained to students in a very lucid form.

Course Learning Outcomes: The students will learn the role of biomolecules in structural, cellular and functional organization. Illustrate that fundamental structural units define the function of all living things also, gain knowledge about the cross-talk among the various macromolecules and cell cycle checkpoints. Communicate biological concepts and understanding to members of a diverse scientific community as well as to the general public.

Course Content

	No. of classes
Unit 1: • Origin of cells and unicellular evolution: Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller • The first cell; origin and evolution of prokaryotes of eukaryotic cells • Evolution of unicellular to multicellular eukaryotes; anaerobic and aerobic metabolism.	6
Unit 2: • Ultrastructure of Prokaryotic and Eukaryotic cell • Cell Membrane: Chemical Composition and Fluid Mosaic Model • Membrane transport of micro molecules and macromolecules • Ion Channels and Membrane Potential of neurons • Structure and Functions of Endoplasmic Reticulum, Ribosome, Lysosome, Peroxisomes, Plastids (Chloroplast) and Mitochondria, Vacuole	15

• Exocytosis and Endocytosis	
Unit 3: • Protein sorting: organelle biogenesis and protein secretion, synthesis and targeting, of mitochondria, chloroplast, peroxisomal proteins, translational modification in the ER. Intracellular traffic, vesicular traffic in the secretary pathway, protein sorting in the Golgi, traffic in the endocytic pathway, exocytosis, ubiquitination • The cytoskeleton, the nature of cytoskeleton, Intermediate filaments, Microtubules, Actin filaments, Cilia and centrioles, Organization of the cytoskeleton • Cell division (Mitosis and Meiosis) and its control, Cell cycle in mammalian system and its regulation • Cell-cell adhesion, Levels of structural organization: Unicellular, colonial and multicellular forms; levels of organization of tissues, organs and systems; comparative anatomy.	17
Unit 4: • Cell to cell signalling, Overview of extracellular signalling • Role of Secondary messengers- cAMP, Ca^{2+}, IP_3, Nitric Oxide, H_2S and CO • Cell surface receptors - GPCRs, TGF, Cytokine receptors, Receptor Tyrosine kinases • Signalling pathways – JAK – STAT, MAP kinase, Activation of Ras, Signaling Pathways that depend on Regulated proteolysis Synthesis and trafficking of neuronal proteins	7
List of Practical (Tentative): ✓ Basic principles of Microscopy ✓ Squash and smear techniques to prepare slides ✓ To prepare an onion cell slide ✓ Sectioning of Plant tissues ✓ Staining of different plant cell types ✓ Pollen viability test by the use of KI_2 solution ✓ To Studies the different stages of Mitosis and Meiosis cell division ✓ Callus Initiation and Plantlet Regeneration	30 hrs
Suggested Readings*: 1. Alberts B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. Molecular Biology of the Cell. Garland Publishing, Taylor & Francis Group, USA. 2. Karp, J.G. Cell and Molecular Biology. John Wiley & Sons, USA. 3. Kleinsmith, L.J.and Kish, V.M. Principles of Cell & Molecular Biology. Second Edition. Harper Collins College Publishers, USA. 4. Lodish, H., Berk, A., Zipursky, S.L., Matsudaria, P., Baltimore, D. and Darnell, J. (Eds). Molecular Cell Biology. Freeman & Co., USA. 5. Pollard, T.D. and Earnshow, W.C. Principles of Cell and Molecular Biology, Saunders, USA.	

Course Title: Molecules of Life - I			
Course Code	LSC6MJ01104	**Credits**	4
L + T + P	**3 + 0 + 1**	**Course Duration**	One Semester
Semester	**IV**	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Intermediate level course that is to be studied by a student as a requirement to gain knowledge about Molecules present in Life Forms		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objective:

- To understand important principles of physical sciences which run biological systems.
- To explain structures, properties and functions of simple molecules and macromoleculesin biological systems.
- To describe biomolecular hierarchy - simple molecules are the units for building complexstructures.
- To introduce major methods of separation and analysis of biomolecules.

Course Learning Outcomes:

Students will be able –

- To understand and explain physical laws which govern the structures and importantprocesses in biological systems
- To correlate molecular structures with the higher level of organization in biologicalsystems
- To analyse and understand fundamental properties which are utilized by nature during evolution

Course Content

Unit 1: Fundamental of Physical and Chemical basis of Life	No. of classes
• Introduction to biochemistry, Properties of biomolecules that reflect their fitness to living condition, Stabilizing interactions in biomolecules (covalent, hydrophobic, hydrophilic, van der Waals, electrostatic interaction) importance of weak forces	21

• Water as solvent, Acid base and buffer, Good buffers, Biological relevance of pH • Law of thermodynamics, Gibb's free energy, Chemical equilibria, Redox potential, High Energy Biomolecules of Biological Systems • Stereochemistry and its importance to biological systems, Stereoisomerism: Optical activity and optical isomerism, asymmetry, chirality, enantiomers, diastereomers. specific rotation; Configuration and projection formulae: Newmann, Fischer projections and their interconversion. Chirality in molecules with one and two stereo-centres; CIP rules: D/L and R/S designations.; absolute configuration; thalidomide case and chiral drugs; Geometrical isomerism: cis-trans, syn-anti; Cis-trans isomerism in vision. Colligative properties, diffusion, osmosis. Introduction to spectrophotometry, ultraviolet visible fluorescence Circular dichroism uses in biomolecular analysis	
Unit 2: Carbohydrates • Classification, Structure and biological importance, reducing and non-reducing sugars, biological functions, linkage between monosaccharides, general properties and reactions of glucose and fructose, their open chain structure, epimers, mutarotation and anomers, reactions of monosaccharides, configuration, cyclic structure and Haworth projection formulae of glucose and fructose: structure of disaccharides (sucrose, maltose, lactose); Glycoconjugates, lipopolysaccharides, Glycosaminoglycans, proteoglycans, protein glycosylation and its significance, lectin-carbohydrate interactions, Symbol Nomenclature for Glycans (SNFG), Roles of Glycosylation in Biology, Uses of Glycans Isolation, separation and analysis of carbohydrates	12
Unit 3: Lipids • Storage lipids, Structure and function of fatty acids, Glycerol, Phospholipid, Sphingolipids, Cholesterol and its derivatives, Lipoproteins, galactolipid, Waxes, Terpenes and Their Relevance to biological systems • Structural lipids in biological membranes, integral membrane proteins, lipoproteins and trafficking through membrane, Lipids as signals, cofactors and pigments, Isolation, separation and analysis of lipids	12
List of Practical (Tentative): 1. Essential Laboratory techniques (Volume measurement, Weighing, Solution preparation, pH measurement) 2. Preparation of phosphate buffer and verification of Henderson Halsselblach equation. 3. Verification of Beer's law 4. Determination of PI of Glycine by titration 5. Qualitative tests of carbohydrates 6. Quantitative test of carbohydrate	**30 hrs**

7. Essential Laboratory techniques	
Suggested Readings*: 1. Donald Voet, Judith G Voet: Biochemistry. Foruth edition, John Wiley & Sons , Inc 2. Nelson D.L. and Cox, M.M. 2008. Principles of Biochemistry. 5th Edition. W H Freeman& Co., USA. 3. Fasman, G.D. Circular Dichroism and the Conformational Analysis of Biomolecules. Plenum Publishing Corporation, USA. 4. Clark, R.J.H. and Hester, R.E. Biomolecular Spectroscopy (Advances in Spectroscopy)Part A and B. John Wiley & Sons, USA. ** Please refer to latest editions available*	

Course Title: Genetics			
Course Code	LSC6MJ01204	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	IV	**Contact Hours**	45 (L) +30 (P) Hours
Course Type	Discipline Based Core Course (DBCC)		
Nature of the Course	Theory & Practical		
Special Nature/ Category of the Course (*if applicable*)	Intermediate level course that is to be studied by a student as a requirement to gain knowledge about hereditary principles.		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in naturebut also contributing to the final grades) • 70% - Summative Assessment in the form of End Term Examination		

Course Objectives:

This course deals with basic understanding of genetic constitution and laws of genetics; organization of genes in prokaryotes and eukaryotes and their role in governing the phenotypic traits. Emphasis is laid on development of overall concept of genetic composition of living world and mode of its inheritance.

Course Learning Outcomes: After completion of the course the learners will be able to:

- Identify Mendelian and non-Mendelian inheritance patterns and explain the relationship between genotypes and phenotypes

- Use a Punnett square and probability method to calculate the expected proportions ofgenotypes and phenotypes in a cross
- Explain Mendel's law of segregation and independent assortment in terms of genetics and the events of meiosis
- Explain the effect of linkage and recombination on gamete genotypes
- Explain the phenotypic outcomes of epistatic effects among genes and polygenic inheritance
- Understand the importance of specific model organisms
- Analyze the implication of structural rearrangements and special features inchromosomes
- Understand the basic principles of sex determination
- Explain the organization of nuclear and organelle genomes

Course Content

	No. of Classes
Unit 1: Introduction to Genetic Research • Mendelism: Brief overview of Mendel's work, Principle of equivalence of reciprocal hybrids, Application of laws of probability (Product and Sum rule), Chromosomal theory of inheritance, Extensions of Mendelism, Linkage and Crossing Over. • Model systems in Genetic Analysis: Bacteriophage, *E. coli*, *Neurospora crassa*, yeast, *Arabidopsis*, maize, *Drosophila*, *C. elegans*, Zebra fish, - Outline general features and importance in biological research.	15
Unit 2: Genes & Chromosomes • Evolution of gene concept - Definition of factors, alleles, multiple alleles, pseudoalleles, Beadle and Tatum's One gene one enzyme concept, One gene one polypeptide concept, Complementation test, Benzer concept of gene • Gene interaction: allelic and gene interactions • Structural and numerical changes in chromosome and its implications. • Special chromosomes: (a) B Chromosomes (b) Structural organization and significance of Polytene chromosomes (c) Lampbrush chromosomes and implications of their study in genetic research; Fragile X – chromosome, heterochromatin and Lyon's hypothesis; somatic cell hybridization and use of somatic cell hybrids in gene mapping • Sex determination in *C. elegans*, drosophila, birds, and humans; environmental basis of sex determination.	18
Unit 3: Nuclear & Organelle genome • Concept of gene: Conventional and modern views. Fine structure of gene, split genes,pseudogenes, coding and non-coding genes, overlapping genes and multi-gene families. • Mutation; Type, cause & detection. Epigenetics, C-value paradox,	6

Repetitive DNA- satellite DNAs and interspersed repeated DNAs • Extra nuclear inheritance: Maternal effect- Shell coiling in Limnaea, Organelle heredity: Chloroplast in *Chlamydomonas*; Mitochondria- Poky in *Neurospora*, Petite in *Saccharomyces*	
Unit 4: Principles of breeding • Breeding methods in self-pollinated plants: Pure line theory and pure line method, Pedigree method, Bulk population method, Back cross method • Breeding methods in cross pollinated plants: Theory of selection and response to selection, hybrid vigour, Hybrid varieties.	6
List of Practical (Tentative): 1. Study of morphology of *Drosophila melanogaster* – Wing, Sex comb, Genital plate and Bristles. 2. Study of model organisms through slides or specimens. 3. Study of morphology of a plant model system. 4. Visit to a plant breeding center.	30 hrs

Suggested Readings*:

1. Concepts of Genetics, Klug WS & Cummings MR, Prentice – Hall.
2. An Introduction of Genetic Analysis, Griffiths A. Macmillan Learning.
3. Genetics – a conceptual approach, Pierce BA. W H Freeman & Co.
4. Genetics: A Molecular Approach, Peter J. Russel, Pearson.
5. Genetics, Strickburger MW, Prentice – Hall.
6. Genetic Analysis of Genes & Genomics, Hartl, D.L, Jones FW, Jones & Barlett.
7. Advanced Genetics, Miglani, G.S, Alpha Science.
8. Genetics- Classical to Modern, Gupta, P.K, Rastogi Publications.

*Please refer to latest editions available

Course Title: Principles of Pathology			
Course Code	LSC6MJ01302	**Credits**	2
L + T + P	1+0+1	**Course Duration**	One Semester
Semester	IV	**Contact Hours**	15(L) + 30 (P) Hours
Course Type	Discipline Based Core Course		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Intermediate level course that is to be studied by a student as a requirement to gain fundamental knowledge about plant and animal pathology		
Methods of Content Interaction	Lecture, group discussion, laboratory-work, assignments, seminar, presentations, individual and group drills		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades)		

	70% - End Term External Examination (University Examination)

Course Objective:
This course aims to provide a fundamental understanding of plant and animal pathology by exploring disease mechanisms, host-pathogen interactions, and epidemiology. Students will gain knowledge about major infectious diseases, their causal agents, and emerging challenges such as antimicrobial resistance. Through practical training, students will also develop essential skills in pathogen identification.

Course Learning Outcomes:
Upon successful completion of the course, students will be able to:

- Understand the fundamentals of pathology, including its scope, history, and disease classification.
- Learn about disease development in plants and animals, focusing on host-pathogen interactions and defence mechanisms.
- Study major plant and animal pathogens, their life cycles, and associated symptoms.
- Develop practical skills in diagnosing plant and animal diseases through microscopy and staining techniques

Course Content

	Number of classes
Unit I: Fundamentals of Pathology • Definition, scope, and history of pathology • Concept of disease and pathogenesis in plants and animals • Host-pathogen interactions: Virulence factors and host defense mechanisms • Host, Definitive host, Intermediate host, Parasitism, Biotroph, Necrotrophs, Hemibiotrophs • Koch's postulates and molecular Koch's postulates	**3**
Unit II: Plant Pathology • Mechanisms of plant disease development and symptomatology • Major diseases, causal agents and their life cycles o Rusts and smuts (fungal diseases) o Bacterial blights and wilts o Viral diseases (mosaic, leaf curl) o Nematode diseases	**5**
Unit III: Animal Pathology • Mechanisms of disease development in animals: Inflammation, immune response, and tissue damage • Major diseases, causal agents and their life cycles: o Viral: Rabies, Chikungunya, Ebola, o Bacterial: Tuberculosis, Pneumonia, Cholera o Parasitic Protozoa: Amebiasis, Malaria and Trypanosomiasis, Leishmaniasis	**5**

o Parasitic Helminthes: Ascariasis, Taeniasis, Filariasis	
Unit IV: Disease Management • Antimicrobial resistance and disease control challenges • One Health approach in pathology • Molecular diagnostics (microscopy, serology, molecular techniques etc.) and disease control	**2**
Tentative List of Practical 1. Microscopic observation of phytopathogenic fungal spores 2. Staining techniques for fungi (Lactophenol Cotton Blue staining) 3. Identification of nematodes from soil and plant roots 4. Study of insect damage to different plant parts/stored grains through damaged products/photographs 5. Study of *Plasmodium vivax*, *Entamoeba histolytica*, *Trypanosoma gambiense*, *Ancylostoma duodenale* and *Wuchereria bancrofti* and their life stages through permanent slides/photomicrographs or specimens 6. Study of Platyhelminthes through permanent slides: Liver Fluke w.m., *Planaria* w.m., Tapeworm with *Scolex* w.m., Tapeworm c.s., Tapeworm Proglottid Immature & Tapeworm Proglottid Mature	**30**
Suggested readings*: 1. Plant Pathology, T.N. Agrios, Academic Press, 2001 2. Introduction to Plant Pathology, Richard N Strange, 2003, Springer publication 3. Viral Infections of Humans by Alfred S. Evans, Richard A. Kaslow, 2014, Springer 4. Protozoa and Human Disease by Mark F Wiser, 2010, Garland Science 5. Human Parasitology by by Burton J. Bogitsh, Clint E. Carter, Thomas N. Oeltmann, 2018, Academic Press 6. Antimicrobial Resistance in Bacteria by Carlos Amabile-Cuevas, 2006, Horizon publication 7. Articles from journals **Refer to latest edition available*	

Semester V

Course Title: Basics of molecular biology			
Course Code	LSC7MJ01402	**Credits**	2
L + T + P	2+0+0	**Course Duration**	One Semester
Semester	V	**Contact Hours**	30 (L)
Course Type	Discipline Based Core Courses (DBCC)		
Nature of the Course	Theory based		
Special Nature/ Category of the Course (*if applicable*)	Higher-level course that is to be studied by a student as a requirement to understand the fundamental of molecular biology.		
Methods of Content Interaction	Lecture, assignments followed by oral and poster presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objectives:

- To develop an understanding of the fundamentals of genomic organization and their role in information pathways through transcription and translation in prokaryotes and eukaryotes.
- To understand gene regulation at post transcriptional and translational levels.

Learning Outcomes: After completion of the course the students should understand:

- Prokaryotic and eukaryotic DNA replication, DNA repair and transposition
- RNA synthesis including transcription and post transcriptional modifications.
- Genetic code and regulation of protein synthesis in prokaryotes and eukaryotes
- Mechanisms of regulation of genetic expression.

Course Content

	Number of classes:
Unit 1: DNA replication and transposition • Chromosomal elements, Structure and organization of Chromosomes, DNA supercoiling • DNA replication in prokaryotes and eukaryotes, • DNA repair • Transposable elements in bacteria, *Drosophila*, plants	10
Unit 2: Transcription and RNA Processing • Different types of RNA, Prokaryotic and eukaryotic transcription • RNA splicing and processing • Gene Regulation: Operon system, eukaryotic regulation, epigenetic effects.	10

Unit 3: Protein Synthesis • Genetic code, wobble hypothesis, degeneracy of codons • Translation in prokaryotes and eukaryotes - amino acylation of tRNA, tRNA-identity, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination • Translational proof-reading, post-translational modifications, Protein Degradation	10
Suggested Readings*: • Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick (2014). Lewin's genes XI, Jones & Bartlett Publishers • H. Lodish, A. Berk, S L.Zipursky, P. Matsudaira, D. Baltimore, and J. Darnell (2016). Molecular Cell Biology, 8th edition. W. H. Freeman and Company. • Nelson D.L. and Cox, M.M (2008). Principles of Biochemistry, 5th Edition. W H Freeman & Co., USA. * *Please refer to latest editions available.*	

Course Title: Metabolism and integration			
Course Code	LSC7MJ01504	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	V	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course (DBCC)		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Higher-level course which is to be compulsorily studied by a student as a core requirement to understand metabolism		
Methods of Content Interaction	Lecture, Feedback or hand note preparation, group and individual self/laboratory-based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Objective of the Course: Course aims to understand the role of enzymes in metabolism of carbohydrate, fats, amino acid, and nucleotides along with catabolic and anabolic pathways of animal and plant system.

Outcome of the Course: Students will understand the core metabolic pathways of biological system that will allow lucid comprehension of integrated catabolic and anabolic pathways of Carbohydrates, Protein, Lipids and Nucleic acids. Understand the importance of the metabolic

pathways and related diseases.

Course Content

	No. of classes
Unit 1: Carbon Assimilation Light absorption and energy conversion, Photolysis of water and Cyclic and Non-cyclic photophosphorylation, Carbon dioxide uptake and assimilation, Calvin Cycle (C_3), Photorespiration (C_2), Hatch-Slack pathway (C_4); CAM pathway; Sucrose transport, Starch, Cellulose synthesis	10
Unit 2: Biological Oxidation and Release of Energy Glycolysis, Synthesis of glucose from non-carbohydrate sources and Pentose phosphate pathway; Cori cycle, Glyoxylate pathway, TCA cycle as amphibolic pathway, High energy compounds; Shuttle systems, Oxidative phosphorylation; Chemiosmotic hypothesis and ATP production.	15
Unit 3: Metabolism of Macromolecules Biosynthesis of Starch, Cellulose and Glycogen; Biosynthesis and degradation of Fatty acids, β-oxidation, ω-oxidation, gluco-neogenesis and its role in mobilisation of lipids during seed germination, α-oxidation, ketone-bodies metabolism, ketoacidosis, saturated and unsaturated fatty acids and Biosynthesis and degradation of Lipids and steroids, Metabolism of nucleotides, De novo and Salvage pathways, amino acids metabolism, Urea cycle	15
Unit 4: Diseases associated with metabolic irregularities Diabetes, Galactosemia, Lactose intolerance, Glycogen storage diseases, Maple syrup urine disease, Gaucher disease, Niemann-Pick disease, Phenylketonuria, Tay-Sachs disease, Wilson's disease	5
List of Practical (Tentative): 1. Kranz anatomy and estimation of Starch from C_3 and C_4 plant 2. Observation of starch granules in potato 3. Estimation of Carbohydrates e.g, Starch, Total Soluble sugars, etc. 4. Estimation of Amino acid e.g, Proline, Glycine, etc. 5. Extraction of Lipid from egg yolk	30 hrs

Suggested Readings*:

1. Buchanan, B., Gruissem, W. and Jones, R. (Eds.). *Biochemistry & Molecular Biology of Plants*. American Society of Plant Physiologists, USA.
2. Dey, P.M. and Harborne, J.B. (Eds.). Plant Biochemistry. Academic Press, USA.
3. Metzler, D.E. Biochemistry. Second Edition. Academic Press, USA.
4. Nelson D.L. and Cox, M.M. Principles of Biochemistry. 5th Edition. W H Freeman & Co., USA.
5. Stryer L., Berg, J.M. and Tymoczko, J.L. Biochemistry.Sixth Edition.W.H. Freeman & Co., USA.

**Refer to latest edition available*

Course Title: Microbiology			
Course Code	LSC7MJ01604	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	V	**Contact Hours**	45 (L) + 30 (P) Hours
Nature of the Course	Discipline Based Core Course (DBCC)		
Special nature/ Category of the Course (if applicable)	Higher-level course which is to be compulsorily studied by a student as a core requirement of integrated UG-PG program in Life Science to understand the structure and functions of microbes and their diverse roles and applications.		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - Summative Assessment in the form of End Term Examination		

Course Objectives:

- To understand and appreciate the structural and functional diversity of microbes and the extent of their involvement in shaping the sustenance of life on Earth
- To highlight environmental, medicinal and industrial applications of microbes

Course Learning Outcomes: After completion of the course the learners will be able to:

- Appreciate the enormous diversity of microbes in nature.
- Understand the basics of microbial cell structures
- Get acquainted with techniques of microbial culture
- Explain growth patterns and constrains on microbial growth
- Differentiate between nutritional types and classification of microbes based on nutritional requirement
- Understand the means of genetic transfer among microbes
- Understand the basic principles of host microbe interaction and explain the principles of pathogenicity
- Apply the knowledge of microbial systems in diverse fields such as environment maintenance, medicine and industry

Course Content

Unit 1: INTRODUCTION TO MICROBIOLOGY	No. of Classes 6
• A brief history of microbial world, insight into diversity of microbes, Bergey's manual and bacterial classification (as tutorial) • Cultivation of viruses using embryonated eggs, experimental animals and cell cultures, purification of viruses by adsorption, precipitation, enzymes, serological methods – haemagglutination and ELISA. Assay for viruses.	

Unit 2: GROWTH & NUTRITION • **Growth and Nutrition** -Microbial growth and population kinetics, Auxotrophs & Prototrophs, methodology for measuring growth and growth regulation, Nutritional requirements of micro-organisms, Mode of nutrition, phototrophy, mixotrophy, saparophytic mode, Chemolithotrophy - oxidation of ammonia, nitrite, molecular hydrogen, Ferrous and sulfur/sulfide symbiosis • **Solute Transport** - Primary and Secondary transport, ABC transporters, Phosphotransferase system, Drug export systems • **Quorum sensing** - A and C signaling system	12
Unit 3: BIOCHEMISTRY, PHYSIOLOGY AND GENETICS OF MICROBES • **Nitrogen fixation** • **Photosynthesis** - Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria. • **Respiration** - Bacterial aerobic respiration, components of electron transport chain, Bacterial anaerobic respiration: Introduction. Nitrate, carbonate and sulfate as electron acceptors. Electron transport chains in some anaerobic bacteria. • **Sporulation** – characteristics of spores and mechanism of sporulation • **Gene transfer** by conjugation, phage strategies for lysogenic regulation and mechanism of transduction and transformation	12
Unit 4: MODERN TRENDS IN MICROBIOLOGY • **Environmental Microbiology** - Microbial diversity in extreme environments: Occurrence, diversity, adaptations; Culture-dependent and culture-independent approaches for understanding microbial diversity in the environment; **Eutrophication** – algal blooms and toxicity, Physico-chemical and biological measures to control eutrophication, **Microbial degradation** of aliphatic and aromatic hydrocarbons, Bioremediation of Xenobiotics; **Microbes in mineral recovery** - Bioleaching of copper, gold and uranium • **Medical Microbiology** – Normal microflora of human body, diverse applications of microbes in the field of medicine. • **Space Microbiology** - Life detection methods -Evidence of metabolism, evidence of photosynthesis (autotrophic and heterotrophic), ATP production, evidences of phosphate and sulphur uptake; **Martian environment** (atmosphere, climate and other details), Antarctica as a model for Mars. Search for life on Mars, Viking mission, Viking landers, and Biology box experiment. • **Microbial Technology - Enzyme Engineering** - Industrially important microbial enzymes; Immobilization of microbial enzymes – methods, properties and applications; **Microbial strain improvement**- Isolation, selection and improvement of microbial cultures, Screening and isolation of microorganisms, enrichment, strategies of strain improvement for primary, secondary metabolites, Preservation of cultures after strain improvement programme; Role in production of biofuels and biofertilizer	15

List of Practical 1. Preparation of defined media for culturing microbes 2. Plating technique and observation of differential microbial flora. 3. Enumeration of CFU of *E. coli*/other microbes by serial dilution. 4. Isolation of pure culture of microbe (streaking and liquid culture transfer techniques) 5. Gram staining for identification of wall type in bacteria. 6. LCB staining for microscopic observation of fungi. 7. Identification of eubacteria by 16s rDNA PCR amplification as a tool. 8. Determination of bacterial growth kinetics. 9. To study the effect of different antibiotics on bacterial culture. 10. Qualitative and quantitative assay for a microbial product (siderophore using CAS/Arnow/Atkin's assay)	30 hrs

Suggested Readings*:

- Prescott, Harlay and Klein: Microbiology. New York : McGraw-Hill Higher Education
- Madigan, Martinko and Parker:Brock Biology of Micro-organism. Pearson
- Alcamo: Fundamentals of Microbiology. Jones & Bartlett Learning
- Talaro K. and Talaro A.: Foundations in Microbiology. McGraw Hill
- Pelczar M. J.,Chan E. C. S. and Krieg N.R.: Microbiology: Concept and Applications. McGraw-Hill College
- Atlas , R. M.: Principles of Microbiology. McGraw Hill Education
- Gornity, G. M.: Bergey's Manual of Systematic Bacteriology Springer

**Please refer to latest editions available.*

Course Title: Molecules of Life - II			
Course Code	LSC7MJ01704	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	V	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course		
Nature of Course	Theory & Practical		
Special Nature/ Category of the course *(if applicable)*	Higher level course that is to be studied by a student as a requirement to gain knowledge about Molecules present in Life forms		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		

Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)

Objective of the Course:

- To understand important principles of physical sciences which run biological systems.
- To explain structures, properties and functions of simple molecules and macromoleculesin biological systems.
- To describe biomolecular hierarchy - simple molecules are the units for building complexstructures.
- To introduce major methods of separation and analysis of biomolecules.

Outcome of the Course:

Students will be able –

- To understand and explain physical laws which govern the structures and importantprocesses in biological systems
- To correlate molecular structures with the higher level of organization in biologicalsystems
- To analyse and understand fundamental properties which are utilized by nature duringevolution
- To correlate biochemistry with diseases, daily observations and environment.

Course Content

Unit 1: Amino Acids and Protein Purification • Classification and general properties of amino acids, nomenclature of stereoisomers of amino acids Isolation, separation and analysis of protein and amino acids. • Protein purification, characterization of proteins, sequence determination, massspectrometry, one and two dimensional gel electrophoresis, Isoelectric focusing gels	15
Unit 2: Proteins Structure and Function • Peptides bonds and Ramachandran Plot, Secondary structure, domain, motif, fold, tertiary and quaternary structure of proteins, methods to determine the secondary and tertiary structure of proteins, Protein Data bank • Structure of haemoglobin, oxygen binding kinetic and its relation to its structure mechanisms of cooperativity in oxygen binding • Glycoproteins, Lipoproteins, Protein modifications and their functional implications.	25

Unit 3: Nucleic acids • Nitrogenous bases, Nucleosides, Nucleotides, Nucleic acids, Forms of DNA, Types of RNA	5
List of Practical (Tentative): 1. Estimation of protein content in a solution by biuret and UV method 2. Determination of molecular mass using SDS PAGE 3. Estimation of DNA	30 hrs

Suggested Readings*:

- Creighton, T.E. Proteins: Structures and Molecular Properties. W.H. Freeman & Co.,USA.
- Donald Voet, Judith G Voet: Biochemistry. Fourth edition, John Wiley & Sons , Inc
- Nelson D.L. and Cox, M.M. 2008. Principles of Biochemistry. 5th Edition. W H Freeman& Co., USA.
- Sheehan, D. Physical Biochemistry: Principles and Applications. John Wiley & SonsLtd., UK.
- Lesk, A. M. Introduction to Protein Science: Architecture, Function and Genomics. Oxford University Press, UK.
- Fasman, G.D. Circular Dichroism and the Conformational Analysis of Biomolecules.Plenum Publishing Corporation, USA.
- Clark, R.J.H. and Hester, R.E. Biomolecular Spectroscopy (Advances in Spectroscopy)Part A and B. John Wiley & Sons, USA.
- Branden, C. I. and Tooze, T. Introduction to Protein Structure. Garland Publishing,USA

Course Title: Internship			
Course Code	LSC7MJ01802	**Credits**	2
L + T + P	0 + 0 + 2	**Course Duration**	One Semester
Semester	V	**Contact Hours**	60 (P) Hours
Course Type	Skill Enhancement Course (SEC)		
Nature of the Course	Skill based		
Special Nature/ Category of the Course (*if applicable*)	A Skill Enhancement Course that is to be studied by a student as a core requirement to complete integrated UG-PG in Life Science.		
Methods of Content Interaction	Laboratory-work, review of literature, feedback or hand note preparation, group and individual self/ and assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - Internship report (Evaluation of the mentor)		

Course Objective: The primary aim of this internship course is to provide students with practical, hands-on work experience in Life Sciences, allowing them to apply theoretical knowledge learned in the classroom to real-world situations, develop professional skills, explore potential career paths, and enhance their employability by building a professional network and gaining valuable experience before graduating

Course Learning Outcomes: The students will be able to:

- Gain real-world experience in the field of their internship.
- Skills in specific field of internship.
- Experience in managing time, working as team members and networking.

Area of Internship: Any area related to Life Science – Research/lab work/field work and Review of Literature/Indian Knowledge System/any other suitable topic approved by the DC.

Semester VI

Course Title: Systems Physiology			
Course Code	LSC7MJ01904	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	VI	**Contact Hours**	45(L) + 30 (P) Hours
Course Type	Discipline Based Core Course		
Nature of Course	Theory & Practical		
Special Nature/ Category of the course *(if applicable)*	Higher level course that is to be studied by a student as a requirement to gain knowledge about physiology of biological systems		
Methods of Content Interaction	Lectures, Laboratory work, Discussions, Problem Solving		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in naturebut also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objectives:

- To understand basic processes that maintain life in biological systems
- To know strategies adapted by biological systems to maintain life
- To integrate and connect the physiological processes to the physical and chemical surrounding

Course Learning Outcomes: Students will be able:

- To apply the knowledge of physiology to his/her own and surrounding life
- To imagine physiological processes that can change in variety of stresses including seasonal stresses
- To learn the strategies / mechanisms nature develop for survival of life forms

Course Content

Unit 1: Movements and Bulk Transport Cellular movements, ciliary and flagellar structure and function; Introduction to musculoskeletal system; Terrestrial, aquatic and aerial locomotion; Locomotory cost; Long distance transport of water and nutrients in plants (xylem and phloem transport); General plan and physiology of circulatory system in vertebrates and invertebrates	Number of classes: 09
Unit 2: Gas exchange in organism; Generation and utilization of energy Exchange in unicellular organisms and plants; Respiratory organs in aquatic and terrestrial systems; Physiology of aquatic breathing and aerial breathing; Feeding patterns, digestive tract systems; Digestion of food	11

Unit 3: Regulatory Physiology Mechanism of opening and closing of stomata. Regulation of water and solutes in aquatic and terrestrial animals; Osmoregulatory organs. Transpiration in plants; Excretion of nitrogenous wastes in animals; Patterns of Thermoregulation: Ectotherms and Endotherms; Structural and functional adaptation to stress	11
Unit 4: Integrative Physiology An overview of neuronal structure and function; Sensory physiology -mechano, chemo, thermo, photo and electro receptors; Endocrine systems in animals and their physiological effects; Plant hormones and their physiological effects; Regulation of metabolism and response to environmental cues; Circadian rhythm	14
List of practical: 1. Effect of isotonic, hypotonic and hypertonic solution on erythrocytes 2. Enumeration of RBC using haemocytometer 3. Estimation of total count of WBC using haemocytometer 4. Study of the effect of various environmental factors on transpiration in an excised twig/leaf 5. Calculation of the stomatal index, stomatal frequency and percentage of leaf area open through stomata in a mesophyte and a xerophytes 6. Study of the mechanism of stomatal opening and closing 7. Plant movement in response of light 8. Slides of various endocrine glands	30 hrs
Suggested Readings*: 1. Knut Schmidt-Nielsen , Animal Physiology , Cambridge University Press 2. David Randall, Eckert's Animal Physiology, W.H.Freeman and Co. 3. Taiz, Møller, Murphy, Zeiger, Plant Physiology and Development **Refer latest edition*	

Course Title: Fundamentals of Ecology			
Course Code	LSC7MJ02004	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	VI	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course (DBCC)		
Nature of the Course	Theory and practical		
Special Nature/ Category of the Course (*if applicable*)	Higher level course to provide knowledge of ecological principles and ecosystems		
Methods of Content Interaction	Lecture, group discussion, laboratory-work, assignments, field work, seminar, presentation		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective:
The course aims to provide students with a foundational understanding of ecological principles, including ecosystem structure, population dynamics, and community interactions. It explores environmental issues such as climate change, conservation, and pollution, while examining evolutionary processes. Students will also gain practical skills in field research and data analysis.

Course Learning Outcomes:

- Understand ecosystem structure, function, and biogeochemical cycles
- Learn about species interactions, population growth, and biodiversity patterns
- Explore environmental challenges such as climate change, pollution
- Analyze landscapes, model ecosystems, and apply GIS for ecological research
- Gain hands-on experience in ecological fieldwork, data collection, and analysis

Course Content

Unit 1: Introduction to Ecology • Principles and scope of ecology • Ecosystem structure and function • Energy flow, food chains, and trophic levels • Biogeochemical cycles • Ecological succession and stability • Concept of ecological efficiency and productivity • Biomes	Number of classes 09
Unit 2: Population and Community Ecology • Population dynamics: Growth models (exponential, logistic) • Population interactions: Competition, predation, mutualism, commensalism • r- and K-selection, life history strategies • Community structure, species diversity, and ecological niche • Species Diversity, Species Richness Patterns • Island biogeography theory • Metapopulation dynamics and dispersal	14
Unit 3: Environmental and Applied Ecology • Biodiversity and conservation (*in-situ* & *ex-situ*) • Climate change: Causes, impacts, and mitigation • Pollution ecology: Air, water, and soil pollution • Ecotoxicology and bioremediation • Sustainable development Goals and ecosystem services • Environmental laws and policies in India	12
Unit 4: Landscape Ecology and Ecological Modelling • Landscape ecology • Habitat fragmentation and connectivity • Ecosystem stability and resilience	10

• Ecological modelling • Remote sensing and GIS applications in ecological research • Ecological forecasting	
Tentative practical list: 1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, and lux meter. 2. Determination of pH, and analysis of soil samples. 3. Water Quality Assessment: Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), pH, turbidity. 4. Study of adaptations of Xerophytes and Hydrophytes 5. Field study: Quadrats and Transects based	30 hrs
Suggested readings*: 1. Michael Begon, Colin R. Townsend. – *Ecology: From Individuals to Ecosystems 5th edition* 2. Odum, E.P. & Barrett, G.W. – *Fundamentals of Ecology* 3. Peter Stiling Ecology: Global Insights and Investigations 4. Oswald J. Schmitz– *Ecology and Ecosystem Conservation* 5. Richard B. Primack- Essentials of Conservation Biology 6. Peter A. Henderson-Southwood's ecological methods **Refer to latest edition available*	

Course Title: Research Methodology			
Course Code	LSC7MJ02104	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	VI	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline based Core Course		
Nature of the Course	Theory and Practical, Hands-on training		
Special Nature/ Category of the Course *(if applicable)*	Higher level course that is to be studied by a student as a requirement to gain knowledge about basics of research in Life science		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field-based assignments.		

Assessment and Evaluation	30% - Continuous Internal Assessment (Formative innature but also contributing to the final grades) 70% - End Term External Examination (University Examination)

Course Objectives:

The course aims to -

- Acquaint the students with fundamental knowledge of Research methodology and methods in biology.
- It will provide an understanding of scientific terms, the scope of research, experimental design and interpretation of results, scientific communication, and ethics.
- Develops an understanding of the concept and importance of research, raising questions, planning methodology, documentation, and presentation.
- The biophysical methods and advanced methods will help students in learning the basic and new technologies.

Course Learning Outcomes:

After completion of the course, the students shall have an understanding:

- To gather scientific information from reliable sources, formulate a scientific question, design a hypothesis, collect and discuss the results that answer the question, making effective scientific communication, along with the ethics and regulations related to the research.

Course Contents

	Number of classes:
Unit 1: Perspectives of scientific research, Experimental design and interpretation of results Science and technology, Importance of scientific research, Scientific aptitude and temper, skills for being a research scientist, Scientific question and social responsibility, Qualities of a good researcher, Challenges faced in research, Research funding and fellowship: National (ANRF, CSIR, DST, DBT, DRDO, BIRAC-eYUVA etc.), international (Fulbright fellowship, DAAD etc.); Contribution of Indian scientists in global research, Literature review, and analysis, Literature databases, Identification of relevant gap areas in the area of interest, generate a hypothesis, Research Plan, define objectives, Plan of Work, select methods to address the problem, Collect data, Sampling methods, evaluation of data	12
Unit 2: Interpretation and report writing Meaning of interpretation, techniques of interpretation, precautions of interpretation, Communication of results, Oral and Poster presentation, Significance of report writing, Layout of research article, Types of reports, Precautions of writing reports, Essentials of effective scientific writing, publication guidelines and references	12
Unit 3: Model Organisms and Regulatory guidelines Model organisms for basic and applied research in life science, Ethical issues and guidelines related to research involving recombinant DNA technology, transgenic plants, genetically modified crops, use of small and large animals. Ethical issues related to the use of human - subjects, embryos, tissues, and stem cells - for	11

research.	
Unit 4: Publication and ethics: Citations and indices; journal Impact factor, H-index, Journal Matrics, SCI, SCOPUS Indexing, UGC Care listed journals, Web of Science Indexing, Ethics in scientific publishing and awareness of misconduct in research, and Intellectual property rights.	10
Tentative List of Practical 1. Poster making and presentation on contribution of Indian Scientist in global research 2. Searching scientific database for research on a specific topic 3. Selection of review article for summary and presentation 4. Selection of research article for summary and presentation 5. Access selected journal websites to understand differences in scientific layouts etc.	30 hrs

Suggested Readings*:

- C R Kothari, Research Methodology, Methods and techniques
- Ronald B Corley, A guide to methods in biomedical sciences
- Responsible Conduct of Research Adil E. Shamoo and David B. Resnik Oxford University Press
- https://oir.nih.gov/sourcebook/ethical-conduct/research-ethics
- https://www.ccmb.res.in/newsfiles/year-2020/csir_ethics_2020.pdf
- https://publicationethics.org/

**Refer to latest editions available.*

Course Title: Comparative Anatomy and Developmental Biology of Animals			
Course Code	LSCZ7MJ02104	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	VI	**Contact Hours**	45 (L) + 30 (P) hrs
Course Type	Discipline Based Elective Course (DBEC)		
Nature of the Course	Theory & Practical		
Special Nature/ Category of the Course (*if applicable*)	A higher-level course that is to be studied by a student as a requirement to attain knowledge about comparative anatomy and developmental stages of animals.		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field-based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objectives: The course aims to:

1. Acquaint the students with fundamental knowledge of anatomy and developmental biology
2. Learn the basic concepts of animal development.
3. Make the students aware of various modes of regeneration and therapeutic interventions to treat diseases.

Course Learning Outcomes: After completion of the course the students shall have an understanding of:

- It will enable students to capture the advantages of using different model organisms.
- The knowledge of the developmental process in detail will broaden the analysis of principles underlying morphogenesis in animals.
- The application of studying developmental processes in health, diseases, and development of therapies.

Course Contents

	No. of classes
Unit 1: Comparative anatomy of Integumentary system: Derivatives of integument-glands and digital tips, **Skeletal system:** Evolution of visceral arches, **Digestive system:** Brief account of alimentary canal and digestive glands, **Respiratory system:** Brief account of Gills, lungs, air sacs and swim bladder	11
Unit 2: Comparative anatomy of Circulatory system: Evolution of heart and aortic arches, **Urinogenital system:** Succession of kidney, Evolution of urinogenital ducts, **Nervous system:** Comparative account of brain, **and Sense organs:** Types of receptors	11
Unit 3: Basic concepts, gametogenesis, fertilization, and early Development Potency, commitment, specification, induction, competence, determination and differentiation, morphogenetic gradients; cell fate, cell lineages, mosaic vs regulative development, stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development Production of gametes, cell surface molecules in sperm-egg recognition in animals; cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals, Notch pathway, Wnt pathway, TGFbeta pathways	11
Unit 4: Morphogenesis and organogenesis in animals Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; Teratogenesis, differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination, Hydra: Stem Cell-Mediated Regeneration, Morphallaxis, and Epimorphosis, Stem cells and aging	12
Tentative list of practical:	30 hrs

1. Osteology: a) Disarticulated skeleton of frog and rabbit b) Carapace and plastron of Frog /tortoise 2. Study of *Xenopus* development through prepared permanent slides. 3. Study of comparative anatomy by permanent slides. 4. Various stages of *Caenorhabditis elegans* development. 5. Growth and maintenance of Hydra culture to display regeneration in Hydra.	

Suggested Readings:

- Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education
- Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. The McGraw-Hill Companies.
- Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons.
- Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House
- Gilbert, S.F. 2000. Developmental Biology. Sixth edition. INC Publishers, USA.
- Wolpert, L. 2001. Principles of Development. Second Edition. Oxford Univ. Press, UK.
- James M Wells, Fiona M Watt. 2018. Diverse mechanisms for endogenous regeneration and repair in mammalian organs. Nature, May;557(7705):322-328. doi: 10.1038/s41586-018-0073-7
- Halfon N, Forrest CB, Lerner RM, et al., editors. Cham (CH): Springer; 2018. Handbook of Life Course Health Development [Internet].

*Please refer to latest editions available.

Course Title: Comparative Anatomy and Developmental biology of plants			
Course Code	LSCB7MJ02104	**Credits**	4
L + T + P	3+ 0+ 1	**Course Duration**	One Semester
Semester	VI	**Contact Hours**	45 (L) + 30(P) Hours
Course Type	Discipline Based Elective Course		
Nature of the Course	Theory and practical		
Special Nature/ Category of the Course (*if applicable*)	Higher level course that is to be studied by a student as a requirement to gain knowledge about plant anatomy and developmental biology		
Methods of Content Interaction	Lecture, Feedback or hand note preparation, group and individual self/laboratory-based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objective: Understand on the organization of tissues and tissue systems in plants. Illustrate and interpret various aspects of embryology. Discuss the basic concepts of developmental biology

Course Learning Outcome:
An understanding basic structure and functions of plant tissues, growth and vegetative, including and reproductive growth, fertilization, embryogenesis and fruit formation compare environmental influence on development and homeostasis of and plants.

Course Content

	No. of classes
Unit-1: Tissues, Organs and special tissues • Meristematic and permanent tissues : Root and shoot apical meristems; Simple and complex tissues • Organs: Anatomy of dicot and monocot root stem and leaf. • Secondary Growth: Vascular cambium – structure and function, seasonal activity. Secondary growth in and stem, Wood (heartwood and sapwood) • Adaptive and protective systems: Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.	10
Unit-2: Structural organization of flower and Pollination • Structural organization of flower: Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac. • Pollination and Pollination mechanisms and adaptations • Flower development and organ patterning: Organization of floral organs, ABC model, modification of floral organs, boundary genes; homeotic genes of plants, MADS box, evolutionary conservation between eudicot and cereal crop plants.	12
Unit-3: Fertilization and embryogenesis • Gametophyte development and fertilization, post-fertilization changes, organization of shoot and root apical meristem, shoot and root development; leaf development and phyllotaxy • Embryonic pattern formation and polarity development: Development of embryo from zygote, cell division pattern, initiation of shoot apical meristem (SAM), root apical meristem (RAM); development of embryonic polarity, hormonal regulation of polarity development.	12
Unit-4 Embryo and endosperm • Shoot Apical Meristem (SAM) and organ size control: Initiation and organization of SAM, roles and interaction of CUC, NAM, STM, WUS, auxin and cytokinin in SAM initiation and size control. • Root apical meristem (RAM) and radial patterning: Initiation and organization of RAM, role of SHR, SCR, ethylene and auxin organization of radial patterning, root-branching, differentiation of root epidermal layer. • Endosperm: Endosperm types structure and functions.	11

• Embryo: Dicot and monocot embryo; Structure and development, Embryo endosperm relationship. • Seed-structure and development, appendages and dispersal mechanisms.	
List of Practical (Tentative): 1. Study of meristems through permanent slides and photographs. 2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs) 3. Stem: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides). 4. Root: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides). 5. Leaf: Dicot and Monocot leaf (only Permanent slides). 6. Adaptive anatomy: Xerophyte (Nerium leaf); Hydrophyte (Hydrilla stem). 7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides). 8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous. 9. Structure of anther (young and mature), tapetum (amoeboid and secretory). 10. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous. 11. Female gametophyte: Polygonum (monosporic) type of Embryo sac Development. 12. Calculation of percentage of germinated pollen in a given medium.	30 hrs
Suggested Readings*: • Scott F Gilbert: Developmental Biology • JMW Slack: Essentials of Developmental Biology • Louis Wolpert: Principles of Developmental Biology • Scott F Gilbert and Epel: Ecological developmental Biology integrating epigenetic, medicine and evolution • Taiz and Zeiger: Plant Physiology; Sinauer Associate Inc. Publishers • Ed. Jones, Ougham, Thomas, and Waaland: Molecular Life of Plants; Wiley- Blackwell **Please refer to latest editions available*	

Semester VII

Course Title: Enzymology			
Course Code	LSC8MJ02204	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	VII	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course		
Nature of Course	Theory & Practical		
Special Nature/ Category of the course *(if applicable)*	Advanced level course that is to be studied by a student as a requirement to gain knowledge about enzymes as a biocatalyst		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual self/laboratory-based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in naturebut also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

This course will cover in detail the nomenclature and classification of enzymes, Principles of catalysis, enzyme kinetics, and structural as well as chemical basis of catalytic mechanisms of enzyme reaction with an emphasis on kinetics, specificity and regulation of various types of reaction.

Learning Outcomes

The course will provide the knowledge about role of - classification of enzymes, catalyst in a chemical reaction, various factors affecting catalysis. It will help in understanding the kinetics of reaction, effect of inhibitors on kinetics, catalytic mechanism explained by structure-function relationships and regulatory strategies of various enzymes. Also, the students learn the rational design, directed evolution and applications of enzymology in therapeutics and industry

Course Content

UNIT I: Introduction	Number of Classes
• Enzyme nomenclature and Classification • Activation energy, Active site and its importance, Thermodynamics and Equilibrium; Enzyme activity; Enzyme activity, Specific activity and Units; Factor affecting enzyme activity and catalysis, Effect of pH and temperature. Role	11

of metal ions in enzyme catalysis • Isozymes; Ribozymes; Zymogens; Abzymes • Enzyme assays: Types, Continuous and discontinuous assays; Optimization of enzyme assays.	
UNIT II: Enzyme Kinetics • Enzyme Kinetics: Significance; Rapid Equilibrium, Steady state, pre-steady state, equilibrium kinetics, Michaelis and Menten Equation and its derivation, Lineweaver – Burk plot, • Significance of Km, Catalytic efficiency, and turnover number; Order of kinetics • Transient kinetics, flow techniques (continuous, stopped, quenched), Enzyme Inhibition, Models and types of inhibition; multi-substrate enzymes; Multisite and allosteric enzymes; Models and examples	12
UNIT III: Mechanisms and strategies of enzyme catalysis • Basic Catalytic principles, catalytic strategies of enzymes- Chymotrypsin, Protease, carbonic anhydrase, lysozyme, Restriction enzymes • Regulatory Strategies of allosteric enzymes-Aspartate transcarbamoylase, Kinases, Phosphatase, isozymes, proteolysis, Integration of kinetic, chemical and structural data to describe enzyme action	11
UNIT IV: Frontiers in enzymology • Rational design of an enzyme catalyst, directed evolution, selection, screening, Structural basis of enzyme action and characterization of active site residues; structure guided active site (re)design, design of inhibitors • Enzymes used in biotransformation, drug synthesis, biosensors, Therapeutic enzymes, industrial enzymes	11
Tentative list of Practical#: • Extraction of Acid phosphatase enzyme from potato • Ammonium sulfate precipitation technique for enzyme purification • Determination of Acid phosphatase activity • Effect of pH on Acid phosphatase activity • Effect of temperature on Acid phosphatase activity • Effect of substrate concentration on Acid phosphatase activity • Effect of enzyme concentration on Acid phosphatase #Experiments can be performed by some other available enzymes	30 hrs

Suggested Readings*:

1. Dixon W. B.: Enzyme kinetics.
2. IUPAC Enzyme nomenclature series.
3. J. Raymond: Enzyme Assays.
4. Nelson D.L. and Cox, M.M. 2008. Principles of Biochemistry. 5th Edition. W H Freeman& Co., USA.

5. Palmer: Enzyme Kinetics (1995).
6. Richard A. Harvey and Denise R. Ferrier: Lippincott's Illustrated Reviews:Biochemistry Fifth Edition.
7. Stryer L., Berg, J.M. and Tymoczko, J. L. 2006. Biochemistry. Sixth Edition. W.H.Freeman & Co., USA.
8. N.C. Price, L. Stevens. 2000. Fundamentals of Enzymology: The Cell and MolecularBiology of Catalytic Proteins, Oxford University Press, USA.
9. D. Purich. 2010. Enzyme Kinetics: Catalysis and Control, Academic Press, San Diego,USA.

*Refer to latest editions available.

Course Title: Advanced Molecular Biology			
Course Code	LSC8MJ02304	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	VII	**Contact Hours**	45 (L) + 30 (P) hrs
Course Type	Discipline Based Core Course (DBCC)		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Advanced level course which is to be compulsorily studied by a student as a core requirement of integrated UG -PG program in Life Science.		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - Summative Assessment in the form of End Term Examination		

Course Objectives:
The course aims to develop an understanding of the molecular dynamics of central dogma of life and mechanisms involved in maintenance, repair and selective expression of genome.

Learning Outcomes: After completion of the course the students shall have an understanding of:

- DNA repair and recombination
- Regulatory RNAs and gene silencing
- Mechanisms of regulation of genetic expression

Course Contents

Unit 1: Replication and recombination of DNA	Number of classes
• DNA Replication at molecular level in prokaryotes and eukaryotes • Repair of DNA – direct reversal of DNA damage, mismatch repair, Base excision repair, Nucleotide excision repair, recombination repair, non-homologous end-joining and translesion DNA synthesis	20

• Homologous Recombination at the Molecular Level • Site-Specific Recombination	
Unit 2: Regulation of gene expression • Gene expression – Revisiting transcription and translation • Transcriptional Regulation in Prokaryotes – transcriptional regulation by operons • Transcriptional Regulation in Eukaryotes – signal integration and combinatorial control involving activators and repressors, Epigenetic gene regulation - regulation through histone and DNA modification • Regulatory RNAs – Riboswitches, Synthesis and functions of miRNA, RNAi as a defense mechanism, long non-coding RNAs and X-inactivation	15
Unit 3: Gene regulation at organism level • Gene Regulation in Development and Evolution – Strategies for expressing specific sets of developmental genes, Homeotic genes as developmental regulators • Systems Biology – Regulatory circuits, autoregulation, Bistability, Feed forward loops, Oscillating circuits	10
List of Practical (Tentative): 1. To observe differential expression of a gene by qPCR 2. To compare binding sites of transcription factors on promoters of different genes by *in silico* approach 3. To check inducer-based regulation of lac operon 4. To detect catabolite repression	30 hrs
Suggested Readings*: 1. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick: Lewin's genes XI 2. H. Lodish, A. Berk, S L.Zipursky, P. Matsudaira, D. Baltimore, and J. Darnell: Molecular Cell Biology 3. Watson J.D., Baker T., Bell S.P., Gann A., Levine M.S., Molecular Biology of The Gene. Pearson Education 4. Watson R.F. Molecular Biology. McGraw-Hill Education * *Please refer to latest editions available.*	

Course Title: Recombinant DNA Technology			
Course Code	LSC8MJ02404	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	VII	**Contact Hours**	45 (L) + 30 (P) hrs
Course Type	Discipline Based Core Course (DBCC)		
Nature of the Course	Theory, Hand on, and Skill development		
Special Nature/ Category of the Course (*if applicable*)	Advanced level course that is to be studied by a student to gain knowledge and skill in recombinant DNA technology		
Methods of Content Interaction	Lecture, laboratory-work and assignments followed by oral and poster presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective: This course objective for students to get basic understanding of recombinant DNA technology (RDT) tools which are very helpful to understanding of genetic makeup of organism. It is also beneficial and used in different company in making medicines, health related product as well as gene manipulation. RDT has wide application in animal, plants and microorganism new variety development as well as improvement of existing varieties quality. Emphasis is laid on development of overall concept of genetic composition of living world and its inheritance.

Course Learning Outcomes:

- Students should learn RDT and its application in gene manipulation.
- Understand application of RDT in improvement of animal and plants health, varieties and productivity.
- Evaluate pros and cons of GMO and its implications in human welfare.
- Learning RDT course students should high chance to get job in biotechnology company and research institutes.

Course Content

Unit 1: Basic concept of recombinant DNA technology	**Number of classes**
• Overview of recombinant DNA technology, construction of genomic and cDNA libraries, screening of a clone from gene library, Restriction enzymes and its types (I, II, III and IV), mode of action, nomenclature, applications of Type II restriction enzymes in DNA manipulation. Blunt and sticky end DNA fragments, ligation of DNA molecules. DNA ligases, linkers and adapters. • Isolation, purification, and quantification of RNA and DNA, Restriction analysis, cloning vectors (plasmid, phage, cosmid, BAC, YAC), cloning (directional and gateway), Identification of recombinants - insertional inactivation, blue-white selection, and colony PCR.	**17**

• Method of Transformations, Vector Engineering and codon optimization; expression in bacteria, yeast, insects and insect cells, mammalian cells, plants;), over – expression of recombinant protein and its characterization (CD, MALDI-TOF, HPLC), antibodies generation.	
Unit 2: Advance recombinant DNA technology • Next generation sequencing (NGS), strategies for genome sequencing, DNA microarray, southern, northern, and western blotting. Molecular marker (e.g RFLP, AFLP, & RAPD), • *in vitro* translation, cell-free translation systems, FISH, in situ PCR, gene silencing, gene knock down in bacterial and eukaryotic organisms, CRISPR-Cas9, Reporter Gene Assays, DNA-Protein Interaction Assays, Protein-Protein Interaction Assays, yeast two hybrid assay • Genetic mutation analysis, Protein sequencing methods, detection of post translational modification of proteins. • DNA modifying enzymes: Alkaline phosphatase, Poly nucleotide kinase, Terminal deoxynucleotidyl transferase	**18**
Unit 3: Applications of RDT • Applications in medicine, production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII. • Recombinant vaccines (Hepatitis B). Gene therapy. Applications in agriculture - plant genetic engineering, • Herbicide resistant crops, problems with genetically modified plants, safety concerns. • Diagnosis of Genetic Diseases, DNA Fingerprinting, Animal Husbandry, gene editing, Bioethical issues. • Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, *Ti plasmids*, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants	**10**
List of Practical (tentative) 1. Isolation of chromosomal DNA from plant cells and agarose gel electrophoresis. 2. Qualitative and quantitative analysis of DNA using spectrophotometer 3. Restriction digestion of DNA 4. Transformation of competent cells. 5. Demonstration of PCR	**30**

Suggested Readings:

- Brown, T.A. (2010). Gene Cloning and DNA Analysis 6th ed, Wiley-Blackwell publishing (Oxford, UK).
- Primrose, S.B. and Twyman, R. M. (2006), Principles of Gene Manipulation and Genomics 7th ed., Blackwell publishing (Oxford, UK).
- Glick, B.R, Pasternak, J.J. and Patten, C.L. (2010), Molecular Biotechnology, Principles and Applications of Recombinant DNA 4th ed, ASM Press (Washington DC).
- Clark, D.P and Pazdernik N.J. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
- Glick, B.R. Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- Sambrook, J. Fritsch, E.F. and Maniatis, T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press

Course Title: Instrumentation and applications			
Course Code	LSC8MJ02504	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	VII	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course (DBCC)		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Advanced course to gain knowledge related to instrumentation and their applications in Biology.		
Methods of Content Interaction	Lectures, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field-based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objectives: The course aims to:

1. Comprehensive understanding of the principle of instrumentation and applications.
2. To provide knowledge about instrumentation used to perform research work
3. To orient the students with various techniques including bioinformatics, biostatistics, biophysics, radiolabeling and AI.
4. To learn techniques and developing skills in designing methodology and logical interpretation of the results.

Course Learning Outcomes: After completion of the course, the students shall have an understanding of:

- Knowledge of principle, component and applications of instruments.
- Develop the ability to integrate interdisciplinary knowledge for innovative research and problem-solving.

Course Contents

	Number of classes: 10
Unit I Introduction to Bioinformatics, hands-on computers, Biological databases, access the databases for data retrieval: nucleic acid databases (NCBI, EMBL, DDBJ), fasta format, protein databases (SWISS Prot, PIR), structural databases (PDB, CATH, SCOP), pdb format, specialized databases (KEGG, OMIM, Sequence similarity search: input file preparation, BLAST and its types, Multiple Sequence alignment: CLUSTALW, phylogenetic analysis, Domain analysis of protein sequences, Application of computational methods in experimental design of genetic manipulations.	
Unit II Principle, component and applications of: Centrifugation, ultracentrifugation, Spectrophotometry, Microscope, fluorescence microscope: FRAP, FRET, Confocal microscopy; Chromatographic techniques, Electrophoresis, Circular dichroism spectrophotometer, Secondary structure analysis of proteins; Protein structure	15

determination using X-ray diffraction (XRD), Nuclear magnetic Resonance (NMR), Scanning Electron Microscope, Transmission Electron Microscope; Dynamic light scattering (DLS); Mass spectrometer; surface plasmon resonance spectroscopy Geiger-Müller radioactivity detector, scintillation counter, Northern blotting, southern blotting, western blotting, safety guidelines, disadvantages, alternatives to radiolabelling techniques of Direct or indirect labelling, Biotin, Alkaline phosphatase, Horse radish peroxidase, Detection methods	
Unit III Introduction to biostatistics, concept of variables in biological systems, types of variables; Measures of central tendency and dispersal, preparing plots and charts in excel, graph pad Prism, concept of probability distributions (Binomial, Poisson and normal), Sampling distribution; Difference between parametric and non-parametric statistics; confidence interval; Errors; Levels of significance; Regression and correlation; t-test; Inferential aspects of analysis of variance	10
Unit IV Artificial Intelligence (AI) in Life Science, Basic concepts and terminology, Biological Intelligence Vs Artificial Intelligence, Application in Healthcare, Mia; Application of AI in: pharmaceutical industry, drug design, lead optimization and clinical trial, Biomarker discovery, precision medicine, health diagnostics, and Agriculture. Ethical concerns of AI in biology, Omics and its applications in Life Science.	10
List of Practical (Tentative): 1. DNA and protein sequence retrieval from NCBI and swiss-prot database 2. Similarity search using BLAST 3. Multiple sequence alignment using CLUSTALW 4. Assignment on Principle, component and applications of instruments (Electrophoresis, Microscope, Centrifuge, spectrophotometry, HPLC) 5. Examining the distribution of a test dataset 6. Calculating probabilities and p-values 7. One and two sample test 8. Generating good quality plots: scattered plot, bar plot, histogram, pi-chart, density plots and box plots	30 hrs
Suggested Readings*: • David Mount (2004): Bioinformatics: Sequence and Genome Analysis, Second Edition • Arthur Lesk (2008): Introduction to Bioinformatics, 3rd Edition • Teresa Attwood and David Parry-Smith (2001): Introduction to Bioinformatics • Stephen A. Krawetz and David D. Womble (2003): Introduction to Bioinformatics: A Theoretical and Practical Approach, 1st Edition • Andreas D. Baxevanis (Editor), B. F. Francis Ouellette (Editor): (2004) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition • Daniel W. W. (9th Edition). Biostatistics: A Foundation for Analysis in the Health Sciences. Wiley. • Sokal R. R. & Rholf F. J.: Biometry W.H. Freeman, San Francisco, USA. • Principles and Techniques of Biochemistry and Molecular Biology 14 July 2010 by Wilson/Walker • The Cell: A Molecular Approach; Cooper GM.; Sunderland (MA): Sinauer Associates; 2000. **latest editions of the textbooks should be referred*	

Semester VIII

Course Title: Defense Mechanism			
Course Code	LSC8MJ02604	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	VIII	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field-based assignments followed by workshops and seminar presentation.		
Nature of Course	Theory & Practical		
Special Nature/ Category of the course *(if applicable)*	Advanced level course that is to be studied by a student as a requirement to gain knowledge about defense strategies/ mechanisms of biological systems		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in naturebut also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Objective of the Course:

- To understand the defense mechanism of animals.
- To identify the various components of immune system with their functions
- To acquaint with and explain the processes like inflammation, allergy, transplantation,autoimmune diseases etc.
- To utilize antibody for applications in different fields

Outcome of the Course:

Students will be able to:

- Identify and explain components of defense system of animals.
- Correlate observations in the surrounding environments with the immune system.
- Use techniques important for diagnostic and experimental purposes.
- Explain mechanisms, at molecular and cellular level, of different pathological conditions.

Course Contents

Unit 1: Introduction Overview of defense mechanisms in plants and animals; Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (MALT).	Number of Classes 10
Unit 2: Innate immunity in plants, Chemical and morphological defense in plants; elicitors, receptors, Basal resistance and innate biochemical host defenses	5

Unit 3: Innate immunity in animals, Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity, cell adhesion molecules, chemokines, leukocyte extravasation, localized and systemic response. Complement activation by classical, alternate and MBL pathway, biological consequences of complement activation, regulation and complement deficiencies.	5
Unit 4: Adaptive Immunity in Plants Abiotic- strategies and mechanisms; effect of UVB light on herbivory. Biotic- interactions with symbionts, pathogens. Biochemical host defenses, Basal resistance and basic compatibility; epidemiological and population genetics, co-evoluton in natural plant pathogen systems. Gene for gene concept; interaction in host-pathogen systems, receptor-elicitor model, plant gene-gene interaction. Cytological protection and induced resistance. Passive and active defenses: Jasmonic acid, MAPKS, SROS, HPL, systemins, Heatshock proteins, oxylipin, Basic ROS cycle and adaptation during stress, Phytolexins, mechanism of production and scavenging of NO. Herbivory related signals and other induced signals.	10
Unit 5: Adaptive Immunity in Animals Antigens and haptens, Factors that dictate immunogenicity, B and T cell epitopes. Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family. Generation of antibody Diversity. Monoclonal antibodies; Immunological methods- Antigen-antibody interactions; Histocompatibility antigens - HLA and Disease; T cell differentiation – Positive and Negative selection, Antigen Presentation, Activation of T and B cells. Cytokines and Chemokines.	10
Unit 6: Immune dysfunction and applications Immunological tolerance; Immunological disorders-Hypersensitivity and Autoimmune diseases. Immunodeficiencies; Transplantation Immunology; Immune response against major classes of pathogens. Applications in agriculture, pharmaceuticals, and biopest conrol.	5
List of Practical (Tentative): • Characterization of diseases symptoms and identification of pathogenic organisms (at least one each from viral, fungal, pest and nematodes injection). • Survey of structural plants defenses: viz. cuticle, wax, lignin, bark, thorns, prickles, trochomes, armour in different plants species including thigmonasty, camouflage, mimicry. • Survey: Quantitative secondary metabolites in plants: alkaloids, glycosides, glycosinolates, terpinoids, phenolics, gammosis etc. in healthy and diseased plant/plant organs. • Partial purification of Immunoglobulin's by Ion Exchange chromatography • Immunodiffusion • ELISA	30 hrs

SUGGESTED READINGS:	
1. Deverall, Brain J. 1977. Defences mechanisms of plants, Cambridge University Press. 2. K. Murphy, P. Travers, M. Walport. Janeway's Immunobiology, Garland Science, Taylor and Francis Group, LLC 3. Judith A. Owen: Kuby Immunology	

Course Title: Indian Knowledge System in Traditional Medicine			
Course Code	LSC8MJ02704	**Credits**	4
L + T + P	2 + 2 + 0	**Course Duration**	One Semester
Semester	VII	**Contact Hours**	30 (L) + 30 (T) Hours
Nature of the Course	Discipline Based Core Course		
Special nature/ Category of the Course (if applicable)	A course which is to be studied by a student for appreciating Indian contribution to medicine and its vast traditional knowledge as a core requirement of integrated UG – PG program in Life Science.		
Methods of Content Interaction	Lecture, Expert Talks, Tutorials, Group discussion, self-study, seminar, presentations by students, individual and group tasks.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Objective of the Course: The course is aimed to develop an understanding of traditional Indian system of medicine and a sense of appreciation towards efficacy of this therapeutic system. It shall inculcate scientific aptitude amongst students towards traditional medicines and help them explore career opportunities in the field and the proficiencies of India becoming an all-inclusive global health capital.

Outcome of the Course: After completion of the course students will:

- Have knowledge of various sources of Indian traditional medicine
- Instill an understanding of alternative and supportive health therapies originated in India
- Visualize scope and careers of traditional medicines in India and abroad

Course Content

Unit 1: Introduction to Ayurved and Siddha	No. of Classes 20 (10L + 10T)
History of medicine in India, Contribution of India to medical world; Introduction to AYUSH and Local Health Traditions; A brief understanding of YOGA and philosophy	

• A detailed outline of Siddha System of Medicine. • Ayurveda as science of life and it philosophical roots (vedas, upanishads darshana and shastras), Important books in Ayurveda - Brihat Trayee (charka, sushruta and vagbhata) and laghu trayee (sharangdhara , madhava nidana and bhav prakasha) • Ashtanga Ayurveda • Fundamental principals - Panchamahabhuta, tridosha, dhatu and mala • Prakriti - Constitution of a person • Trayaopastambha - Swapna, aahara and (a)brahmacharya • Preservation of health through - DINAcharya, Ritucharya and Vega na dharnaSiddha history, siddha medicine and fundamental principles, Anthric theories, with three primordial, Humoural theory, learning of seven physical constituents, epistemology. • Concept of Digestion and Detailed understanding of diet and nutrition in ayurveda.	
Unit 2: Herbal Medicine • Understanding of disease in ayurveda - prakriti vs vikriti • Examination of disease and diseased - Roga and Rogi pareeksha • Knowledge of Panchakarma • Knowledge of Dravya Guna - Basic idea for understanding herbs (medicinal plants) throngh rasa, guna, veerya vipaka • Knowledge of Bhaishajya kalpana - basic dosage forms • Knowledge of Rasashastra. - Metals and Minerals , their processing, safety and efficacy • Concept of herbalism and its significance. Introduction to phyto-medicines and herbal raw materials. Local health traditions, ethnomedicine. • Pharmacognosy and mode of action of herbal based drugs	20 (10L + 10T)
Unit 3: Current Research and Career prospects • Concept of Mind - Indian Psychology • Research papers, journals, govt. initiatives , etc. • Traditional knowledge and Modern Herbal Industry - Delinking from herbalism • Intigrative Medicine as future of modern healthcare.Ethnobotany genomics and Ethnoagriculture • Herbal Translational Research and evidence based clinical outcomes • Standardization of plant based drugs and quality control • Patents and careers in Ayurveda	20 (10L + 10T)
SUGGESTED READINGS: 1. Clinical Research Protocols for Traditional Health Sciences (Ayurveda, Siddha, Unani, Sowa Rigpa, and Other) by Central Council for Research in Ayurveda and Siddha 2. The Book of Ayurveda: A Holistic Approach to Health and Longevity by Judith Morrison; Simon & Schuster 3. Encyclopedia of Herbal Medicine by Andrew Chevallier; DK Publication, Penguin Random House 4. Herbal Medicine in India: Indigenous Knowledge, Practice, Innovation and its Value. Edited by Saikat Sen, Raja Chakraborty. Springer Singapore	

Course Title: Vocational training in Animal Research			
Course Code	LSCZ8MJ02804	**Credits**	4
L + T + P	0+1+3	**Course Duration**	One Semester
Semester	VIII	**Contact Hours**	15 (T) + 90 (P) Hours
Course Type	Discipline Based Elective Course (DBEC)		
Nature of the Course	Laboratory Work		
Special Nature/ Category of the Course (*if applicable*)	Vocational/Skill Based		
Methods of Content Interaction	Protocol instruction by Lecture and Laboratory demonstration/hands-on training		
Assessment and Evaluation	30% - Continuous Internal Assessment (10% Internal Assessment by faculty member, 20% - Record keeping + Bench skill) 70% - End Term External Examination (University Examination) (Overall Record Book, Viva, Activity performed in examination)		

Course Objectives:

- To give an exposure of standard procedures of a recombinant DNA laboratory.
- To run enzyme assays and its data analyses.

Course Learning Outcomes: This course is to provide students with hands-on experience with tools and techniques used in the Life Science laboratory, with a focus on the production and downstream processing of recombinant proteins. This training will help students to develop the necessary skills required for placement in research laboratories and biotech industries.

Course Contents

	Number of Classes **45**
Laboratory 1: Cloning and Expression of desired gene from a biological source *Protocol of RNA isolation and cDNA synthesis:* Material required for total RNA isolation Quality and Quantification of RNA Synthesis of complementary cDNA *Amplification of desired DNA segment from cDNA:* Primer designing Material required for Polymerase chain reaction Handling of enzymes Cleaning and maintenance of Thermocycler Preparing a polymerase chain reaction Design of Program in thermocycler Initiate the reaction in thermocycler Real Time PCR and its applications *Verification of amplified product:* Verification of amplification of the desired DNA fragment by agarose gel	

electrophoresis. Use of standard DNA length markers Purification of DNA fragment from agarose gel Sequencing of PCR products using Sanger and NGS methods Ligation of PCR amplified DNA fragment in TA / blunt end cloning vector	
Laboratory 2: Expression of desired gene in prokaryotic system from a biological source *Transformation of E. coli by constructs:* Preparation of Competent *E. coli* cell Transformation of *E. coli* cells with construct Screening of transformed cells by colony PCR Purification of plasmid from positive colonies Release of insert by Double digestion from the purified constructs Double digestion from the purified expression vector Purification of digested insert and digested expression vector from agarose gel Ligation and transformation of Expression host by construct. Screening of colonies by colony PCR *Expression and Purification of Expressed Protein:* Induction of protein expression in transformed *E. coli* Verification of expression by SDS PAGE. Purification of Expressed protein by chromatography	45
Suggested Readings: Molecular Cloning: A Laboratory Manual Book by E. F. Fritsch, Joseph Sambrook, and Tom Maniatis	

Course Title: Insect, Vector and Animal Diseases			
Course Code	LSCZ8MJ02904	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	VIII	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Elective Course (DBEC)		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Advanced level course that is to be studied by a student as a requirement to enhance their knowledge about the insects and their role in spreading diseases in humans.		
Methods of Content Interaction	Lecture, group discussion, laboratory-work and assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective: To equip students with a comprehensive understanding of the biology of arthropod pests, and the disease-causing pathogens they transmit to the humans, enabling students to study and analyze problems related to vector borne diseases. A hands-on laboratory will provide an up close look at the biology of arthropods of medical importance.

Course Learning Outcomes:

- Identify arthropods that affect human health.
- Understand the mechanisms of disease transmission to humans.
- Understand the dynamics of vector-borne diseases.

Course Content

Unit I: Introduction to Insects & Concept of Vectors Introduction to Insects: General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits Concept of Vectors: Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, Vectorial capacity, Adaptations as vectors, Host Specificity	Number of classes: 08
Unit II: Insects as Vectors Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera	06
Unit III: Dipteran as Disease Vectors Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes; Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever; Control of Sand fly; Study of house fly as important mechanical vector, Myiasis, Control of house fly	18
Unit IV: Siphonaptera, Siphunculata and Hempitera as Disease Vectors Siphonaptera as Disease Vectors: Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas; Siphunculata as Disease Vectors: Human louse (Head, Body and Pubic louse) as important insect vectors; Study of louse-borne diseases –Typhus fever, Relapsing fever, Trench fever, Vagabond's disease, Phthiriasis; Control of human louse Hempitera as Disease Vectors: Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures	13
List of Practical (Tentative): 1. Study of different kinds of mouth parts of insects 2. Study of following insect vectors through permanent slides/ photographs: *Aedes, Culex, Anopheles, Pediculus humanus capitis, Pediculus humanus corporis, Phithirus pubis, Xenopsylla cheopis, Cimex lectularius.*	30 hrs

Phlebotomus argentipes, Musca domestica,	

Suggested Readings*:

- Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK
- Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press, UK
- Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication
- Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell

Course Title: Plant Pathology			
Course Code	LSCB8MJ03004	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	VIII	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Elective Course (DBEC)		
Nature of the Course	Theory and practical		
Special Nature/ Category of the Course (*if applicable*)	Advanced level course on plant-pathogen interactions, disease resistance, and advanced diagnostics.		
Methods of Content Interaction	Lecture, group discussion, laboratory-work, assignments, seminar, presentation		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective:

The objective of this course is to provide an in-depth understanding of plant pathogens, disease development, and host defense mechanisms. It covers molecular interactions in host-pathogen relationships, disease resistance strategies, and advanced diagnostic techniques, equipping students with both theoretical knowledge and practical skills for plant disease management.

Course Learning Outcomes:

Upon successful completion of the course, students will be able to:

1. Explain plant defense mechanisms at molecular and biochemical levels.
2. Analyze host-pathogen interactions, including effectors and toxins.
3. Differentiate plant disease resistance mechanisms and their applications.
4. Apply integrated disease management and genetic engineering approaches.
5. Utilize molecular diagnostics for disease detection.
6. Perform laboratory techniques for pathogen isolation and identification.

Course Content

Unit I: Pathogen and Disease Development • An overview of nature of pathogens and pests	**Number of classes**

• Effectors, biotrophic-hemibiotrophic-necrotrophic lifestyles • pathogen penetration, establishment, colonization in host • Genetic and molecular basis for disease resistance, Flor's hypothesis, Koch postulates, disease epidemics and epidemiology • Disease triangle, disease forecasting models, climate change and disease emergence	**10**
Unit II: Defence Mechanisms and Biochemical Responses • Preformed plant defences and induced host defences • Biochemical and physiological responses • Physiology and biochemistry of plant disease • Primary metabolism, Secondary metabolism, role of cell wall in plant defence	**08**
Unit III: Host-pathogen Interactions • Molecular determinants of pathogenicity, effectors, elicitors, defensins, phytoalexins, common phenolics • Host- pathogen interaction mechanisms • Plant cell wall degrading enzymes • Host specific toxins, host nonspecific toxins • Hormones and signaling	**12**
Unit IV: Disease Resistance, Management and Advanced Diagnostics • Plant disease resistance, classes of resistance genes • Adapted host resistance, non-adapted host resistance • Systemic acquired resistance, Induce Systemic acquired resistance, Pathogenesis-related (PR)-proteins • Role of DNA methylation, histone modification, and small RNAs in plant defence • Genetic Engineering Approaches for disease resistance • Integrated Disease Management • Advanced techniques such as qPCR, LAMP, ELISA, biosensors, microfluidics, and CRISPR-based diagnostics for plant disease diagnosis • AI in Plant Pathology	**15**
Tentative List of Practical 1. Collection and Identification of Diseased Specimens 2. Isolation and Culturing of Plant Pathogens 3. Microscopy and Staining Techniques for Pathogen Identification 4. Artificial Inoculation & Koch's Postulates 5. Fungicide Sensitivity Assays and Biocontrol Testing 6. Serological and Molecular Detection of Pathogens (ELISA, PCR)	**30 hrs**

Suggested readings:

- Plant Pathology, T.N. Agrios, Academic Press, 2001
- Introduction to Plant Pathology, Richard N Strange, 2003, Springer publication
- Host Pathogen Interactions, Lucas, 2001, Blackwell publication
- Plant Diseases, RS Singh (2008), Oxford and IBH Publishing Co. Pvt Ltd 15. Principles of Plant Pathology, RS Singh (2008), Oxford and IBH Publishing Co. Pvt Ltd
- *Annual Review of Phytopathology*
- *Annual Review of Plant Biology*

Course Title: Vocational Training in Plant Research			
Course Code	LSCB8MJ03104	**Credits**	4
L + T + P	0+ 1+ 3	**Course Duration**	One Semester
Semester	VIII	**Contact Hours**	15(T) + 90(P) Hours
Course Type	Discipline Based Elective Course		
Nature of the Course	Tutorial and Practical		
Special Nature/ Category of the Course (*if applicable*)	An advanced level course for students opting for specialization in plant science also include group discussion, demonstration, skill-based, guided practice, practical experiences, fieldwork and other independent learning.		
Methods of Content Interaction	Lecture, Feedback or hand note preparation, group and individual self/laboratory-based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objective:

- To equip students with hands-on experience in plant science research techniques

Course Learning Outcome:

- Students will be able to identify soil types and how they are formed and ways to modify soil structure and drainage to reduce erosion and improve water quality and water availability to plants.
- Students will understand how soil fertility is determined and how plant nutrient deficiencies are identified, and means of improving soil fertility and adding nutrients for plant growth.
- Students will be able to apply knowledge to solve problems related to crop production and

plant growth by different methods

- Students will be able to handle different instruments and technique in modern plant science.

List of Practical:	Number of classes
1. Collection of soil samples and assess soil acidity/alkalinity and conductivity 2. Soil Moisture Content Determination 3. Evaluate seed germination potential under controlled conditions 4. Steps of *Agrobacterium*-mediated transformation in plants 5. Hydroponic culture 6. Understanding the functioning, maintenance, and environmental control mechanisms of a greenhouse, nursery and garden 7. Assays for Stress Response in plants • Morpho-Physiological parameters • Bio-chemicals parameters • Molecular parameters 8. Estimations of plant organic and inorganic nutrients 9. To assess soil microbial population using serial dilution and plate count 10. Different types of media used in microbial culture 11. Culturing bacteria and fungi from infected plant tissues 12. Basic steps of plant tissue culture 13. Different types of media used in plant tissue culture 14. RNA isolation from plant tissues and cDNA synthesis 15. Primer designing 16. PCR amplification 17. Gel electrophoresis, spectrophotometry, and quality assessment 18. Bacterial expression of plant protein and SDS-PAGE 19. Purification of expressed plant protein and conc. estimation 20. Statistical analysis	60 (15T+45P) 95 hrs

Suggested readings*: • Plant Biotechnology and Molecular Biology : A Laboratory Manual By M.S. Punia • Plant Cell, Tissue and Organ Culture Fundamental Methods by Gregory C. Phillips, Oluf Gamborg • Plant Biotechnology A Practical Approach by H. S. Chawla **Please refer to latest edition available*	

Course Title: Research Project			
Course code	LSCZ8MJ032012/ LSCB8MJ032012	**Credit**	12
L+T+P	0+0+12	**Course duration**	One Semester
Semester	VIII	**Contact Hours**	360 (P) Hours
Course Type	Discipline Based Core Elective (DBCE)		
Nature of the Course	Research work		
Special Nature/ Category of the Course *(if applicable)*	Project-work/Laboratory-work/Hands-on learning/Skill Development/Entrepreneurship		
Methods of Interaction	One to one interaction, presentation, lab work and field work		
Assessment and Evaluation	• 30% - Continuous Internal Assessment by the Dissertation supervisor (With in department: supervisor; Outside the department: joint evaluation by internal and/or external supervisors both) • 70% - Research Project Report [50% - Problem Definition and novelty (20), Methodology and experimental design (10 marks), Results & Discussion (10 marks), Conclusion & Future Scope (5 marks), Formatting & References (5 marks)], & Presentation by the candidate [20% - Presentation Content (5 marks), Quality of slides, Effective use of diagrams, tables, and graphs (5 marks), Presentation Skills (5 marks), Q&A Handling (5 marks)] – joint evaluation by DC.		

Course objectives:

- To develop analytical, critical thinking, problem-solving, and decision-making skills
- To acquire and develop autonomous skills
- To develop scientific communication and public speaking skills
- To develop abilities to independently learn new knowledge and methods
- To learn scientific writing skills.

Learning outcomes: Upon successful completion of this course, the students will be able to grasp the fundamental concepts and requirements of laboratory-oriented work which is essential to becoming a professional researcher. The student will be equipped with laboratory basics and various techniques that enable them to either enter a Life Science related industry or pursue higher studies.

Course Content: Any potential research problem relevant to local/national/international needs; research on SDGs related problems, research on Government of India's priority areas.

Semester IX

Course Title: Biosafety and IPR			
Course Code	LSC9MJ03304	**Credits**	4
L + T + P	3+1+ 0	**Course Duration**	One Semester
Semester	IX	**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline Based Core Course (DBCC)		
Nature of the Course	Theory		
Special Nature/ Category of the Course (*if applicable*)	Advanced level course that is to be studied by a student as a requirement to understand biosafety issue and preserve their research finding in form of intellectual property rights.		
Methods of Content Interaction	Lecture, group discussion, and assignments followed by oral and poster presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective: To teach proper handling, containment, and disposal procedures for potentially hazardous biological agents to protect researchers and the environment. To gain knowledge about the process of patent filing and other IPRs for biological invention, including claim drafting and patent prosecution. It aims to introduce the legal framework for IPR and biosafety including international treaties and national laws.

Course Learning Outcomes:

- Students will learn about biosafety and Intellectual Property Right (IPR).
- They understand biosafety norms of laboratory help them to save ownself, surrounding researchers along with environment.
- Students received idea after this course completion about how to save their research works findings through patent, trademarks and other IPR rights.
- IPRs knowledge helps to safely works in research laboratory and keep save their innovation protected through different type of IPRs.

Course Content

Unit 1: Introduction of biosafety • Overview of biosafety and health hazards • Concept of contaminant level and good laboratory practices biological safety cabinets & its types, details about different type of biological biosafety levels (BSL1, BSL2, BSL3, & BSL4) of microorganisms and its importance. • Biosafety guidelines and regulations for Genetic Modified Organisms (GMOs), Concerns, and Challenges, • Role of Institutional Biosafety Committees, Review Committee on Genetic Manipulation (RCGM), Genetic Engineering Appraisal Committee (GEAC) etc. for GMO applications in food and agriculture,	**Number of classes:** 20 (15L+5T)

Environmental release of GMOs, Animal cloning, stem cell research, and Risk management.	
Unit 2: Introduction of Intellectual Property Right (IPR) • Overview of IPR, patents and its types, Trademarks, Copyright & Related Rights, • Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR – patentable and non-patentable. • Patenting life legal protection of biotechnological inventions – world intellectual property rights organization (WIPO).	20 (15L+5T)
Unit 3: Details on Patent • Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, Patent cooperation treaty (PCT), Conventional, Divisional and Patent of Addition; • An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.	14 (10L+4T)
Unit 4: Biomedical waste management and Radioisotopes usage guidelines • Biomedical Waste (Management and Handling) Rules, • AERB, RSD, RES guidelines for using radioisotopes in laboratories and precautions.	6 (5L+1T)
Suggested Readings*: • Goel, D. and Prashar, S. (2013). IPR, Biosafety and Bioethics. Pearson • Sadhasivam, S.K and Mohammed Jaabir, M. S.(2008). IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India. • Bare Act, (2007). Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi. • Kankanala, C. (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi. • Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd. • Singh, K. K (2015). Biotechnology and Intelectual Property Rights: Legal and Social Impliocations, Springer India.	

Course Title: Animal Physiology & Endocrinology			
Course Code	LSC9MJ 03304	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	IX	**Contact Hours**	45(L) + 30 (P) Hours
Course Type	Discipline Based Course Elective		
Nature of Course	Theory & Practical		
Special Nature/ Category of the course *(if applicable)*	Advanced level course that is to be studied by a student as a requirement to complete the BSc-MSc in Life Science with specialization in Zoology.		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual research paper-based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in naturebut also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objectives:

- To understand basic physiological processes of life in animals and endocrinology.
- To focus on structures and processes of organs and organ systems in an organism.
- To understand mechanisms of homeostasis.
- To integrate the molecular and cellular processes with tissue, organ and organ system levels and their coordination.

Course Learning Outcomes: Students will be able:

- To correlate life processes with daily activities like breathing and respiration, nutrition digestion, visual and neural connections etc.
- To connect variations in physiological conditions and their cause like nutritional, environmental or psychological etc.
- To understand pathological conditions of certain disorders.
- To compare and understand evolution of structures to perform physiological functions for the adaption of organisms.
- To perform hematological tests in the pathology or other laboratories.

Course Content

Unit 1:	Number of classes: 06
• **Blood and Circulation** – Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin and other respiratory pigments,immunity, haemostasis, open and closed circulation. • **Cardiovascular System** - Anatomy of heart structure, myogenic heart, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.	

Unit 2: • **Respiratory System** – Anatomy of respiratory system, Respiration in vertebrates, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. • **Nervous System** - Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Senses -Vision, hearing and balance, olfaction, taste, ouch and temperature. • **Excretory System** - Physiology of excretion in vertebrates, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid- base balance.	12
Unit 3: • **Digestive System** - Introduction to evolution of digestive system, digestion, absorption, neuronal and endocrine regulation of digestive processes, energy balance, BMR. • **Thermoregulation** - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization, stress and adaptation. • **Physiology of male and female reproduction** – Spermatogenesis, oogenesis, follicular development, steroidogenesis, implantation, pregnancy, and mammary gland development.	12
Unit 4: • **Endocrinology:** Endocrine glands, concept of endocrine regulation of physiological process. Hormones: classification – proteins, steroid and derived hormones. Regulation of hormonal secretion-feedback control, secretory mechanism, Role of hypothalamus. Mechanism of hormone action-protein and steroid. • **Histology and functions of endocrine glands:** Adenohypophysis and neurohypophysis, Hypothalamus, Thyroid gland and Parathyroid gland, Endocrine pancreas; Adrenal cortex and medulla; Gonads: Endocrine testis and endocrine ovary.	15
List of Practical (Tentative): 1. Introduction to the laboratory and Lab safety Do's & Don'ts. 2. To count the total RBC in blood. 3. To determine of hemoglobin content. 4. To measure the sugar level in blood. 5. To measure blood pressure by sphygmomanometer. 6. To find the blind spot of eye and related phenomena. 7. Study of different types of eggs 8. Observation of rat/frog sperm and ova 9. General study of endocrine glands in rat 10. Examination of sections of Pituitary, Adrenal, Thyroid, Parathyroid	30 hrs

Suggested Readings*:

- Guyton and Hall textbook of medical physiology by Hall, John E. and Guyton, Arthur C. Published by: Elsevier (Philadelophia), 2011.
- Barrett, Kim E.: Gangong's review of medical physiology by Publication Tata McGrawHill, 2012.
- David Randall, Warren Burggren, and Kathleen French., WH Freeman: EckertAnimal Physiology: Mechanisms and Adaptations, Fifth Edition.
- Kandel ER, Schwartz JH, Jessell TH: Principles of neural science 2000, 4th edition.New York: McGraw-Hill.
- Martini H, Nath JL, Bartholomew EF: Fundamentals of Anatomy Physiology. Pearson, 2017.
- Mack E Hedley. Endocrinology. Pearson Press.

*Refer latest edition

Course Title: Animal biotechnology			
Course Code	LSCZ9MJ03404	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	IX	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Elective (DBCE)		
Nature of the Course	Theory and Practical, Hand on Skill Development		
Special Nature/ Category of the Course (*if applicable*)	Advanced level course course that is to be studied by students to enhance the understanding and skills in animal biotechnology through integrated UG-PG program.		
Methods of Content Interaction	Lecture, laboratory-work and assignments followed by oral and poster presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective:

To explain the students', the principle, practices and application of animal biotechnology. They learn cell line, stem cell, animal cloning and generation of knockout which help them to resolved problems related to health and medicine. It also includes make students aware the scope / career in animal biotechnology which encompasses almost every field of science like research, commercialization/entrepreneurship, and academics.

Course Learning Outcomes:

- Students learn components of animal biotechnology for instance, cell line & culture, stem cells, animal cloning, and gene knockout
- Enable students to do manipulation of the genetic materials of an organism for the improvement in desired trait.
- Understand better the ethical and social issues of GMOs.
- Use the course content knowledge for designing & execution of a research project.

- Acquire technical skills which are essential for students to peruse future career in research labs/industry/institute/pharmaceutical etc. including entrepreneurship.

Course Content

Unit 1: Animal cell line & culture • Introduction of cell and tissue culture, requirements, components, cell line and cell types, primary culture, two- and three-dimensional cell culture, applications, and prospects; microfluidics, organ-on-chip	Number of classes: 05
Unit 2: Stem cells, animal cloning, and gene editing • Biology of stem cells: Overview, different types of stem cells, embryonic stem cells, fetal tissue stem cells, and adult stem cells. Stem cell therapy and its application. • Stem cell differentiation and plasticity: Overview, self-renewal potential; differentiation versus stem cell renewal; • Human Embryonic Stem Cells and Society: The religious, legal, ethical and scientific debate; the future of the debate; the regulatory aspects of therapeutical use of stem cells. • Animal cloning: challenges in human therapeutic cloning, overview of somatic cell nuclear transfer techniques and its application. Pros and cons of animal cloning. • Gene editing: overview of transient and permanent gene editing/knock down by siRNA, shRNA, and CRISPR-Cas9 and its application in biomedical research.	25
Unit 3: Genetically Modified Organisms and application • Production of transgenic animals: DNA microinjection, Retrovirus mediated gene transfer, sperm mediated gene transfer, and Embryonic stem cell mediated gene transfer. • Ethical issue related to transgenic animals: animal welfare concern, religious social outreach, medical issue with GMO products (allergens), and environment concerns. • Applications of transgenic animals: Production of pharmaceuticals, vaccines, production of donor organs. Research model for animal diseases (Transgenic and humanized). • Overview of nude mice: Xenograft model and its relevance for animal research works.	15

List of Practical (Tentative):	30 hrs
1. Animal cell culture demonstration, cell counting, and trypan blue staining. 2. Demonstration of rodent mice and handling. 3. Demonstration of microtomy and animal tissue paraffin embedded section cutting and staining. 4. Demonstration of genotyping in mice.	

Suggested Readings*:

- Capes-Davis, A and Freshneys, R.I.(2021). Freshneys culture of animal cells a manual of basic technique and specialized applications. Wiley Blackwell.
- Kasper, C. Egger, D. Lavrentieva, A (2021). Basic concepts on 3D cell culture, kindle edition.
- Mummery, C, Wilmut, S.I, Stolpe, A.V de. Roelen B.A.I (2011). Stem cells scientific facts and fiction. Elsevier Academic Press.
- Atala, A and Lanza, R (2012). Handbook of Stem Cells. Volume 2 Eds, Elsevier Academic Press.
- Panno, J.P(2004), Animal cloning: The science of nuclear transfer. Facts on file Inc.
- Armstrong, B(2023). Textbook of transgenesis and cloning. American academic publisher.
- Glick, B.R., Pasternak, J.J. and Patten, C.L. (2010). Molecular Biotechnology- Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.
- Clark, D. P. and Pazdernik, N.J. (2012) Biotechnology, Academic Press.
- Fogh, J. and Giovanella, B.C.(1978). The Nude Mouse in Experimental and Clinical Research. Academic Pr.
- Hofkar , M.H and Deursen, J.V.(2002).Transgenic mice : Method and protocol. Volume-209, Humana Press.

*Refer to latest edition

Course Title: Animal Behavior			
Course Code	LSCZ9MJ03504	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	IX	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Courses (DBCC)		
Nature of the Course	Theory and Practical, Hands-on		
Special Nature/ Category of the Course (*if applicable*)	Advanced level course that is to be studied by students to develop deep understanding of animal behavior		
Methods of Content Interaction	Lecture, field projects, laboratory-work and assignments followed by oral and poster presentation.		

Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)

Course Objective: Students get familiar with different prospective of animal behavior and their significance in chronobiology, conservation biology, behavioral ecology, and evolutionary biology. They study about biological clocks and rhythms operating inside the living organisms and its adaptive and practical important.

Course Learning Outcomes:

- Enhance their observation, analysis, interpretation and documentation skills by taking short projects pertaining to animal behavior.
- Corelate the animal behavior with other subjects such as animal biodiversity, evolutionary biology, ecology, conservation biology and molecular basis of the behavior.
- Understand various process of chronobiology in their daily life such as jet lag.
- Learn about the biological rhythm and their application in pharmacology and modern medicine.
- Realize, appreciate and develop passion to biodiversity; and will respect the nature and environment.

Course Content

	Number of classes:
Unit 1: Introduction of animal behaviour • Overview of ethology, contribution of pioneers of modern ethology: Karl *von* Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen. • Tools, techniques, and methods used in studying animal behaviour. Individual behaviour of animals: foraging, predation; prey defense; Orientation; Kinesis - orthokinesis, klinokinesis; Taxis: tropotaxis and klinotaxis, menotaxis. • Cryptic and parental care behaviour in animals.	08
Unit 2: Mechanisms and patterns of behaviour • Innate behaviour, instinct (reflex) *versus* learned behaviour, stereotyped behaviour (orientation). • Individual behavioural patterns, associative learning (classical and operant conditioning). • Non -associative learning (Habituation, sensitization), cognitive learning, and imprinting.	10

Unit 3: Social and sexual behaviour • Insects' society, sex differentiation in insect society, division of labour, polyethism, foraging, round and waggle dance, • Migration of fishes and birds, navigational tools and homing. • Animal relationship: communication (visual, chemical, auditory, and tactile), courtship behavior, and parental care, association between species and culture in animals.	15
Unit 4: Biorhythms and biological clocks • Characteristics feature of biorhythms and biological clocks, • Molecular mechanism of circadian rhythms, • Tidal and lunar rhythms, circannual rhythms, jet lag, and importance of biological clocks. • Different kinds of learning and memory in animals.	12
List of Practical (Tentative): 1. Study of geotaxis behaviour in earthworm/ phototaxis behaviour in insect larvae. 2. Study of courtship behaviour in Grebes and peacock from short videos/films. 3. Visit to Forest/Wild life Sanctuary/Biodiversity Park/zoological park or Central University of South Bihar campus to study and record the behavioural activities of animals and prepare a short report. 4. Parental care in monkey/domestic animal.	30 hrs

Suggested Readings*:

- McFarland, D.(1993). Animal Behaviour, second edition, Pitman Publishing Limited, London, UK.
- Manning, A. and Dawkins, M. S,(2012). An Introduction to Animal Behaviour, Cambridge University Press, UK.
- Alcock, J.(2005). Animal Behaviour, eighth edition, SP Oxford University Press, CBS Publishers and Distributors.
- Sherman P.W, and Alcock, J,(2010). Exploring Animal Behaviour, sixth edition, Sinauer Associate Inc., Massachusetts, USA.
- Prasad , S.(2009). Animal behaviour. CBS publishers and distributors.

Please refer to latest editions available

Course Title: Techniques in Animal Research			
Course Code	LSCZ9MJ03604	**Credits**	4
L + T + P	2+0+2	**Course Duration**	One Semester
Semester	IX	**Contact Hours**	30 (L) + 60 (P) Hours
Course Type	Discipline Based Core Elective		
Nature of the Course	Theory and Practical, Hand on Experience		
Special Nature/ Category of the Course (*if applicable*)	A compulsory course for students opting for specialization in Animal Science.		
Methods of Content Interaction	Lecture, group discussion, field projects, laboratory-work and assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective: This course offers an in-depth exploration of advanced techniques in animal research, focusing on animal cell culture and in vivo studies. Students will gain a foundation in these critical research fields while staying updated on the latest scientific developments and technological advancements. The course is designed to equip students with the knowledge and skills needed to engage in innovative research, apply cutting-edge techniques, and contribute to groundbreaking discoveries in animal research.

Course Learning Outcomes: After completion of the course the learners will be able to:

- Identify key factors impacting human health, animal health and productivity in different production systems.
- Develop practical solutions to challenges in disease monitoring and surveillance, animal husbandry and pest management.
- Evaluate the ethical implications of applied zoological practices and promote animal welfare.

Course Content

	Number of classes:
Unit 1: General guidelines for Animal Research • Guidelines for animal-based research • Safety, bioethics and validation • Infrastructure and equipment required for animal research • Standard Operating Procedures for working in Cell Culture laboratory and animal house	5
Unit 2: Cell Culture • Biology of cultured cells; Media requirements and maintenance of cell lines • Characterization, transformation and immortalization • Contamination and troubleshooting • Cryopreservation of cell lines and organs	15

• Quantitation and Cytotoxicity assays • Culture of stem cells, tumour cells and three-dimensional culture	
Unit 3: Animal Studies • Animal models for *in vivo* research • SoPs for housing and experiments on animals • Animal housing and care; animal husbandry • Anesthesia and Sedation • Care of Animals During Surgical Experiments • Methods of Euthanasia and Disposal of Laboratory Animals • Methods of Parasitic Infections: Outline of General Principles • Collection and Withdrawal of Body Fluids and Infusion Techniques • Histopathological analysis for providing context to molecular, biochemical, and in vivo data • Methods in Germfree Animal Research	10
Tentative list of Practicals 1. Cell thawing and seeding 2. Cell passage/sub-culturing 3. Cell counting 4. Cell viability assays 5. Cell morphology observation 6. Cytotoxicity assays 7. Demonstration of animal housing for mice, rats, chicks, fishes 8. Visualization of vital organs of mice 9. Histopathological study of a vital organ in mice	60
Suggested Readings*: 1. Culture of animal cells: a manual of basic technique and specialized applications. (2010) R. Ian Freshney. – 6th ed. John Wiley & Sons, Inc., Hoboken, New Jersey. ISBN 978-0-470-52812-9 2. Animal Cell Culture: Principles and Practice. (2023) S Mani, M Singh, A Kumar. (Eds) Springer Nature Switzerland. ISBN 978-3-031-19484-9. 3. Handbook of Laboratory Animal Science: Essential Principles and Practices (4th ed.). (2021).Hau, J., & Schapiro, S.J. (Eds.). CRC Press.	

Course Title: Plant Physiology			
Course Code	LSCB9MJ03604	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	IX	**Contact Hours**	45(L) + 30 (P) hrs
Course Type	DBCC		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Advanced level course which is to be compulsorily studied by a student as a core requirement to complete the study at PG level.		
Methods of Content Interaction	Lecture, Feedback or hand note preparation, group and individual self/laboratory-based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Objective of the Course: This course will cover the harvesting of light energy, oxidation of biomolecules for generation of energy, nitrate assimilation, role of plant hormones, photo morphogenesis, movement of ions, and responses of plant under biotic and abiotic stresses.

Outcome of the Course: This course will allow students to understand the Nitrogen Metabolism and effect of plant hormones on different cellular processes of plants. Explain assimilation of different mineral nutrients in plants. Will be explaining the relations between secondary metabolites and plant defense. They will grasp the mechanisms of action light harvesting complex and also response of plant towards abiotic and biotic stress. Explain the plant hormones and their roles in plant development. Explain physiological responses produced by plants against environmental stresses.

Course Content

	No. of classes
Unit-1 • **Transport and Translocation: Fundamentals** • Classical and quantitative method of taxonomy of plants, nonvascular and vascular plants, Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; Phloem loading and unloading; Source– sink relationship. • **Nitrogen Metabolism** Biological Nitrogen fixation in legume- *Rhizobium* system: rhizobium and leguminous plants. perception and signalling, nitrate and ammonium assimilation; amino acid biosynthesis.	12
Unit-2 • **Secondary Metabolites** Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. • **Plant growth regulators:**	

Discovery, chemical nature (basic structure), bioassay and physiological roles of auxins, cytokine, gibberellins, ABA, ethylene, salicylic and jasmonic acid: action and their application; photoperiodisin and vernalization, Germination, growth movements, parthenocarpy, abscission and senescence.	15
Unit-3 • **Sensory Photobiology** Primary processes of photosynthesis, Light Harvesting Complex, Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement and their role in photo morphogenesis; photoperiodism and biological clocks.	8
Unit-4 • **Stress Physiology:** Responses towards abiotic factors: stresses involving water deficit, high and low temperature stress, salinity stress, drought stress, anoxia and heavy metal stress, role of osmotic adjustments towards tolerance, understanding of genetic basis. • Understanding signalosome under stress conditions: Perception, transduction and response trigger, induction of specific gene expression, stress proteins, convergence and divergence of signalling pathways, ABA as stress hormone • Responses of plants towards biotic factors: plant defence system, systemic plant defence responses	10
List of Practical (Tentative): 1. Isolation and quantification of photosynthetic pigments. of photosynthetic pigment. 2. Separation of different plant pigment through paper chromatography. 3. Basic steps of Plant Tissue Culture 4. Inoculation of Brassica seeds for tissue culture to check the effect of phytohormones. 5. Estimation of Osmolytes from plant tissues under stress. 6. Estimation of ROS from plants systems. 7. To study totipotency of plant cell by preparing regenerative media.	30 hrs
Suggested Readings*: • Hopkins, W.G. and Huner, N.P.A.: Introduction to Plant Physiology. John Wiley, UK. • Taiz, L. and Zeiger, E:. Plant Physiology.Fourth Edition.Sinauer Associates Inc. Publishers, USA. • Bob B. Buchanan, Wilhelm Gruissem, Russell L. Jones: Biochemistry & Molecular Biology of Plants • Frank Salisbury, Cleon Ross: Plant Physiology • Robert M. Devlin: Plant Physiology * *Please refer to latest editions available.*	

Course Title: Plant Biotechnology			
Course Code	LSCB9MJ03804	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	IX	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Elective Course		
Nature of the Course	Theory and practical		
Special Nature/ Category of the Course (*if applicable*)	Advanced level elective course for acquiring knowledge on crop improvement strategies and industrial applications of plant biotechnology.		
Methods of Content Interaction	Lecture, group discussion, laboratory-work, assignments, seminar, presentation		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective:
To equip students with fundamental and advanced knowledge of plant biotechnology, focusing on tissue culture, and genetic improvement while addressing industrial applications, biosafety regulations, and ethical considerations.

Course Learning Outcomes:
By the end of this course, students will be able to:

1. Understand Plant Biotechnology Fundamentals
2. Apply Genome Editing and Trait Improvement Strategies
3. Explore Industrial and Therapeutic Applications of plant biotechnology
4. Assess biosafety regulations, GMO policies, and ethical considerations in genome editing
5. Develop Practical Skills related to plant biotechnology

Course Content

Unit I: Introduction to Plant Biotechnology • Introduction to Plant Biotechnology: Scope and Applications • Plant Cell, Tissue, and Organ Culture: Principles and Techniques • Micropropagation: Somatic Embryogenesis and Organogenesis • Somaclonal Variation and Applications • Protoplast Isolation, Fusion, and Somatic Hybridization • Cryopreservation and Germplasm Conservation	Number of classes 11
Unit II: Plant Transformation • Tools for Plant Transformation • *Agrobacterium*-mediated Transformation: Mechanism, Host Range, and Factors Affecting Efficiency	08

• Direct DNA Transfer Methods: Particle Bombardment, Electroporation, PEG-Mediated Transformation • Stable vs. Transient Expression in Plants: Applications in Research and Crop Improvement	
Unit III: Strategies for Novel Trait Discovery • Overexpression and gene silencing, RNA interference, virus-induced gene silencing (VIGS) tools • Activation Tagging, T-DNA Insertion Mutagenesis, FOX Hunting System, Fast Neutron Bombardment • TALENs, ZFNs, CRISPR-Cas9, EMS Mutagenesis, TILLING strategies • Plant microRNAs and their targets	13
Unit IV: Industrial Applications and Regulatory aspects • Plant-based vaccines, antibodies, and therapeutic proteins • Plant cell culture for secondary metabolite production (hairy root cultures, bioreactors) • Artificial seeds and conservation biotechnology for endangered species • Biodiesel and bioethanol production from algae and plant • Engineering algae and plants for higher CO_2 absorption • Bioplastics from Plants • Biosafety regulations, GMO policies, and risk assessments • CRISPR-edited crops and global regulatory frameworks • Ethical considerations in genome editing	13
Tentative List of Practical 1. Laboratory safety, sterilization techniques, and preparation of culture media. 2. Surface sterilization of plant materials and culture of explant 3. RNA isolation and cDNA synthesis and PCR. 4. Analysis of gene expression 5. Exploring and Analyzing Gene Data using "The Arabidopsis Information Resource (TAIR) Database" 6. Identify regulatory elements in promoter sequences using PlantCARE. 7. Designing RNAi constructs for gene silencing. 8. Designing CRISPR-Cas9 constructs	30 hrs

Suggested readings*:

1. Plant Biotechnology: The Genetic Manipulation of Plants by Adrian Slater, Nigel W Scott, Mark R Fowler, Oxford University Press
2. Plant Biotechnology and Genetics: Principles, Techniques, and Applications by C. Neal Stewart Jr.
3. Kole C and Abott AG Molecular breeding: principles and practices of plant genomics. Science Publishers, US
4. Introduction to Plant biotechnology by H.S.Chawla, Oxford & IBH Publishing Co Pvt. Ltd
5. Review articles on individual topics form the major basis for this course as no single book covers all the topics listed above

**Refer to latest edition available*

Course Title: Plant Breeding and Genetic Engineering			
Course Code	LSCB9MJ03904	**Credits**	4
L + T + P	3 + 0+ 1	**Course Duration**	One Semester
Semester	IX	**Contact Hours**	45 (L) + 30(P) Hours
Course Type	Discipline Based Elective Course		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Advanced level elective course that is to be studied by a student as a requirement to enhance their skills to improve the crop plants through breeding and genome editing methods.		
Methods of Content Interaction	Lecture, Feedback or hand note preparation, group and individual self/laboratory-based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objective: To provide the students' knowledge of main engines of implementation and transmission of a genetic material at molecular and cellular levels, and also methods of change of a genetic material and construction of transgene organisms with the given properties.

Course Learning Outcome:
Plant breeding has been a human practice for thousands of years. Breeding focuses on crop qualities such as higher yield, better-tasting fruits, and increased drought and disease resistance. The course will enable the students to understand the advanced recombinant DNA techniques in the field of plant genetic engineering and prepare them for research in the field of plant system.

Course Contents

	No. of classes
Unit 1: • **Mutagenesis in plants:** T-DNA/transposon mutagenesis, selection of mutants from random library, promoter/enhancer trap, gene-trap constructs. • **Hybrid seed production:** Negative selection markers, male sterile and restorer lines, self-incompatibility, hybrid vigor, RILs, NILs • **Molecular markers:** Random Amplified Polymorphic DNA (RAPD), Amplified Fragment Length Polymorphism (AFLP), Restriction Fragment Length Polymorphism (RFLP), and Simple Sequence Repeat (SSR). SSR/SSLP, GWMAS (Genome wide marker assistance selection), application of markers in forward genetics and breeding • Polyploidy in relation to plant breeding	15
Unit 2: • Isolate the gene of interest for genetic engineering of plants for improved stress tolerance • DNA Modifying Enzymes, DNA Cloning and Manipulating Cloned DNA Types of Vectors. • Construction of genomic and c-DNA library; Applications and advantages	7

• Vectors transformation and screening of transformed cells	
Unit 3: • Basis of tumor formation; Features of Ti and Ri plasmids; Methods and Mechanisms of DNA transfer to plant cell; Co-integrate vector and Binary vectors; Transgene stability and gene silencing. • Transgenic plants: *Agrobacterium* and other bacteria mediated DNA transformation, fungal transformation, Chloroplast transformation, mutant approach, wild relatives approach, contrasting genotypes approach etc. • Production of novel plant genotypes with improved tolerance towards abiotic stresses: success of plant breeding vs modern genetic modifications	15
Unit 4: • Rising of stress tolerant genotypes through genetic engineering. • Transgenic crops for improved yield and nutritional quality: Delayed fruit ripening, improved protein and vitamin contents, plant architecture and productivity. • Control of plant pests and pathogens by genetic engineering: insect, nematodes, virus, bacteria and fungus resistant plants • Transgenic crops with improved stress resistance: GM plants with enhanced resistance against biotic and abiotic stresses. • Safety and societal concerns with GM crop	8
List of Practical (Tentative): 1. Emasculation and hybridization techniques in self & cross pollinated crops; viz. Rice Pigeonpea, Mungbean, Brinjal etc. 2. Study of floral structure of self- pollinated and cross pollinated crops 3. Study of field techniques for seed production and hybrid seeds production in Kharif/ Rabi crops 4. Visit to seed production plots 5. Gel electrophoresis (demonstration)	30 hrs

Suggested Readings*:

- **George Acquaah**: Principle of Plant Genetics and Breeding; Willy-Blackwell
- **Maarten J. Chrispeels and David E. Sadava**: Plants, Genes and Crop Biotechnology; American Society of Plant Biologists.
- **H.S. Chawla**: Introduction of Plant Biotechnology; Oxford and IBH Publishing
- **M.K. Razdan**: Introduction of Plant Tissue Culture; Science publishers
- **S.S. Bhojwani, and, M.K. Razdan:** Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam, The Netherlands
- **Kirsi Marja Oksman Caldentey** Genetic transformation of plants
- **Adrian Slater.** Plant Biotechnology; the Genetic Manipulation of plants
- **W G Hopkins** Plant Biotechnology
- **N G Halford** Plant Biotechnology: current and future applications of genetically modified crops

**Please refer to latest editions available*

Course Title: Economic Botany			
Course Code	LSCB9MJ04004	**Credits**	4
L + T + P	2+ 1+ 1	**Course Duration**	One Semester
Semester	IX	**Contact Hours**	30 (L) + 15(T) + 30(P) Hours
Course Type	Discipline Based Elective Course (DBEC)		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Economic botanists use a variety of disciplines, including archeology, sociology, and ecology, to study human-plant interactions.		
Methods of Content Interaction	Lecture, Feedback or hand note preparation, group and individual self/laboratory based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objective:

To understanding of plants and human health - historical foundations of medicine, the practice of herbal medicine, poisonous and allergy plants, and the chemistry of secondary plant products. Study all the ways that people use plants as source of food and income.

Course Learning Outcome:

- ✓ An understanding of plants as a source of food – emphasis on major food crops with respect to the following: requirements for human nutrition, the origin of agriculture, legumes, and starchy staples.
- ✓ An understanding of commercial products derived from plants that provide us with consumable products such as beverages, herbs and spices, and materials such as cloth, paper, and wood.
- ✓ An understanding of the impact of plants as sources of human food, industrial products, fermented beverages and foods, sources of antibiotics, toxins, and diseases affecting crops and people.
- ✓ An understanding of plants and the environment with emphasis on the principles of ecology: the major biomes of the world, economic value of certain plants, and the strategy of extractive reserves in the rain forest.

Course Content

Unit-1	Number of classes
• Origin of Cultivated Plants: Concept of centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of newcrops/varieties, importance of germplasm diversity. • Cereals: Brief account of Wheat, Rice and millets. • Legumes: General account, importance to man and ecosystem. • Sugars & Starches: Morphology and processing of sugarcane, products and byproducts of sugarcane industry, Potato and Maize – morphology, propagation & uses.	12

Unit-2 • Spices: Listing of important spices, their family and part used, economic importance with special reference to fennel, saffron, clove and black pepper Beverages: Tea, Coffee (morphology, processing & uses) • Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver and Cannabis, Tobacco: Tobacco (Morphology, processing, uses and health hazards)	15
Unit-3 • Oils & Fats: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed and Brassica (Botanical name, family & uses) • Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.	8
Unit-4 • Natural Rubber: Para-rubber: tapping, processing and uses. • Timber plants: General account with special reference to teak and pine. Fibers: Classification based on the origin of fibers, Cotton and Jute (morphology, extraction and uses).	10
List of Practical (Tentative): 1. Cereals: Rice (habit sketch, study of paddy and grain, starch grains). 2. Legumes: Soya bean/moong bean/black gram, Groundnut, (habit, fruit, seed structure, micro-chemical tests). 3. Sugars & Starches: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, starch grains, micro-chemical tests). 4. Spice and Beverages: clove, black pepper, Tea (plant specimen, tea leaves), Coffee (plant specimen, beans). 5. Oils & Fats: Groundnut, Mustard–plant specimen, seeds; tests for fats in crushed seeds. 6. Drug-yielding plants: Specimens of Digitalis, Papaver and Cannabis. 7. Woods: Tectona, Pinus/Sal: Specimen, Section of young stem. 8. Fiber-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).	30 hrs
Suggested Readings*: **Please refer to latest editions available* • B. P. Pandey: Economic Botany. S. Chand Publication, New Delhi. • S.L. Kochhar: Economic Botany in Tropics, MacMillan & Co. New Delhi, • India. • Samba Murty and Subrahmanyam: Text Book of Modern Economic Botany, • CBS Publishers and Distributors, New Delhi. • Hill, F. Albert: Economic Botany, Tata Mc Grow Hill Publishing Company, Ltd. New Delhi. • G.E Wickens: Economic Botany: Principles & Practices. Kluwer Academic • Publishers, The Netherlands. • Singh, Pandey and Jain: Economic Botany, Rastogi Publication, Meerut. • B. Baruah: Economic Botany, Kalyani Publishers, New Delhi.	

Semester X

Course Title: Wildlife Conservation and Management			
Course Code	LSC9MJ04104	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	X	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Courses		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Advanced level course that is to be studied by students to gain knowledge and skills for Wildlife Conservation and management		
Methods of Content Interaction	Lecture, group discussion, field projects, laboratory-work and assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective: To equip students with essential elements, concepts and skills related to wildlife conservation and management. This includes implementing habitat management practices; identifying wildlife conflicts; and participation in personal and community leadership development activities and planning. The perspectives of science and management will be elucidated in the context of historical, current and future strategies designed to conserve the diversity of life.

Course Learning Outcomes:

After successful completion of this course, students will be able to:

1. cite the scientific evidence for biodiversity change in the modern era and detail the contemporary causes of diversity loss,
2. Understand and convey the ecological, social, and economic impacts of diversity loss.
3. Apply management principles and tools that are used to conserve diversity at levels from genes to landscapes.

Course Content

Unit I: Introduction of Wildlife Conservation & Habitat analysis	Number of classes: 10
• Values and ethics of wildlife conservation; importance of conservation; • Evaluation and management of wild life - Physical parameters and Biological Parameters; • Standard evaluation procedures: Faecal analysis of ungulates and carnivores: Faecal samples; • Pug marks and census method, Geographical Information System (GIS), Global Positioning System (GPS), and Remote Sensing (RS)	

Unit II: Human-wildlife conflict • Poaching, illegal trading, invasive species, conflict management and shifting from extraction to preservation; • Effect of extinction of a species on ecosystem; Forest landscape restoration.	6
Unit 3: Modern concepts of management • Protected Area Network (PAN), WWFN, IUCN, and CITES. Wild life Legislation – Wild life Protection act (1972), its amendments and implementation; Regulation of biodiversity: Convention on Biological Diversity, National Biodiversity Authority, WCMC, CITES. • IUCN Red data book and red list categories (only names), Protected areas National parks & sanctuaries, Community reserve; Important features of protected areas in India; Project Tiger and Project Elephant	15
Unit 4: Conservation strategies: • *In-situ* and *ex-situ* conservation, biodiversity hot spots, hottest hot spots, mega diversity countries, centers of plant diversity and endemism. India –Biospheres, Frozen Zoo	14
List of Practical (Tentative): 1. Identification and study of any five endangered mammalian fauna, avian fauna, herpetofauna 2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses) 3. Familiarization and study of animal evidences in the field: Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers. 4. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences)	30
Suggested Readings*: • Primack, Richard B., and Anna Sher (2016). Introduction To Conservation Biology. Sinauer Associates, Incorporated, Publishers. • Berlatsky (2013) Biodiversity – Global Viewpoints. Gale Cengage Publishers. ISBN: 9780737769050. • Gary G. Mittelbach (2012) Community Ecology. Sinauer Associates, Inc.; 1 edition. ISBN: 978-0878935093. • Jase Fitzgerald 2017. Biodiversity: An Introduction. Larsen and Keller Education. ISBN: 978-1635490428 • Caughley, G., and A.R.E. Sinclair, editors. 1994. Wildlife Ecology and Management, Blackwell Science. • Woodroffe R., S. Thirgood and A. Rabinowitz. 2005. People and Wildlife, Conflict or Coexistence? Cambridge University. • Bookhout, T.A. 1996. Research and Management Techniques for Wildlife and Habitats,	

5th edition. The Wildlife Society, Allen Press.

- Sutherland, W.J. 2000. The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
- Hunter M.L., J.B. Gibbs and E.J. Sterling. 2008. Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.

**Refer to latest edition*

Course Title: Nanobiotechnology			
Course Code	LSC9MJ04204	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	X	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course		
Nature of the Course	Theory and practical		
Special Nature/ Category of the Course (*if applicable*)	Advanced level course bridging nanotechnology and biotechnology with applications in healthcare, agriculture, and environmental science		
Methods of Content Interaction	Lecture, group discussion, laboratory-work, assignments, seminar, presentation		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objective:

This course aims to provide a fundamental understanding of nanobiotechnology, focusing on the synthesis, characterization, and applications of nanomaterials in healthcare, agriculture, and environmental science. Students will explore the role of nanotechnology in diagnostics, drug delivery, and sustainability, while also assessing biosafety, regulatory, and ethical considerations. Additionally, hands-on training will enhance their skills in the synthesis, characterization, and application of nanoparticles.

Course Learning Outcomes:

Upon completion of the course, students will be able to:

1. Understand the fundamentals of nanobiotechnology and its interdisciplinary applications.
2. Apply nanomaterial synthesis methods for diverse applications.
3. Explore the role of nanotechnology in drug delivery, diagnostics, agriculture, and environmental remediation.
4. Evaluate the biosafety, toxicity, and ethical considerations associated with nanomaterials.
5. Assess the potential of nanobiotechnology in addressing current challenges in healthcare and the environment.
6. Apply laboratory techniques to synthesize and characterize nanoparticles and evaluate their effects on biological and environmental systems.

Course Content

Unit I: Fundamentals of Nanobiotechnology • Introduction to nanobiotechnology: History of nanotechnology, origins of nanotechnology, Scope, significance, and interdisciplinary nature • Types of nanomaterials: Metallic, polymeric, lipid-based, and carbon-based nanostructures • Synthesis of nanomaterials: Top-down and bottom-up approaches • Characterization techniques: SEM, TEM, AFM, DLS, XRD, FTIR, Raman Spectroscopy • Current status of Nanotechnology, future of Nanotechnology	**Number of classes** **14**
Unit II: Biomedical Applications • Mechanism of biological systems at nanoscale, biological motors, Biphotonic devices • Biocompatibility, dispersibility, and water solubility of nanoparticles • Introduction to DNA Nanotechnology, DNA as construction materials • Nanoparticles in drug delivery: Liposomes, dendrimers, polymeric nanoparticles, silicon nanostructures, PEGylation • Targeted drug delivery and controlled release systems • Nanotechnology in diagnostics: Biosensors, quantum dots, and molecular imaging • Nanomedicine applications in cancer therapy, gene therapy, and regenerative medicine	**12**
Unit III: Agricultural and Environmental Applications • Role of nanotechnology in plant growth, protection, and productivity • Nano-fertilizers, nano-pesticides, and their impact on soil and plant health • Nanosensors for soil, water, and plant disease monitoring • Nanoremediation: Use of nanomaterials in pollution control and waste management	**10**
Unit IV: Biosafety, Toxicity, and Ethical Concerns • Toxicological impact of nanomaterials on human health and the environment • Biodegradation and bioaccumulation of nanoparticles • Regulatory guidelines for nanotechnology in healthcare and agriculture • Ethical, legal, and societal implications of nanobiotechnology	**09**
Tentative List of Practical 1. Green synthesis of nanoparticles 2. Nanoparticles synthesis using DNA 3. Characterization of nanoparticles using UV-Vis 4. Study the effect of commercially available nanoparticles on bacterial growth 5. Study the effect of commercially available nanoparticles on plant growth	**30 hrs**

6. Application of nanoparticles in the treatment of waste water	
Suggested readings*: • Nanobiotechnology: Principles and Applications by Juhi Saxena, Abhijeet Singh, Anupam Jyoti, Bentham books • Nanobiotechnology: concepts applications and perspectives by C.M. Niemeyer and C.A. Mirkin, WILEY-VCH • Nanotoxicology for Agricultural and Environmental Applications by Mahendra Rai, Academic Press • *Articles in the Journal of Nanobiotechnology* and *Nanobiotechnology Reports* *Refer to latest edition	

Course Title: Protein Structural Biology			
Course Code	LSC9MJ04304	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	X	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course		
Nature of the Course	Theory & Practical, Hands-on training course		
Special Nature/ Category of the Course (*if applicable*)	Advanced course to gain knowledge on protein structure determination methods and its applications in drug designing.		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field-based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Objectives: The course aims to

- Acquaint the students with fundamental knowledge about structural biology.
- Understand the structure and dynamics of macromolecules and their complexes at atomic or near atomic resolution, and subsequently to explain the in vivo functions and interactions emphasizing protein structure-function relationship.
- Gain insights into the field of X-ray crystallography from making the protein to structure solution.

Course Learning Outcomes: After completion of the course the students will:

- Be proficient in protein sequence analysis, structure determination, and visualization.
- Gain hands-on experience in computational and experimental methods for studying protein

structure.

- Apply their knowledge to drug design and other real-world applications.
- Develop the ability to integrate interdisciplinary approaches for innovative research in structural biology.

Course Contents

Unit 1: Protein sequences, sequence alignment; Basic polypeptide stereochemistry, hierarchy in protein folds, Motifs and domains of Protein Structure, Alpha domain structures, Alpha/Beta structures, Beta structures, Structural classification of proteins, Structure-function relationship of proteins, Databases: SCOP, and PDB database.	Number of classes: 11
Unit 2: Protein structure determination by computational methods, Homology/comparative modeling, Fold recognition (threading), Ab initio (de novo, new folds) methods; protein structure determination by experimental methods, X-ray crystallography, Crystal, NMR spectroscopy, Electron microscopy- Sample preparation (Negative stain, cryo-EM), Types of samples, Advantages and disadvantages of various methods	12
Unit 3: Principles of protein purification for crystallization, Methods of crystallization, structure determination; Structure validation, X-ray sources and area detectors, waves and their properties, X-ray diffraction, Bragg's law, Symmetry and unit cells, Structure factor and Phase problem, Solving the crystallographic phase problem: Patterson maps and Molecular replacement, Multiple Isomorphous replacement (MIR), Multi-wavelength anomalous diffraction (MAD), R-factors, validation and Analysis	12
Unit 4: Time resolved crystallography- visualization of reaction in four dimensions, pump-probe, diffusion-trapping, study of haemoglobin oxygenated and deoxygenated states, Applications of techniques: Structure based drug design, carbonic anhydrase inhibitor dorzolamide, tyrosine kinase inhibitor Imatinib	10
List of Practical (Tentative): 1. Model preparation to understand basic polypeptide stereochemistry 2. Model preparation to understand the structure of DNA 3. Access/Retrieval of data from databases: SCOP, PDB 4. Using the PDB structure visualization software: PYMOL 5. Crystallization of Lysozyme	**30 hrs**

Suggested Readings*:

- Alexander McPherson; Introduction to Macromolecular Crystallography, 2nd Edition
- Bernhard Rupp; Biomolecular Crystallography: Principles, Practice, and Application to Structural Biology
- Branden and Tooze; Introduction to protein structure
- Cedric Notredame and Jean-Michel Claverie; Bioinformatics for Dummies
- Gale Rhodes, Crystallography Made Crystal Clear (Third Edition).

- James Keeler; Understanding NMR spectroscopy. John wiley & sons, England. ISBN: 978-0-470-74609-7
- U. Valdre (Editor), Peter W Hawks (Editor): Biophysical electron microscopy: Basic concepts and modern techniques
- Joachim Frank: Three-dimensional electron microscopy of Macromolecular assemblies
- Reviews: M H Stowell I, A Miyazawa, N Unwin. 1998. Macromolecular structure determination by electron microscopy: new advances and recent results. Curr Opin Struct Biol 8, 595-600
- Links: Bernhard Rupp's Interactive Crystallography Course

**Please refer to latest editions available*

Course Title: Cellular Stress Biology			
Course code	LSC9MJ04404	**Credit**	4
L+T+P	3+1+0	**Course duration**	One Semester
Semester	X	**Contact Hours**	45 (L) + 15 (T)
Course Type	Discipline Based Core Course		
Nature of the Course	Theory based		
Special Nature/ Category of the Course (*if applicable*)	A course that is to be compulsorily studied by student as a core requirement to acquaint students with various aspects of biotic and abiotic stresses and their implications.		
Methods of content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students.		
Assessment and Evaluation	• 30%-Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70%-End Term External Examination (University Examination)		

Course Objectives

- To acquaint students with all aspects of stress and develop an understanding of stress research and scientific studies in general
- To enable the students to appreciate both, the evolutionary conserved aspects of cell stress responses (e.g. heat shock proteins and chaperones) and individual signaling pathways and molecules controlling the action of specific stress stimuli.
- To enable students to set up experiments for stress related problems

Course Learning Outcomes:

After completion of the course the learners will be able to:

- Understand the basic mechanism of stress perception
- Explain stress responses at cellular level
- Get acquainted with techniques of analyzing effects of stress and response towards them
- Explain various mechanisms of cell survival and cell death

Course Contents

Unit 1: Stress mediated Signaling Cascades	**No. of Classes**
• Introduction to the concept of stress and stimulus perception	10 L

• Signaling cascade active during osmotic stress, hypoxia, salinity • Temperature sensing through DNA, RNA thermometers and proteins; membrane modulations in perception and mitigation of temperature stress • Reactive Oxygen Species in Stress Perception – detection and mitigation • Iron – the universal stress determinant, production of siderophore as a stress adaptation	
Unit 2: Cellular Stress Responses • The Heat Shock Response, The Response to Oxidative Stress • The Unfolded Protein Response (UPR), The DNA Damage Response • Stress Responses in Disease States – Cancer, Diabetes, Viral infection	15 (10 L + 5T)
Unit 3: Cellular Stress Responses – Adaptations and Cell Death • DNA Damage Response, Unfolded Protein Response – mitochondrial and endoplamic reticulum based UPR, Heat Shock Response; Linking cellular stress to systemic homeostasis • Apoptosis, Ferroptosis, Autophagy, MPT – driven necrosis, Necroptosis, , Pyroptosis, Parthanatos, Entotic cell death, , Immunogenic Cell death, Cellular Senescence, phytaspase induced programmed cell death in plants • Implications of cell death in human diseases	20 (15 L + 5T)
Unit 4: Study of stress response • Designing experiments to study stress responses • Basis of detection for alterations at biochemical and physiological level • Genomic and proteomic approaches for analysis of stress • Computational methods for stress analysis • Assays for analysis of stress responses in microbes, plants, cell lines and animal models; result interpretation	15 (10 L + 5T)

Readings*:

- Prescott, Harlay and Klein: Microbiology, 7th ed. New York : McGraw-Hill Higher Education
- Madigan, Martinko and Parker: Brock Biology of Micro-organism, 11th ed, Pearson
- Lodish, H., Berk, A., Zipursky, S.L., Matsudaria, P., Baltimore, D. and Darnell, J. (Eds). Molecular Cell Biology. 9th ed. Freeman & Co., USA.
- Karp, J.G. Cell and Molecular Biology. 9th ed. John Wiley & Sons, USA.
- Taiz, L. and Zeiger, E. (Eds.) 2006. Plant Physiology. 5th ed. Sinauer Associates Inc. Publishers, USA.

**Please refer to latest editions available*

Course Title: Natural Resource Management			
Course Code	LSC9MJ04504	**Credits**	4
L + T + P	3+ 0+ 1	**Course Duration**	One Semester
Semester	X	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course		
Nature of the Course	Theory and Practical		
Special Nature/ Category of the Course (*if applicable*)	Natural resources designing program will be a combination of several approaches such as group discussion, illustrated lecture, demonstration, simulation, guided practice, practical experiences, fieldwork and other independent learning.		
Methods of Content Interaction	Lecture, Feedback or hand note preparation, group and individual self/laboratory-based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objective:

Develop a sustainable and efficient economy: A key objective of natural resource economics is to develop a supportable economy. This means finding ways to use natural resources in a way that meets present needs without limiting the access of forthcoming generations to the natural resources

Course Learning Outcome:

- Skills to manage natural resources in sustainable manner
- To know the national and international climate and natural resource related policies and treaties
- To create a trained pool of talent to solve natural resource related challenges

	Number of classes
Unit-1 • Sustainable management of natural resources for achieving food, nutritional, environmental and livelihood security in the country. • Natural resources: Definition and types; Sustainable utilization: Concept, approaches (economic, ecological and sociocultural); Land: Utilization (agricultural, horticultural, silvicultural); Soil degradation and management; Water: Fresh water rivers, lakes, groundwater, water harvesting technology, rain water storage and utilization.	12
Unit-2 • Biological Resources: Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan. Forests: Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.	15

Unit-3 • Energy: Renewable and non-renewable sources of energy-solar, wind, tidal, geothermal and bioenergy resources; Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint.	8
Unit-4 • National and international efforts in resource management and conservation, collecting, treating, recycling and disposing of waste in a way that minimizes its impact on the environment and human health. • Resource Accounting; Types of waste management, viz. solid, Biodegradable, Hazardous, Plastics and Electronic etc.	10
List of Practical (Tentative): 1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation. 2. Collections of data on forest cover of specific area. 3. Measurement of dominance of woody species by DBH (diameter at breast height) method. 4. Calculation and analysis of ecological footprint. 5. Ecological modeling	30 hrs
Suggested Readings*: • **B. W. Pandey.** Natural Resource Management. Mittal Publication, New Delhi • **Vasudevan, N.** Essentials of Environmental Science. Narosa Publishing House,New Delhi. • **Singh, J. S., Singh, S.P. and Gupta, S.** Ecology, Environment and ResourceConservation. Anamaya Publications, New Delhi. • **Rogers, P.P., Jalal, K.F. and Boyd, J.A.** An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi. **Please refer to latest editions available*	

Course Title: Research Project			
Course code	LSCZ9MJ04620/ LSCB9MJ04620	**Credit**	20
L+T+P	0+0+20	**Course duration**	One Semester
Semester	X	**Contact Hours**	600 (P) Hours
Course Type	Discipline Based Core Elective (DBCE)		
Nature of the Course	Research work		
Special Nature/ Category of the Course (*if applicable*)	Project-work/Laboratory-work/Hands-on learning/Skill Development/Entrepreneurship		
Methods of Interaction	One to one interaction, presentation, lab work and field work		
Assessment and Evaluation	• 30% - Continuous Internal Assessment by the Dissertation supervisor (With in department: supervisor; Outside the department: joint evaluation by internal and/or external supervisors both) • 70% - Research Project Report [50% - Problem Definition and novelty (20), Methodology and experimental design (10 marks), Results & Discussion (10 marks), Conclusion & Future Scope (5 marks), Formatting & References (5 marks)], & Presentation by the candidate [20% - Presentation Content (5 marks), Quality of slides, Effective use of diagrams, tables, and graphs (5 marks), Presentation Skills (5 marks), Q&A Handling (5 marks)] – joint evaluation by DC.		

Course objectives:

- To develop analytical, critical thinking, problem-solving, and decision-making skills
- To acquire and develop autonomous skills
- To develop scientific communication and public speaking skills
- To develop abilities to independently learn new knowledge and methods
- To learn scientific writing skills.

Learning outcomes: Upon successful completion of this course, the students will be able to grasp the fundamental concepts and requirements of laboratory-oriented work which is essential to becoming a professional researcher. The student will be equipped with laboratory basics and various techniques that enable them to either enter a Life Science related industry or pursue higher studies.

Course Content: Any potential research problem relevant to local/national/international needs; research on SDGs related problems, research on Government of India's priority areas.

Course Title: Research Project			
Course code	LSCZ9MJ04720/ LSCB9MJ04720	**Credit**	20
L+T+P	0+0+20	**Course duration**	One Semester
Semester	IX	**Contact Hours**	600 (P) Hours
Course Type	Discipline Based Core Elective (DBCE)		
Nature of the Course	Research work		
Special Nature/ Category of the Course (*if applicable*)	Project-work/Laboratory-work/Hands-on learning/Skill Development/Entrepreneurship		
Methods of Interaction	One to one interaction, presentation, lab work and field work		
Assessment and Evaluation	• 30% - Continuous Internal Assessment by the Dissertation supervisor (With in department: supervisor; Outside the department: joint evaluation by internal and/or external supervisors both) • 70% - Research Project Report [50% - Problem Definition and novelty (20), Methodology and experimental design (10 marks), Results & Discussion (10 marks), Conclusion & Future Scope (5 marks), Formatting & References (5 marks)], & Presentation by the candidate [20% - Presentation Content (5 marks), Quality of slides, Effective use of diagrams, tables, and graphs (5 marks), Presentation Skills (5 marks), Q&A Handling (5 marks)] – joint evaluation by DC.		

Course objectives:

- To develop analytical, critical thinking, problem-solving, and decision-making skills
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Learning outcomes: Upon successful completion of this course, the students will be able to grasp the fundamental concepts and requirements of laboratory-oriented work which is essential to becoming a professional researcher. The student will be equipped with laboratory basics and various techniques that enable them to either enter a Life Science related industry or pursue higher studies.

Course Content: Any potential research problem relevant to local/national/international needs; research on SDGs related problems, research on Government of India's priority areas.

Course Title: Research Project			
Course code	LSCZ9MJ04820/ LSCB9MJ04820	**Credit**	20
L+T+P	0+0+20	**Course duration**	One Semester
Semester	X	**Contact Hours**	600 (P) Hours
Course Type	Discipline Based Core Elective (DBCE)		
Nature of the Course	Research work		
Special Nature/ Category of the Course (*if applicable*)	Project-work/Laboratory-work/Hands-on learning/Skill Development/Entrepreneurship		
Methods of Interaction	One to one interaction, presentation, lab work and field work		
Assessment and Evaluation	• 30% - Continuous Internal Assessment by the Dissertation supervisor (With in department: supervisor; Outside the department: joint evaluation by internal and/or external supervisors both) • 70% - Research Project Report [50% - Problem Definition and novelty (20), Methodology and experimental design (10 marks), Results & Discussion (10 marks), Conclusion & Future Scope (5 marks), Formatting & References (5 marks)], & Presentation by the candidate [20% - Presentation Content (5 marks), Quality of slides, Effective use of diagrams, tables, and graphs (5 marks), Presentation Skills (5 marks), Q&A Handling (5 marks)] – joint evaluation by DC.		

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