PERIYAR UNIVERSITY

PERIYAR PALKALAI NAGAR
SALEM - 636011

DEGREE OF BACHELOR OF SCIENCE

Syllabus for

B.Sc., ZOOLOGY

CHOICE BASED CREDIT SYSTEM

(SEMESTER PATTERN)

TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI – 600 005

(For Candidates admitted in the Colleges affiliated to Periyar University from 2023 – 2024 onwards)

CONTENTS

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR UNDERGRADUATE EDUCATION	
Programme:	**B.Sc. Zoology**
Duration:	**3 years [Under Graduate]**
Programme Outcomes: **(These are mere guidelines. Faculty can create POs based on their curriculum or adopt from UGC or University for their Programme)**	**PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study. **PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups. **PO3: Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyses and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. **PO4: Problem solving:** Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations. **PO5: Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints. **PO6: Research-related skills**: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesizing and articulating; Ability to recognizes cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyze, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation **PO7: Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team **PO8: Scientific reasoning**: Ability to analyze interprets and draws

	conclusions from quantitative/qualitative data; and critically evaluates ideas, evidence and experiences from an open-minded and reasoned perspective. **PO9: Reflective thinking**: Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society. **PO10 Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data. **PO 11 Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion. **PO 12 Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. **PO 13: Moral and ethical awareness/reasoning**: Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work, avoid unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work. **PO 14: Leadership readiness/qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way. **PO 15: Lifelong learning:** Ability to acquire knowledge and skills, including „learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.
Programme Specific Outcomes: **(These are mere guidelines.**	**PSO1 – Placement:** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur:** To create effective entrepreneurs by enhancing their critical thinking,

Faculty can create POs based on their curriculum or adopt from UGC or University for their Programme)	problem solving, decision making and leadership skill that will facilitate startups and high potential organizations **PSO3 – Research and Development:** Design and implement HR systems and practices grounded in researches that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World:** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society:** To contribute to the development of the society by collaborating with stakeholders for mutual benefit

REGULATIONS

Program specific outcome (PSO) - Zoology

Bachelor of Science in Zoology students will gain fundamental knowledge about

- The Knowledge of Zoology about Animal Kingdom, Classification, Systems, Subjects like Invertebrates, Chordates, Cell Biology, Genetics, Developmental Biology and Physiology and the instruments like Microscope, Incubator, Laminar Air Flow chamber, Centrifuge etc.,
- The microorganism especially Bacteria, Fungi, Algae, Protozoa, Virus.
- The various Skill based subjects like Apiculture, Aquaculture, Biotechnology, Agricultural Entomology, Medical Lab Techniques, and Environmental Biology have been included in order to provide opportunities in employment and research in Government and Private Organizations.
- There is also scope for self employment for the students.
- Practicals and field works are included in the syllabus will improve the skills of the students in Microscopy, Observations, Drawing and Laboratory techniques and visit to mentioned places..

Condition for admission (OBE pattern)

A candidate who has passed higher secondary examination in any one of the biological sciences (Botany, Zoology, Biology). (Academic/Vocational stream-Agri, Home Science, Poultry, Dairy) under higher secondary board of examination, Tamil Nadu or as per norms set by the Government of Tamil Nadu or an examination accepted as Equivalent thereto by the Syndicate subject to such conditions as may be prescribed thereto are permitted to appear and qualify for the B.Sc., Zoology degree examination of this University after a course of study of three academic years.

Duration of the course

The course for the degree of Bachelor of Zoology shall consist of three academic years divided into six semesters.

Course of study

The course of study shall comprise instruction in the following subjects according to the syllabus and books prescribed from time to time.

Examinations

The theory examination shall be three hours duration to each paper at the end of each semester. The candidate failing in any subject(s) will be permitted to appear for each failed subject(s) in the subsequent examinations. The practical examinations for UG course should be conducted in the even semester, that is the academic year, exams for all lab courses, including those for the Second, Fourth, and Sixth semesters will be held.

Maximum Duration for the completion

The course for the degree of Bachelor of Science shall consist of three academic years divided in to six semesters. Each semester consists of 90 working days.

Commencement of this Regulation

These regulations shall take effect from the academic year 2023-24, i.e., for students who are to be admitted to the first year of the course during the academic year 2023-24 and thereafter.

Passing Minimum:

The candidate shall be declared to have passed the examinations if he /she secure not less than 40 marks.

METHODS OF EVALUATION		
Internal Evaluation	Continuous Internal Assessment Test	**25 Marks**
	Assignments / Snap Test / Quiz	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	**75 Marks**
Total		**100 Marks**

METHODS OF ASSESSMENT	
Remembering (K1)	• The lowest level of questions require students to recall in formation from the course content • Knowledge questions usually require students to identify in formation in the text book.
Understanding (K2)	• Understanding of facts and ideas by comprehending organizing, comparing, translating, interpolating and interpreting in their own words. • Thequestionsgobeyondsimplerecallandrequirestudentstocombinedatatoget her
Application (K3)	• Students have to solve problems by using/applying a concept learned in the class room. • Students must use their knowledge to determine a exact response.
Analyze (K4)	• Analyzing the question is one that asks the students to breakdown something into its component parts. • Analyzing requires students to identify reasons causes or motives and reach conclusions or generalizations.
Evaluate (K5)	• Evaluation requires an individual to make judgment on something. • Questions to be asked to judge the value of an idea, a character, a work of art, or a solution to a problem. • Students are engaged indecision-making and problem–solving. • Evaluation questions do not have single right answers.
Create (K6)	• The questions of this category challenge students to get engaged in creative and original thinking. • Developing original ideas and problem solving skills

Internal Assessment Structure:

Test	= 10 marks
Seminar	= 05 marks
Assignment	= 05 marks
Attendance	= 05 marks
Passing minimum for Internal Assessment	= 10 marks
Passing minimum of University examinations	= 30 marks

Practicals

University Examinations	= 60marks
Internal Assessment	= 40marks

Internal Assessment Structure:

Test	= 15 marks
Observation-record	= 10 marks
Regularity in Practical	= 15 marks
Passing minimum for internal assessment	= 16 marks
Passing minimum for University examinations	= 24 marks

Highlights of the Revamped Curriculum:

- Student-centric, meeting the demands of industry & society, incorporating industrial components, hands-on training, skill enhancement modules, industrial project, project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application oriented content wherever required.
- The Core subjects include latest developments in the education and scientific front, advanced programming packages allied with the discipline topics, practical training, devising statistical models and algorithms for providing solutions to industry / real life situations. The curriculum also facilitates peer learning with advanced statistical topics in the final semester, catering to the needs of stakeholders with research aptitude.
- The General Studies and Statistics based problem solving skills are included as mandatory components in the 'Training for Competitive Examinations' course at the final semester, a first of its kind.
- The curriculum is designed so as to strengthen the Industry-Academia interface and provide more job opportunities for the students.
- The Statistical Quality Control course is included to expose the students to real life problems and train the students on designing a mathematical model to provide solutions to the industrial problems.
- The Internship during the second year vacation will help the students gain valuable work experience, which connects classroom knowledge to real world experience and to narrow down and focus on the career path.
- Project with viva-voce component in the sixth semester enables the student, application of conceptual knowledge to practical situations. The state of art technologies in conducting a Explain in a scientific and systematic way and arriving at a precise solution is ensured. Such innovative provisions of the industrial training, project and internships will give students an edge over the counterparts in the job market.
- State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature are incorporated as Elective courses, covering conventional topics to the latest curricular methods.

VALUE ADDITIONS IN THE REVAMPED CURRICULUM:

Semester	Newly introduced Components	Outcome / Benefits
I	**Foundation Course** To ease the transition of learning from higher secondary to higher education, providing an overview of the pedagogy of learning abstract Statistics and simulating mathematical concepts to real world.	• Instil confidence among students • Create interest for the subject
I, II, III, IV	**Skill Enhancement papers** (Discipline centric / Generic / Entrepreneurial)	• Industry ready graduates • Skilled human resource • Students are equipped with essential skills to make them employable
		• Training on Computing / Computational skills enable the students gain knowledge and exposure on latest computational aspects
		• Data analytical skills will enable students gain internships, apprenticeships, field work involving data collection, compilation, analysis etc.
		• Entrepreneurial skill training will provide an opportunity for independent livelihood • Generates self – employment • Create small scale entrepreneurs • Training to girls leads to women empowerment
		• Discipline centric skill will improve the Technical knowhow of solving real life problems using ICT tools
III, IV, V & VI	Elective papers- An open choice of topics categorized under Generic and Discipline Centric	• Strengthening the domain knowledge • Introducing the stakeholders to the State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature • Students are exposed to Latest topics on Radiation biology, Agricultural entomology, Medical Lab Technology,

		that require strong research and entrepreneurial background. • Emerging topics in higher education / industry / communication network / health sector etc. are introduced with hands-on-training, facilitates designing of statistical models in the respective sectors
IV	DBMS and Programming skill, Biostatistics, Statistical Quality Control, Official Statistics, Operations Research	• Exposure to industry moulds students into solution providers • Generates Industry ready graduates • Employment opportunities enhanced
II year Vacation activity	Internship / Industrial Training	• Practical training at the Industry/ Banking Sector / Private/ Public sector organizations / Educational institutions, enable the students gain professional experience and also become responsible citizens.
VI Semester	Project with Viva – voce	• Self-learning is enhanced • Application of the concept to real situation is conceived resulting in tangible outcome
VI Semester	Introduction of Professional Competency component	• Curriculum design accommodates all category of learners; 'Statistics for Advanced Explain' component will comprise of advanced topics in Statistics and allied fields, for those in the peer group / aspiring researchers; • 'Training for Competitive Examinations' –caters to the needs of the aspirants towards most sought - after services of the nation viz, UPSC, ISS, CDS, NDA, Banking Services, CAT, TNPSC group services, etc.
Extra Credits: **For Advanced Learners / Honors degree**		• To cater to the needs of peer learners / research aspirants
Skills acquired from the Courses		Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Credit Distribution for UG Programme

Sem I	Credit	H	Sem II	Credit	H	Sem III	Credit	H	Sem IV	Credit	H	Sem V	Credit	H	Sem VI	Credit	H
Part 1. Language – Tamil	**3**	**5**	Part..1. Language – Tamil	**3**	**6**	Part..1. Language – Tamil	**3**	**6**	Part..1. Language – Tamil	**3**	**6**	5.1 Core Course –\CC IX	**4**	**4**	6.1 Core Course – CC XIII	**4**	**5**
Part.2 English	**3**	**5**	Part..2 English	**3 2**	**4 2**	Part..2 English	**3**	**6**	Part..2 English	**3**	**6**	5.2 Core Course – CC X	**4**	**4**	6.2 Core Course CC XIV	**4**	**5**
1.3 Core Course – CC I	**5**	**4**	2..3 Core Course – CC III	**5**	**5**	3.3 Core Course – CC V	**5**	**3**	4.3 Core Course – CC VII Core Industry Module	**5**	**5**	5. 3.Core Course CC -XI	**4**	**4**	6.3 Core Course – CC XV	**4**	**5**
1.4 Core Course – CC II	**5**	**4 2**	2.4 Core Lab Course –I – CC IV	**3**	**3**	3.4 Core Course – CC VI	**5**	**3 2**	4.4 Core Lab Course-II – CC VIII	**3**	**3**	5. 4. Core Lab Course – III & IV// Project CC -XII	**-**	**6**	6.4 Core Lab Course –III & IV - CC XVI	**3 3**	**3 3**
1.5 Elective I Generic/ Discipline Specific Allied: Botany	**3**	**4 2**	2.5 Elective II Generic/ Discipline Specific ALLIED: Botany & Botany Lab	**3 2**	**4 2**	3.5 Elective III Generic/ Discipline Specific Allied: Chemistry Chemistry Lab	**3**	**4 2**	4.5 Elective IV Generic/ Discipline Specific Allied: Chemistry & Chemistry Lab	**3 2**	**3 2**	5.5 Elective V Generic/ Discipline Specific	**3**	**4**	6.5 Project with viva-voce	**4**	**7**
1.6 Skill Enhancement Course SEC-1	**2**	**2**	2.6 Skill Enhancement Course SEC-2	**2**	**2**	3.6 Skill Enhancement Course SEC-4, (Entrepreneurial Skill)	**1**	**1**	4.6 Skill Enhancement Course SEC-6	**2**	**2**	5.6 Elective VI Generic/ Discipline Specific	**3**	**4**	6.6 Extension Activity	**1**	**-**
1.7 Skill Enhancement - (Foundation Course)	**2**	**2**	2.7 Skill Enhancement Course –SEC-3	**2**	**2**	3.7 Skill Enhancement Course SEC-5	**2**	**2**	4.7 Skill Enhancement Course SEC-7	**2**	**2**	5.7 Value Education	**2**	**2**	6.7 Professional Competency Skill	**2**	**2**
						3.8 E.V.S. Health & Wellness	**- 1**	**1 -**	4.8 E.V.S	**2**	**1**	5.8 Summer Internship /Industrial Training	**2**	**2 / 15 DAYS**			
	23	**30**		**25**	**30**		**23**	**30**		**25**	**30**		**22**	**30**		**25**	**30**
Total – 143 Credits																	

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF)
Guideline Based Credit and Hours Distribution System
for all UG courses including Lab Hours

First Year – Semester-I

Part	List of Courses	Credit	No. of Hours
Part-1	Language – Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses [in Total]	13	14
Part-4	Skill Enhancement Course SEC-1	2	2
	Foundation Course	2	2
		23	**30**

Semester-II

Part	List of Courses	Credit	No. of Hours
Part-1	Language – Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses including laboratory [in Total]	13	14
Part-4	Skill Enhancement Course -SEC-2	4	2
	Skill Enhancement Course -SEC-3 (Discipline / Subject Specific)	2	2
		25	**30**

Second Year – Semester-III

Part	List of Courses	Credit	No. of Hours
Part-1	Language - Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses including LAB [in Total]	13	14
Part-4	Skill Enhancement Course -SEC-4 (Entrepreneurial Based)	2	1
	Skill Enhancement Course -SEC-5 (Discipline / Subject Specific)	2	2
	E.V.S	-	1
		23	**30**

Semester-IV

Part	List of Courses	Credit	No. of Hours
Part-1	Language - Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses including LAB [in Total]	13	13

Part-4	Skill Enhancement Course -SEC-6 (Discipline / Subject Specific)	2	2
	Skill Enhancement Course -SEC-7 (Discipline / Subject Specific)	2	2
	E.V.S	2	1
		25	**30**

Third Year

Semester-V

Part	**List of Courses**	**Credit**	**No. of Hours**
Part-3	Core Courses including Project / Elective Based	18	26
Part-4	Value Education	2	2
	Internship / Industrial Visit / Field Visit	2	2
		22	**30**

Semester-VI

Part	**List of Courses**	**Credit**	**No. of Hours**
Part-3	Core Courses including Project / Elective Based & LAB	22	28
Part-4	Extension Activity	1	-
	Professional Competency Skill	2	2
		25	**30**

CONSOLIDATED SEMESTER WISE AND COMPONENT WISE CREDIT DISTRIBUTION

Parts	**Sem I**	**Sem II**	**Sem III**	**Sem IV**	**Sem V**	**Sem VI**	**Total Credits**
Part I	3	3	3	3	-	-	**12**
Part II	3	3	3	3	-	-	**12**
Part III	13	13	13	13	18	22	**92**
Part IV	4	6	4	6	4	1	**25**
Part V	-	-	-	-	-	2	**2**
Total	23	25	23	25	22	25	**143**

***Part I. II, and Part III components will be separately taken into account for CGPA calculation and classification for the under graduate programme and the other components. IV, V have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the UG degree.**

B.Sc - ZOOLOGY

FIRST YEAR - SEMESTER-I

Part	Course Code	List of Courses	Credit	No. of Hours
Part-1		Tamil- I/Language	3	5
Part-2		English - I	3	5
Part-3	23UZOCO01	Invertebrata - I	5	4
	23UZOCO02	Invertebrata - II	5	4
	Core Lab Course	Core Lab – I	-	2
	Elective Course-I	Allied-I - Botany	3	4
	Elective Lab Course	Allied Lab – Botany	-	2
Part-4	Skill Enhancement Course – (NME) –SEC-I	Animal Behavior/ Sericulture	2	2
	23UZOFC01 (Foundation Course)	Economic Zoology	2	2
			23	**30**

SEMESTER-II

Part	Course Code	List of Courses	Credit	No. of Hours
Part-1		Tamil II/Language	3	6
Part-2		English-II	3	6
Part-4	NMDC	Overview of English Language Communication	2	2
Part-3	23UZOCO03	Chordata	5	5
	23UZOCOP01	Core Lab -I	3	3
	Elective Course-II	Allied-II - Botany	3	4
	Elective Lab Course	Allied Lab - Botany	2	2
Part-4	Skill Enhancement Course - (NME) SEC-II	Wildlife Conservation and Management / Apiculture	2	2
	23UZOSE01 Skill Enhancement Course - SEC-III	Basics of Marine Biology	2	2
			25	**30**

SECOND YEAR - SEMESTER-III

Part	Course Code	List of Courses	Credit	No. of Hours
Part-1		Tamil- III/Language	3	6
Part-2		English-III	3	6
Part-3	23UZOCO04	Cell Biology	5	3
	23UZOCO05	Genetics	5	3
	Core Lab Course	Core Lab – II	-	2
	Elective Course-III	Allied-III - Chemistry	2	4
	Elective Lab Course	Allied Lab - Chemistry	1	2
Part-4	23UZOSE02 SEC-IV -Entrepreneurial Based	Aquarium Keeping	1	1
	23UZOSE03 - SEC-V	Biocomposting for Entrepreneurship	2	2
		Health and Wellness	**1**	-
		Environmental Studies	-	1
			23	**30**

SEMESTER-IV

Part	Course Code	List of Courses	Credit	No. of Hours
Part-1		Tamil-IV/Language	3	6
Part-2		English-IV	3	6
Part-3	23UZOCO06	Developmental Biology	5	5
	23UZOCOP02	Core Lab -II	3	3
	Elective Course-IV	Allied-IV - Chemistry	3	3
	Elective Lab Course	Allied Lab - Chemistry	2	2
Part-4	NMSDC	Healthcare & Data Management	2	2
	23UZOSE04 Skill Enhancement Course – SEC-VI	Food, Nutrition and Health	2	2
	23UZOSE05 Skill Enhancement Course – SEC-VII	Ornamental Fish Farming and Management	2	2
	23UZOEV01	Environmental Studies	2	1
			25	**30**

THIRD YEAR - SEMESTER-V

Part	Course Code	List of Courses	Credit	No. of Hours
Part-3	23UZOCO07	Evolutionary Biology	4	4
	23UZOCO08	Animal Physiology	4	4
	23UZOCO09	Environmental Biology	4	4
	23UZOCOP03 & P04	Core Lab -III & IV	-	6
	Elective Course-V	Agricultural Entomology	3	4
	Elective Course -VI	Medical Laboratory Techniques	3	4
Part-4	23UZOVE01	Value Education	2	2
	23UZOSI01 Summer Internship	Internship /Industrial Training/Fauna Survey (During Summer Vacation)	2	2 / (15 Days)
			22	**30**

SEMESTER-VI

Part	Course Code	List of Courses	Credit	No. of Hours
Part-3	23UZOCO10	Animal Biotechnology	4	5
	23UZOCO11	Microbiology	4	5
	23UZOCO12	Immunology	4	5
	23UZOCOP03	Core Lab -III	3	3
	23UZOCOP04	Core Lab -IV	3	3
	23UZOPR01	Project with vivo voce	4	7
Part-4	23UZOEA01	Extension Activity	1	-
Part-5	Professional Competency Skill	Employability Readiness	2	2
			25	**30**

Total Credits – 143

Students are permitted to gain extra credits by attending the value added / Add- on/ Swayam courses offered by the Institution or other institutions through online mode or extra hours if the students are interested.

SEMESTER - I

Course Code CC1	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	INVERTEBRATA - I	Core	Y	-	-	-	5	4	25	75	100
Learning Objectives											
CO1	To understand the basic concepts of lower animals and observe the structure and functions.										
CO2	To illustrate and examine the systemic and functional morphology of various group of invertebrates.										
CO3	To differentiate and classify the various groups of animal modes of life and to estimate the biodiversity.										
CO4	To compare and distinguish the general and specific characteristics of reproduction in lower animals.										
CO5	To infer and integrate the parasitic and economic importance of invertebrate animals										

UNIT	Details	No. of Hours	Course Objectives
I	Invertebrate: Classification, taxonomy and nomenclature. Protozoa: General characters and classification up to classes. Type study – Paramecium. Parasitic Protozoans: *Plasmodium, Entamoeba & Trypanasoma*	12	CO1
II	Porifera: General characters and classification up to Classes. Type study - Ascon & Sycon - Canal system in sponges.	12	CO2
III	Coelenterate: General characters and classification up to classes. Type study - *Obelia* and *Aurelia* - Corals and coral reefs – Polymorphism.	12	CO3
IV	Platyhelminthes: General characters and classification up to classes. Type study – *Fasciola hepatica, Taenia solium, Ascaris lumbricoides.* Parasitic adaptations.	12	CO4
V	Annelida: General characters and classification up to Classes. Type study –*Nereis* and *Hirudinaria granulosa*. Metamerism, Nephridium and Coelomoducts. Regeneration in Annalids.	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand the basic concepts of invertebrate animals and recall its structure and functions.	PO1
CO2	Illustrate and examine the systemic and functional morphology of various groups of invertebrata.	PO1, PO2
CO3	Differentiate and classify the animal's mode of life in various taxa and estimate the biodiversity.	PO4, PO6
CO4	To compare and distinguish the various physiological processes and organ systems in lower animals.	PO4, PO5, PO6
CO5	Infer and integrate the parasitic and economic importance of invertebrate animals.	PO3, PO8
Text Books (Latest Editions)		
1.	Ekambaranatha Iyer, 2000. A Manual of Zoology, 10th edition, Viswanathan, S., Printers & Publishers Pvt Ltd	
2.	Jordan, E.L. and Verma P.S, 1995. Invertebrate Zoology, 12th edn. S. Chand& Co.	
3.	Kotpal, R.L, 1992. Protozoa, Porifera, Coelenterata, Annelida, Arthropoda.	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.	
2.	**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**	
3.	Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson	
4.	Hyman L.H, 1955. The invertebrates - Vol. I to Vol. VII – Mc Graw Hill Book Co.	
5.	Parker, J. and Haswell , 1978. A text book of Zoology Vol. I - Williams and Williams.	
Web Resources		
1.	https://www.nationalgeographic.com/animals/invertebrates/	
2.	https://bit.ly/3kABzKa	
3.	https://www.nio.org/	
4.	https://greatbarrierreef.org/	

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) M-Medium (2) L-Low (1) B N

Course Code CC2	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	INVERTEBRATA - II	Core	Y	-	-	-	5	4	25	75	100

Learning Objectives	
CO1	To understand the structures and distinct features of invertebrate phyla.
CO2	To understand and able to distinguish the characteristic features of each phylum
CO3	To understand the economic importance of invertebrates
CO4	To understand the interaction of invertebrates with the environment.
CO5	To understand the evolutionary position of different groups of invertebrates

UNIT	Details	No. of Hours	Course Objectives
I	Arthropoda: General characters and classification up to Classes. Type study: *Penaeus indicus.* Affinities of *Peripatus* – Larval forms in Crustacea – characteristics of Centipede and Millipede.	12	CO1, CO2
II	Mollusca**:** General characters and classification up to Classes. Type study: *Pila globosa*. Foot and torsion in Mollusca, – Cephalopoda as the most advanced invertebrate.	12	CO1, CO2, CO4, CO5
III	Echinodermata: General characters and classification up to Classes. Type study: *Asterias.* Water vascular system in Echinodermata – Larval forms of Echinoderms.	12	CO1, CO2, CO3, CO5
IV	Insect pollinators: predators, parasites. Insects associated with human diseases: Mosquitoes, housefly, bed bug, human head louse. Insects associated with house hold materials: Ants, Termites, Silver fish.	12	CO4, CO5
V	Insect pests: Pest of rice: Rice stem borer (*Scirpophaga incertulas*), Pest of Sugarcane: Shoot borer (*Chilo infuscatellus*), Pest of coconut: Rhinoceros beetle (*Oryctes rhinoceros*), Pest of cotton: Spotted bollworm (*Earias insulana*), Pest of vegetables: Brinjal-Shoot and fruit borer (*Leucinodes orbonalis*), Pest of fruits: Citrus butterfly (*Papilio demoleus*).	12	CO4, CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Classify, Identify and recall the name and distinct features of invertebrate groups.	PO1
CO2	Explain, and relate the origin, structural organization and evolutionary aspects of invertebrates.	PO1, PO2
CO3	Analyze, compare and distinguish the developmental stages and describe the important biological process.	PO3, PO4, PO5
CO4	Correlate the interaction of invertebrates with humans and critique its economic importance.	PO4, PO5, PO6
CO5	Summarize the physiology, ecological adaptations to stimulate and integrate the significance of invertebrates to the environment, humans, and agriculture.	PO1, PO2, PO3, PO8
Text Books (Latest Editions)		
1.	Ekambaranatha Ayyar, and T. N. Ananthakrishnan, 2000. A Manual of Zoology. Vol 1 (Invertebrata). Part II – Viswanathan Pvt. Ltd, 842pp	
2.	Jordan, E.L. and Verma P.S, 1995. Invertebrate Zoology, 12th edn. S. Chand& Co.	
3.	Kotpal R.L. 2019. Modern Text Book of Zoology, Invertebrtes 9th Ed., Rastogi Publications, Gangotri, Shivaji Road, Meerut, 1004 pp.	
4.	Vasantharaj David, B. 2001. Elements of Economic Entomology, Popular Book Depot, Chennai. 400pp.	
5.	Ruppert and Barnes, R.D. 2006. Invertebrate Zoology, VIII Edition. Holt Saunders International Edition, Belmont, CA : Thomson-Brooks/Cole, 928pp.	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Barrington, E.J.W., 2012, Invertebrate structure and function. Boston – Houghton. Miffin and ELBS, London.	
2.	Bhamrah,H.S. and Kavitha Junea, 2002. A text book of Invertebrates. Alilnol Publications Private Limited, 4374/4B.Ansari Road, Dayaganj, New Delhi.	
3.	Hyman L.H, 1955. The invertebrates – Vol. I to Vol. VII – McGraw Hill Book Co.	
4.	Kotpal, 1992. Protozoa, Porifera, Coelenterata, Annelida, Arthropoda, Mollusca, Echinodermata, R.L- Rastogi Publication.	
5.	Parker, J. and Haswell , 1978. A text book of Zoology Vol. I - Williams and Williams.	
6.	Srivastava, M.D.L and Srivastava, 1969. A text book of Invertebrate Zoology, U.S- Central Book Depot, Allahabad.	

7.	Verma, A. Invertebrates: Protozoa to Echinodermata. Narosa Publishing House Private Limited.35-36 Greams Road, Thousand Lights, Chennai.	
Web Resources		
1.	https://www.nationalgeographic.com/animals/invertebrates/	
2.	https://bit.ly/3kABzKa	
3.	https://www.nio.org/	
4.	https://bit.ly/3lJdUX0	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3			S	S	S	S		
CO 4			S	S	S	M		
CO 5			S					S

S-Strong(3) M-Medium (2) L-Low (1)

SKILL ENHANCEMENT COURSE (NME)
ANIMAL BEHAVIOUR

Learning Objectives

1. To learn the origin and development of animal behavior and to understand the influence of genetics, environment on animal behaviors.
2. To understand the biological properties of animal behavior, with an evolutionary and ecological emphasis.
3. To Compare innate and learned behavior and differentiate between various mating system.
4. To impart the knowledge about visual and auditory communication; courtship, mate choice, and mating systems; social behavior and social systems; and animal personality.
5. To discuss how movement and migration behaviors are a result of natural selection.

Unit I: Genetics and Behaviour : Genetic material, Genes and chromosomes, Genetic variation, Single and Polygenic inheritance of behaviour, Heritability of behaviour, Natural selection and behaviour, Frequency distribution of phenotypes, Darwinian fitness, Evolution of adaptive strategies.

Unit II: Evolution and Social Behaviour: Sexual selection, Altruism, Sexual strategy and social organisation, Animal perception, Neural control of behaviour, Sensory processes and perception, Visual adaptations to unfavourable environments.

Unit III: Animal and the Environment: Coordination and Orientation, Homeostasis and Behaviour, Physiology and Behaviour in changing environments, Animal Learning, Conditioning and Learning, Biological aspects of learning, and Cognitive aspects of learning.

Unit IV: Understanding Complex Behaviour: Instinct and learning, Displacement activities, Ritualization and Communication, Decision making behaviour in Animals, Complex behaviour of hobey bees, Evolutionary optimality, Mechanism of Decision making. The mentality of Animals: Languages and mental representation, non-verbal communication in human, mental images,Intelligence, tool use and culture, Animal awareness and Emotion.

Unit V: Chronobiology : Organization of circadian system in multicellularanimals; Concept of central and peripheral clock system; Circadian pacemaker system in invertebrates with particular reference to Drosophila; Photoreception and photo- transduction; The physiological clock and measurement of day length; Molecular bases of seasonality; The relevance of biological clocks for human welfare - Clock function (dysfunction).

Text Books

1. David McFarland, 1985.Animal Behaviour, Longman Scientific & Technical, UK.576pp.
2. HarjindraSingh,1990.ATextBookofAnimalBehaviour,AnomolPublication,293pp.
3. HoshangS.GundeviaandHareGovingSingh,1996.AnimalBehaviour,S.Chand&Co, 280pp.
4. Shukla, J. P 2010, Fundamentals of Animal Behaviour, Atlantic, 587pp.
5. Vinod Kumar, 2002. BiologicalRhythms. NarosaPublishingHouse, Delhi.

Suggested Readings

1. Michael D. Breed and Janice Moore, 2012. Animal Behaviour, Academic Press, USA, 359pp.
2. Aubrey Manning and Martin Stamp Dawkins, 2012. An Introduction to Animal Behaviour, 6th Edition, Cambridge University Press, UK. 458pp.
3. Davis E.Davis, 1970. Integral Animal Behaviour, Mac Millan Company,London, 118pp.
4. Jay, C. Dunlap, Jennifer, J. Loros, Patricia J. De Coursey (ed). 2004. Chronobiology Biological time Keeping, Sinauer Associates Inc, Publishers, Sunderland, MA.

Web Resources

1. https://www.ncbs.res.in/content/animal-behaviour
2. https://bit.ly/3i6wUxR
3. https://www.behaviour.univie.ac.at/
4. https://www.ru.nl/bsi/

Course Outcomes (COs)

1. Recall and record genetic basis and evolutionary history of behaviour.
2. Classify movement and migration behaviors and explain environmental influence upon behaviour.
3. Analyze and identify innate, learned and cognitive behavior and differentiate between various mating systems.
4. Assess complexity involved in behavioural traits and evaluate hormones and their role in aggression and reproduction.
5. Discuss the rhythmicity of behavioural expressions and the scientific concepts in behavior and behavioral ecology.

SKILL ENHANCEMENT COURSE (NME)
SERICULTURE

Learning Objectives:

1. To know about the Mulberry and Non – mulberry silkworm types
2. To understand the mulberry cultivation and silkworm rearing
3. To acquire knowledge about silk reeling
4. To know about the diseases of silkworm.

UNIT -I: Types of silk worms – Tasar, Muga, and Eri. Morphology and life cycle of silk worm (Bombyx mori).

UNIT -II: Mulberry cultivation in India - Selection of land and cultivation of mulberry –Mulberry varietie Different methods of planting –Organic and in organic manure application.

UNIT –III: Disinfection of rearing houses and appliances - Egg transportation and incubation –Egg handling – Hatching –Brushing –Silk worm rearing techniques.

UNIT –IV: Pest and diseases of silk worm and preventive measures. Harvesting of cocoon and quality assessment.

UNIT –V: Reeling methods – Reeling and Re-reeling –Silk examination, cleaning, lacing, bookmaking and grading of silk.

Text Books:

1. Ganga G., Sulochanachetty. J. An Introduction of Sericulture. Oxford, New Delhi – 1977.
2. Johnson M., and Kesary M., Sericulture, CSI Press, Marthandam, 2008.

Suggested Readings:

1. Krisnamoorthy S., Improved Method of Rearing Young Age Silk Worms: Reprinted by CSB, Bangalore, 1986.
2. Tanaka Y., Sericology, CSB, Pub., Bangalore, 1964.
3. Text Book of Tropical Sericulture, Pub., Japan Overseas Volunteers, 1975.
4. Ullal S.R., and Narasimhan M.N., Hand Book of Practical Sericulture, CSB, Bangalore, 1987.
5. HisaoAruga, Principles of sericulture, Oxford and IBH Publishing Company, 1994.
6. An Introduction to sericulture (IInd edition) G.Ganga and Sulochana chetty .
7. Rangaswamy.G. (1987) .Manual on sericulture FAO, Vol –IV, Agriculture service bulletin ,CSB , Bangalore , India .
8. Dandan.S.B. (2004) Hand book of new sericulture technologies ,Central Silk Board Bangalore, pp 287.

Course Outcomes (COs)

1. To identify the types of silk worms, and understand the basic aspects of culture.
2. To assess and integrate the available tools and techniques to increase the productivity in culture areas.
3. To analyze the pros and cons of different methods of culture methods and marketing strategies of products.
4. To evaluate the use of available resources in improving the sericulture breeds, harvesting methods.
5. To design new methods to improve and increased the productivity and disease resistance and to construct new methods in sericulture

FOUNDATION COURSE - ECONOMIC ZOOLOGY

Learning Objective

1. To understand the culturing techniques and production methods of different farm animals.
2. To know the life history of animals and disease control methods used in farming.
3. To understand the concept of breeding, cross breeding and the importance of high yield varieties.
4. To know about the marketing strategies.

Unit I: Economic Entomology: Apiculture: Species of honey bees – Social organization of honey bee – selection of bees and location for apiary – Newton's bee hive – products of bee keeping – enemies and diseases of honey bees. Sericulture: Species of silkworm – life history of mulberry silkworm – Rearing of silkworm – pests and diseases of silkworm.

Unit II: Vermiculture: Introduction: Types of earthworms – ecological classifications of earthworms – Physical, chemical and biological changes caused by earthworms in the soil – Natural enemies of earthworms. Vermicomposting: Methods, factors affecting – Vemiculture unit. Harvesting of vermicompost – vermicast - advantages of vermicompost – vermiwash and its applications.

Unit III: Aquaculture: Fresh water aquaculture: Carp culture – types of ponds – preparation – maintenance – harvesting and management. Integrated and composite fish culture. Prawn culture. Marine Aquaculture: Edible – pearl oyster culture. Ornamental fish culture: Aquarium fishes – Aquarium maintenance in home. Economic importance of Aquaculture.

Unit IV: Poultry Farming : Poultry industry in India – Poultry for sustainable food production and livelihood - Commercial poultry farming – Nutritive value of egg and meat- Broiler management (Definition; Housing and equipment; Brooding, feeding and health cover of broilers; Record keeping; Broiler integration) – Layer management (Brooder; Grower and layer management; Culling of layers; Marketing of eggs and meat). Role of Womens in backyard poultry farming.

Unit V: Dairy Farming: Dairy farming –classification of breeds of cattle – Indigenous and exotic breeds – Selection of dairy cattle. Breeding – artificial insemination, Dairy cattle management – housing, water supply, cattle nutrition feeding standards, common contagious diseases. Milk - Composition of milk, milk spoilage, pasteurization, Role of milk and milk products in human nutrition. Advantages of dairy farming, Dairying as a source of additional income and employment.

Text Books

1. Sastry, N.S.R., C.K.Thomas and R.A.Singh, 2015. Livestock Production Management, 4thEd.Kalyani Publishers, New Delhi.
   Mary violet Christy, A. 2014. Vermitechnology, MJP Publishers, Chennai.
2. ICAR, 2013. Hand book of Animal Husbandry, 4th Ed., ICAR Publication, Pusa, New Delhi.
3. Awasthi, V.B., 2012. Introduction to General and Applied Entomology, third edition, Scientific publishers, India.
4. Vasanthraj David, B and Ramamurthy, VV., 2012. Elements of Economic Entomology, Seventh edition, Namrutha publications, Chennai.
5. Shukla &Upadhyay, 2014. Economic Zoology, 5th edn. Rastogi Publication, Meerut New Delhi.
6. Gupta, S.M., 2010. Text book of fishery, Ann Backer, Mumbai.
7. ShailendraGhosh, 2009. Fisheries and aquaculture management, Adhyayan, New Delhi.

Suggested Readings

1. Glenn Munroe, 2017. Manual of on-Farm vermicomposting and vermiculture, Holdanca Farms Ltd, Wallace, Nova Scotia.
2. Hanifa, M.A., 2011. Aquatic resources and aquaculture, Dominent, New Delhi.
3. Gupta, P.K., 2008. Vermicomposting for sustainable agriculture, 2nd Edition, Agrobios, India.
4. Talashikar, S.C., 2008. Earthworms in Agriculture, Agrobios, India.
5. Abishek Shukla, D ., 2 0 0 9 . A Hand Book of Economic Entomology, Vedamse Books, New Delhi .
6. Banerjee, G.C., 2006. Text book of Animal Husbandry 8thEd.Oxford and IBH Publishing Company Ltd., New Delhi.
7. Walstra, P. Wouters, J.T.M. and Geurts, T.J. 2006. Dairy Science and Technology. CRC Press, New York.
8. Dunham, R.A., 2004. Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications, U.K.
9. Donald.D Bell and William. D. Weaver, 2002. Commercial chicken meat and egg production, Springer, New York.
10. Eckles C.H. and Anthony, E.L., 2001. Dairy Cattle and milk production, Biotech. Tata McGraw Hill Publishing Co.Pvt.Ltd., New Delhi.

Web Resources

1. https://bit.ly/3tXHjk8
2. https://bit.ly/3tUTHBu
3. https://bit.ly/3hVv96q
4. https://bit.ly/39nztH1
5. https://bit.ly/3CzasVO
6. https://agritech.tnau.ac.in/org_farm/orgfarm_vermicompost.html
7. https://bit.ly/3nYvgSF
8. http://caa.gov.in/farms.html
9. http://www.csrtimys.res.in/
10. http://www.agshoney.com/training.htm

Course Outcomes (COs)

1. To identify the breeds and varieties of poultry, fish, bees, and cattle and understand the basic aspects of farming.
2. To assess and integrate the available tools and techniques to increase the productivity in farms.
3. To analyse the pros and cons of different methods of farming and marketing strategies of products.
4. To evaluate the use of available resources in improving the breeds, vermicomposting, farm products etc..
5. To design new methods to improve farm animals with increased productivity and disease resistance and to construct new methods in vermicomposting.

SEMESTER - II

Course Code CC3	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	CHORDATA	Core	Y	-	-	-	5	5	25	75	100

Learning Objectives	
CO1	To understand the structures and distinct features of Phylum Chordata.
CO2	To understand and able to distinguish the characteristic features of each subphylum and class.
CO3	To understand the economic importance of vertebrates
CO4	To know about the adaptations of vertebrates
CO5	To understand the evolutionary position of different groups of vertebrates

UNIT	Details	No. of Hours	Course Objectives
I	**Chordata:** General Characters and Classification. Origin of Chordata, Differences between non-chordates and chordates. **Prochordata:** General Characters, Affinities and systematic position of Hemichordata (*Balanoglossus*), Urochordata (*Ascidia*), Cephalochordata (*Amphioxus*).	12	CO1, CO2
II	**Vertebrata**: General Characters and Classification upto Class level - Type study - Agnatha (*Petromyzon*). **Pisces:** General characters and classification - Origin of fishes – Type study - *Scoliodon sorrakowa* - Types of scales and fins - Accessory respiratory organs - Parental care - Migration - Economic importance of fishes.	12	CO1, CO2, CO4, CO5
III	**Amphibia**: General characters and classification - Origin of Amphibia - Type study - *Rana hexadactyla* - Adaptive features of Anura, Urodela and Apoda - Neoteny in Urodela - Parental care in Amphibia.	12	CO1, CO2, CO3, CO4, CO5
IV	**Reptilia:** General characters and classification - Type study – *Calotes versicolor* - Origin of reptiles, Extinct reptiles. Snakes of India. Poison apparatus and biting mechanism of poisonous snakes - Skull in reptiles as basis of classification.	12	CO1, CO2, CO4, CO5

V	**Aves:** General characters and classification, Origin of birds, Type study - *Columba livia* - Flight adaptations, Migration. **Mammalia**: General characters and classification - Type study - Rabbit - Adaptive radiation in mammals - Egg laying mammals, Marsupials, Flying mammals, Aquatic mammals, Dentition in mammals.	12	CO1, CO2, CO4, CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Classify, Identify and recall the name and distinct features of different subphylum belonging to phylum Chordata.	PO1
CO2	Explain, and relate the origin, structural organization and evolutionary aspects of vertebrates.	PO1, PO2
CO3	Analyze, compare and distinguish the developmental stages and describe the important biological process.	PO3, PO4, PO5
CO4	Correlate the different modes of life and parental care among different vertebrates.	PO3, PO5, PO6
CO5	Summarise the morphology and ecological adaptations in vertebrates and list out the economic importance.	PO2, PO3, PO5, PO8

Text Books (Latest Editions)	
1.	Ayyar, E.K. and T.N. Ananthakrishnan, 1992. Manual of Zoology Vol. II (Chordata), S. Viswanathan (Printers and Publishers) Pvt Ltd., Madras, 891p.
2.	Jordan, E.K. and P.S. Verma, 1995. Chordate Zoology and Elements of Animal Physiology, 10th edition, S. Chand & Co Ltd., Ram Nagar, New Delhi, 1151 pp.
3.	Nigam, H.C., 1983. Zoology of Chordates, Vishal Publications, Jalandhar - 144008, 942.
4.	Ganguly, Sinha,. Bharati Goswami and Adhikari, 2004. Biology of animals Vol.II - New central book Agency (p) Ltd.
5.	Kotpal. R.L. A, Modern text book of Zoology Vertebrates- Rastogi publications. 2009

References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub. Co.
2.	Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
3.	Hickman, C.P. Jr., F.M.Hickman and L.S. Roberts, 1984. Integrated Principles of Zoology, 7th Edition, Times Merror/Mosby College Publication. St. Louis. 1065 pp.
4.	Newman, H.H., 1981. The Phylum Chordata, Satish Book Enterprise, Agra – 282 003, 477 pp.
5.	Parker and Haswell, 1964. Text Book of Zoology, Vol II (Chordata), A.Z.T,B.S.

	Publishers and Distributors, New Delhi - 110 051, 952 pp.	
6.	Pough H. Vertebrate life, VIII Edition, Pearson International.	
7.	Waterman, Allyn J. et al., 1971. Chordate Structure and Function, Mac Millan & Co., New York, 587 pp.	
Web Resources		
1.	http://tolweb.org/Chordata/2499	
2.	https://www.nhm.ac.uk/	
3.	https://bit.ly/3Av1Ejg	
4.	https://bit.ly/3kqTfYz	
5.	https://biologyeducare.com/aves/	
6.	https://www.vedantu.com/biology/mammalia	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview.	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3		S	S	S	S	S		S
CO 4			S	S	S	M		
CO 5			S		S			S

S-Strong(3) M-Medium (2) L-Low (1)

SKILL ENHANCEMENT COURSE (NME)
WILDLIFE CONSERVATION AND MANAGEMENT

Learning Objectives

1. To understand and discuss the importance of wildlife, its values, modern concepts in wildlife management, and relevant conservation policies.
2. To assess and instil strong foundations on wildlife policies and be familiar with a variety of laws and regulations.
3. To analyse and design appropriate approaches to turn conflict into tolerance and coexistence, with an emphasis on the human dimensions of human-wildlife interactions.
4. To evaluate and integrate all the related areas like Fundamentals in Ecology, Forestry, Natural Resource Conservation approaches and develop the role PVA models for protection of Endangered species.
5. To explain the advanced scientific basis for wildlife management and discuss National and International Efforts for successful wildlife conservation.

Unit I :Biodiversity Extinction and Conservation Approaches:
Perspectives and Expressions. Identification and prioritization of Ecologically sensitive area (ESA). Coarse filter and fine filter approaches. Regional and National approaches for biodiversity conservation.

Unit II: Theory and Analysis of Conservation of Populations:
Stochastic perturbations - Environmental, Demographic, spatial and genetic stochasticity. Population viability analysis-conceptual foundation, uses of PVA models. Management Decisions for small populations using PVA models. Minimum viable populations & recovery strategies for threatened species.

Unit III: National and International Efforts for Conservation:
International agreements for conserving marine life, Convention on wetlands of International Importance (Ramsar convention), Conservation of Natural Resources. Overview of conservation of Forest &Grassland resources. CITES, IUCN, CBD National Forest Policy, 1988, National Wildlife Action Plan 2017-2031, Wildlife Protection Act 1972, National and State Biodiversity Action Plans and other Forests and Environmental Acts.

Unit IV: Wildlife in India: Wildlife wealth of India & threatened wildlife, Reasons for wildlife depletion in India, Wildlife conservation approaches and limitations. Wild life Habitat: Characteristic, Fauna and Adaptation with special reference to Tropical forest. Protected Area concept: National Parks, Sanctuaries and Biosphere Reserves, cores and Buffers, Nodes and corridors. Community Reserve and conservation Reserves.

Unit V: Management of Wildlife: Distribution, status. Habitat utilization pattern, threats to survival of Slender Loris, Musk deer, Great Indian Bustard, Olive Ridley turtle. Wild life Trade & legislation, Assessment, documentation, Prevention of trade, Wild life laws and ethics.

Text Books:

1. Robinson W L and Eric G Bolen, 1984. Wildlife Ecology and Management, Maxmillan Publishing Company, New York, p 478.
2. Aaron, N.M.1973 Wildlife ecology, W.H. Freeman Co. San Francisco, U.S.A.
3. Dasmann R F, 1964. Wildlife Biology, John Wiley & Sons, New York, p 231.
4. Justice Kuldip Singh 1998. Handbook of Environment, Forest and Wildlife Protection Laws in India, Natraj Publishers, Dehradun.
5. Hosetti, B.B. 1997 Concepts in Wildlife Management, Daya Publishing House, Delhi.
6. Sutherland, W.J 2000. The conservation handbook: Research, Management and Policy. Blackwell Science.

Suggested Readings

1. Gilas R H Jr.(ed.), 1984. Wildlife Management Techniques, 3rd ed. The Wildlife Society, Washington D.C., Nataraj Publishers, Dehra Dun, p 547.
2. Rodgers W A, 1991. Techniques for Wildlife Census in India - A Field Manual: Technical Manual - T M - 2. WII.
3. Saharia V B, 1982. Wildlife of India, Natraj Publishers, Dehra Dun.
4. Goutam Kumar Saha and SubhenduMazumdar, 2017. Wildlife Biology: An Indian Prospective, PHI Publisher, Delhi.
5. Katwal/Banerjee, 2002. Biodiversity conservation in managed and protected areas, Agrobios, India.

Web resources

1. https://bit.ly/39oPj44; https://bit.ly/3lHdEYJ; https://bit.ly/3CwBCfY; https://bit.ly/3EDYr3a; https://bit.ly/3tVtG4U

Course outcomes (COs)

1. To understand and recall the importance of wildlife, extinction and Conservation Approaches of wildlife.
2. To integrate and assess the National, international approaches for biodiversity conservation.
3. To analyse and differentiate threats to wildlife, various action plans, conservation strategies on wildlife of India to turn conflict into tolerance and coexistence.
4. To explain the role PVA models, Wildlife conservation approaches, and limitations.
5. To construct and simulate National and International strategies for Conservation, Wild life laws and ethics.

SKILL ENHANCEMENT COURSE (NME)
APICULTURE

Learning Objectives:

1. To inculcate importance of Bee keeping and Honey processing.
2. To encourage young learners to take up the small-scale industries after graduation.
3. To teach techniques of construction of Bee Hives and its maintenance.
4. To disseminate information on economic aspects of honey bee.

UNIT – I: History of Bee keeping – Scope and importance – Classification of honey bee species – Apiculture development in India – Institutions involved – Role of Central Honey Bee Research and Training Institute.

UNIT – II: Basic concepts of morphology, mouth parts and sting of Honey bees – Social organization in honey bees: Colony life – Queen, drone, worker – Life cycle of the honey bee.

UNIT – III: Bee hives – Traditional bee hives – Modern bee hive: Newton hive. Bee dances, Flora for apiculture – selection of bees for apiculture – tools and extraction of honey.

UNIT – IV: Modern appliances for Apiaries, Products: Honey, Bee wax, Bee venom, Pollen, Royal jelly, Propolis – Chemical composition, nutritional and medical value of honey.

UNIT – V: Diseases of Honey bee – Symptoms and control measures - Bacterial: American foul brood, European Foul brood – Viral: Thai sac brood, Sac brood virus – Fungal: Chalk brood, Stone brood and Nosemosis,– Bee enemies: Wax moth, Ants, Wasp and birds.

Text Books:

1. Apiculture – Sunithira. C, 2016, DivyaJothi Publication, Kanyakumari, Tamil Nadu.
2. Fundamentals of Bee keeping – Sathe. T.V., 2006, Daya Publishing House Pvt. Ltd., New Delhi.

Suggested Readings

1.Honey Bee Pests, Predators and Diseases, 3rd Edition, Roger A. Morse, b. Kim Flottum, 1998, Wicwas Press.
2.Bee Keeping in India, Ghosh. G.K., 1998, APH Publishing, New Delhi.
3.Honey – A Comprehensive Survey – International Bee Research Association for house – CNRC [England].
4.Honey Bee Biology and Bee keeping, Dewey M. Caron, 2013, Wicwas Press, Kalamazoo.
5.The Backyard Bee keeper, 3rd Edition, Kim Flottum, 2014, Quarry Books, Quayside Publishing Group, Beverly.

Course outcomes (COs)

1. The learner will be able to understand the basics of beekeeping tools, equipment, and managing beehives.
2. The learner will be able to understand the primary life cycle of the honeybees, beekeeping tools and equipment.
3. The learner will be able to learn and manage beehives for honey production and pollination.
4. The course will be useful for providing self-employment to the learner.
5. Beekeeping will be useful in the pollination of flora.
6. The learner will be able to understand the marketing of various bee products.

SKILL ENHANCEMENT COURSE
BASICS OF MARINE BIOLOGY

Learning Objective

1. To understand and learn the physical, chemical and biological aspects of marine environment and to gain knowledge about the management of oceans.
2. To introduce students to the marine environment and its indigenous organisms.
3. To study the principles, concepts and facts through which the student can better understand and appreciate the nature of the sea and its inhabitants.
4. To acquaint the student with the characteristics used to identify and classify marine plants and animals and to develop an awareness of the career possibilities available to students in this area.

Unit I: Marine Ecology: Marine environment- ecological factors- light, temperature, salinity. Classification of marine environment: Pelagic environment – Planktonic and Nektonic adaptations; Benthic environment - intertidal, interstitial and deep sea adaptations; Distribution and ecological role of other coastal environments - coral reefs, estuaries, mangroves, sea grass beds, kelp forests and hydrothermal vents.

Unit II: Physical Oceanography : Physical properties of Seawater- density, viscosity, surface tension, conductivity and their relationship; temperature distribution in the sea - heat budget, UV radiation; Dynamics of the ocean-general surface circulation, Waves, Tides, Currents and Tsunami.

Unit III: Chemical Oceanography : Chemical composition of seawater- ionic, major and minor constituents, methods of measurements, constancy- ionic compositions and factors affecting - major and minor elements, trace elements- their importance, distribution. Nutrients - biogeochemical cycles.

Unit IV: Biological Oceanography: Sea as a biological environment- Plankton- classification based on size, mode of life and habitat. Phytoplankton and Zooplankton - methods of collection, estimation of standing crop - wet and dry weight estimation. Primary productivity – estimation and factors affecting primary productivity.

Unit V: Marine Pollution and Ocean Management: Ocean pollution- kinds and quantities of pollutants, toxic effects and control measures – oil spills, plastics, nuclear waste disposal in marine environment. Eutrophication, Role of National and international agencies and organizations in ocean management. Ocean policy (India) - research and management.

Text Books:

1. Thurman, Harold., 2001 Introduction to Oceanography, Prentice Hall Inc. New Jersey. 506 pp.
2. Bertness, M.D, S. D. Gaines and M.K. Hay 2000. Marine Community Ecology Sinauer Associates.
3. Grant Gross, M., 1993 Oceanography: A view of the earth (sixth edition). Prentice Hall Inc. New Jersey.
4. Fincham A. A, 1984. Basic Marine Biology. Cambridge University Press, England. 157 pp.
5. John Resech Jr.1979, Marine Biology. Reston Publishing Company, Virginia. 257 pp.

Suggested Readings:

1. Barbara E. Curry, 2016. Advances in Marine Biology, Volume 74, Ist Edition. Academic Press ISBN: 9780128036075
2. Peter Castro, Michael E. Huber, 2015. Marine Biology; Series Botany, Zoology, Ecology and Evolution. McGraw-Hill Education.
3. Philip V. Mladenov, 2013 Marine Biology: A very short introduction, Ist Edition. Oxford University Press.
4. Venkataraman K, Raghunathan C, Raghuraman R, Sreeraj C. R, 2012. Marine diversity in India. Zoological Survey of India, Kolkata.178 pp.
5. Amy Hill. 2002. Marine Biology: An Introduction to Ocean Ecosystems (Marine Biology Ser) Walch publishing.
6. Pickard, G.L. and W.J. Emery 1995. Descriptive Physical Oceanography. PergamonPress,London.
7. Gage. J.D. and P.A. Tyler, 1991. Deep Sea Biology, Cambridge University Press,Cambridge
8. Raymont J. E. G., 1980. Plankton and Productivity in the oceans: Volume 1: Phytoplankton, Pergamon Press.
9. Van Der Spoel, S. and PierrotBults, A. C (Eds) 1979. Zoogeography and diversity of plankton. Bungs Scientific Publishers Utrecht, 410pp.
10. Riley, J.P. and Skirrow, 1975-1984. Chemical Oceanography Vols. 1 to 8. Academic Press,London

Web Resources

1. https://www.livescience.com
2. https://www.icriforum.org
3. https://www.cbd.int

Course Outcomes (COs)

1. Define marine ecosystem, recognize and describe the interrelationship between biology and ocean technology.
2. Articulate and classify the dynamics and the physical attributes of the ocean, interpret the factors which affect the global climate.
3. Identify and analyze the physical and biological factors of marine environments, and focus life in the open sea.
4. Evaluate the impact of variations in abiotic factors in marine productivity and justify the role of human activities in the degradation of marine ecosystems.
5. Categorize marine pollutants and develop controlling measures in collaboration with the institutions for ocean management.

SEMESTER – III

Course Code CC4	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	CELL BIOLOGY	Core	Y	-	-	-	5	3	25	75	100

Learning Objectives

CO1	To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.
CO2	To understand how these cellular components are used to generate and utilize energy in cells.
CO3	To understand the cellular components underlying mitotic cell division.
CO4	To apply the knowledge of cell biology to selected examples of changes or losses in cell function.

UNIT	Details	No. of Hours	Course Objectives
I	**The Cell:** Cell theory - Ultra structure of Animal cell - Cytoplasm - Structure and Composition, Function - Extra Cytoplasmic Structure – Cilia, Flagella - Cytoplasmic Inclusions.	12	CO1, CO2
II	**Cell components:** Plasma Membrane Ultra Structure - Different Models - Functions - Ultrastructure, Composition and Function of Endoplasmic reticulam, Ribosome, Golgi Complex, Lissome, Centriole, Microtubules Microfilaments, Mitochondria and Microsomes.	12	CO1, CO2, CO4, CO5
III	**Nucleus:** Ultrastructure, Composition and Functions - Nuclear Membrane - Nucleoplasm - Chromosomes - Heterochromatin and Euchromatin - Nucleolus - Nucleolus Cycle - DNA and RNAs - Protein Synthesis and its regulation.	12	CO1, CO2, CO3, CO4, CO5
IV	**Cell Divisions and Cancer Biology**: Amitosis, Mitosis and Meiosis and their Significance. Characteristics of cancer cells, types, theories on Carcinogenesis, Ageing of Cells – Apoptosis and Stem cell studies.	12	CO1, CO2, CO4, CO5

V	**Tools and Techniques of Cell**: Cell Fractionation, Homogenization, Centrifugation, Isolation of sub cellular Components. Histological techniques - Staining - Vital Stains. – Cytoplasmic and Nuclear Stains. Micro Technique Methods, Microscopes - Types - Light, Phase contrast - Units of measurement.	12	CO1, CO2, CO4, CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	To understand and recall the basic structure, origin and development of cell organelles.	PO1
CO2	To integrate and assess the biochemical, cytological and histological tools to infer cellular basis of organization.	PO1, PO2, PO3
CO3	To analyze and differentiate organisms based on structure, composition and inter and intra cellular interactions.	PO3, PO4, PO5
CO4	To explain the role of cells and cell organelles in various biological processes.	PO2, PO3, PO5, PO6, PO8
CO5	To construct and simulate the role of different cytological tools to explain the structure and complexity of cells and cell organelles.	PO3, PO4, PO5, PO6, PO7, PO8

Text Books (Latest Editions)

1.	Ambrose, E.J. and Dorothy, M. Easty, 1970. Cell Biology, Thomas Nelson & Sons Ltd., 500 pp.
2.	Kumar P. and Mina U. (2018) Life Sciences: Fundamentals and Practice, Part-I, 6th Edn., Pathfinder Publication. p.608.
3.	VeerBala Rastogi, Introductory cytology. Kedar Nath Ram Nath. Meerut 250 001.
4.	Verma, P.S. and V. K.Agarwal, 1995. Cell and Molecular Biology, 8th Edition, S.Chand & co., New Delhi - 110 055, 567 pp.
5.	Verma P.S. and Agarwal V.K. (2016) Cell Biology (Cytology, Biomolecules, Molecular Biology), Paperback, S. Chand and Company Ltd.

References Books
(Latest editions, and the style as given below must be strictly adhered to)

1.	Albert B., Hopkin K., Johnson A.D., Morgan D., Raff M., Roberts K. and Walter P. (2018) Essential Cell Biology 5th Edn.,(paperback) W.W. Norton & Company
2.	Burke, Jack. D., 1970. Cell Biology, Scientific Book Agency, Calcutta.
3.	Challoner J. (2015) The Cell: A visual tour of the building block of life, The University of Chicago Press and Ivy Press Ltd., p.193.
4.	Cohn, N. S., 1979, Elements of Cytology, Freeman Book Co., New Delhi – 110007, 495 pp
5.	Cooper G.M. (2019) The Cell – A Molecular Approach, 8th Edn., Sinauer Associates Inc., Oxford University Press p.813.
6.	DeRobertis, E.D.P. and E.M.F. De Robertis, 1988. Cell and Molecular Biology, 8th Edition, International Edition, Info med, Hong Kong, 734pp.

7.	Dowben, R., 1971. Cell Biology, Harper International Edition. Harper and Row Publisher, New York, 565 pp.	
8.	Giese, A.C., 1979. Cell Physiology, Saunders Co., Philadelphia, London, Toronto, 609 pp.	
9.	Hardin J. and Bertoni G. (2017) Becker's World of the Cell. 9th Edn (Global Edition). Pearson Education Ltd., p. 923	
10.	Karp G., Iwasa J. and Masall W. (2015) Karp's Cell and Molecular Biology Concepts and Experiments. 8th Edn. John Wiley and Sons. p.832.	
Web Resources		
1.	http://www.microscopemaster.com/organelles.html; https://bit.ly/3tXwDSB	
2.	https://bit.ly/3tWNpRX; https://bit.ly/3AuYR9M	
3.	https://rsscience.com/cell-organelles-and-their-functions/	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summaryr overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2		S	S	S	S			S
CO 3		S	S	S	S	S		S
CO 4		S	M			M		
CO 5				S	S	S		S

S-Strong (3) M-Medium (2) L-Low (1)

Course Code CC5	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	GENETICS	Core	Y	-	-	-	5	3	25	75	100

Learning Objectives	
CO1	To understand the structure and functions of nucleic acids in the cell.
CO2	To know the causes and effects of mutations.
CO3	To comprehend the importance of genetic variation in evolution.
CO4	To know about the harmful effects of genetic variations in humans, their cumulative effect in human population and the molecular basis of variations.

UNIT	Details	No. of Hours	Course Objectives
I	**Mendelian Genetics:** Laws of Mendelian experiments - Monohybrid, Dihybrid, back cross and test cross; Interaction of genes: Incomplete dominance, co dominance, complementary genes, supplementary genes, inhibiting genes and lethal genes. **Inheritance:** Polygenic inheritance - sex linked inheritance - skin colour - colour blindness and hemophilia in man. ABO blood groups in man.	12	CO1, CO2
II	**Linkage**: Linked genes, complete and incomplete linkage. **Crossing over:** molecular mechanisms of crossing over, kinds of crossing over, models of recombination. Chromosome mapping: inference and coincidence, haploid mapping, somatic cell hybridization.	12	CO1, CO2, CO4, CO5
III	**Cytogenetics**: Variation in chromosome number and structure: position effect, chromosomal mutation and evolution. Gene mutation: types, molecular basis of mutation, mutational hot spots, reversion; radiation and chemical agents as mutagens.	12	CO1, CO2, CO3, CO4, CO5
IV	**Human Genetics:** Karyotypes and ideogram; sex determination - Barr body technique, drumstick method; chromosomal abnormalities in humans, Pedigree analysis; diagnosis of genetic abnormalities; Population genetics and evolution: gene pool, gene frequency and genotype frequency; Hardy-Weinberg law of equilibrium.	12	CO1, CO2, CO4, CO5

V	**Molecular Genetics:** Insertion elements, transposable elements, retroelements; integrons and antibiotic resistance cassettes; the lactose system and operon model, tryptophanoperon, role and relative positions of promoters and operators, feedback mechanism.	12	CO1, CO2, CO4, CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand the basis of inheritance and expression of genes.	PO1
CO2	Correlate changes in genetic makeup and phenotypic changes in progeny.	PO2, PO3, PO5
CO3	Analyse the causes of variations in genetic material and predict the effect in a population using different techniques.	PO2, PO3, PO4, PO5, P06
CO4	Explain the role of cellular processes and different genetic elements in the expression of genes.	PO2
CO5	Compile the factors which contribute to changes in gene expression and specify the changes which contribute to evolution.	PO1, PO3, PO4, PO5, PO6, PO8

Text Books
(Latest Editions)

1.	David E Sadava, 1993. Cell Biology - Organelle Structure and Function, Jones Bartlett Publishers.
2.	Guptha G. K., 2013. Genetics Classical to Modern, Rastogi publishers, Meerut.
3.	Lewin B., 2008. Genes IX, Jones and Bartlett publishers.
4.	Veer Bala Rastogi., 2019. Text Book of Genetics, Medtech
5.	Verma P.S and Agarwal V.K., 2006. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Ltd.
6.	Verma P. S. and V. K. Agarwal., 2018. Genetics, S. Chand & Company Pvt Ltd.

References Books
(Latest editions, and the style as given below must be strictly adhered to)

1.	Cooper, Geoffrey M., 2018. The cell: A Molecular Approach, Eighth Edition, Oxford University Press.
2.	De Robertis, E. D. P and E.M.F Robertis, 2017. Cell and Molecular Biology 8th Edition, LWW.
3.	Dobzhansky T., 1982. Genetics and The Origin of Species, Columbia University.
4.	Fletcher H and Hickey I., 2015. Genetics, IV Edition. GS, Taylor and Francis Group, New York and London.
5.	Gardner, Anne. 2009. Human Genetics, Scion Publishing Ltd.
6.	Klug, W. S., Cummings, M. R., Spencer, C. A., 2012. Concepts of Genetics. X Edition. Benjamin Cummings.
7.	Lodish, Harvey, Arnold Berk *et al* .,2007. Molecular cell biology. 6th edition, W.

	H. Freeman.
8.	Russel, Peter J. 2013. iGenetics: A Molecular Approach, Pearson.
9.	Strickberger M. W., 1995. Genetics, Prentice Hall India Learning Private Limited.
Web Resources	
1.	https://go.nature.com/2XE8V1q
2.	https://bit.ly/3zoTt6B
3.	https://bit.ly/2XAm7oa
4.	https://bit.ly/2XEbhxi
5.	https://bit.ly/3AB4bso
6.	https://bit.ly/39pZSE4
7.	https://www.genome.gov/genetics-glossary/Sex-Linked
8.	https://www.vedantu.com/biology/mutagens

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2		S	S		S			M
CO 3			S	S	S	S		S
CO 4		S						
CO 5		S	S	S	S	S		S

S-Strong (3) M-Medium (2) L-Low (1)

SKILL ENHANCEMENT COURSE
(ENTREPRENEURIAL BASED)
AQUARIUM KEEPING

Learning Objectives

- To create knowledge on self employment opportunity of ornamental fishes
- To provide the knowledge of ornamental fishes and their equipment
- To understand the different breeding techniques of ornamental fishes

Unit I: Introduction and scope - Aquarium fish keeping as hobby and cottage industry. Commercial aspects like national and international market - Self employment opportunity.

Unit II: External morphology of a typical fish. Exotic and endemic varieties of ornamental fishes.

Unit III: Aquarium preparation and maintenance - Kinds of tanks, tank setting, biological filter and aeration, water management, planting, lighting and feeds. Budget for setting up an Aquarium Fish Farm as a Cottage Industry

Unit IV: Live fish transport- handling, feeding and forwarding techniques of fish. Fish Diseases and their control.

Unit V: Breeding – Common characters and sexual dimorphism of Fresh water and Marine aquarium ornamental fish varieties such as Guppies, Mollies, Sword tails, Platy, Siamese fighters and Gold fish, Butterfly fish, Blue morph and Anemone fish.

Reference Books:

1. Santhanam, P., Sukumaran, N. & P. Natarajan, A manual of freshwater aquaculture (1987), Reprint 1999, Oxford & IBH Publishing Company Pvt., Ltd., New Delhi.
2. Cliff Harrison, A colour guide to Tropical Fish (1980), Chartwell Books, INC, Cerkshire, printed in Hon Kong.
3. O'Connell, R. F., The freshwater aquarium (1977), Arco Publishing Company, INC New York.
4. JingranV.G., 1991: Fish and Fisheries in India – Hindustan Publ.co. New Delhi
5. Mill Dick, 1993: Aquarium Fish, Daya Pub.co., New Delhi

Course Outcome:

1. Students to learn about different ornamental fishes and identify the diseases of them
2. To develop entrepreneur potential in the field of aquarium and get self employment.

SKILL ENHANCEMENT COURSE
BIOCOMPOSTING FOR ENTREPRENEURSHIP

Learning Objectives:

1. To highlight the importance of Biocomposting for entrepreneurship in waste management.
2. To enable students for setting up Biocompost units and bins for waste reduction.

Course outcomes:

1. The students will gain knowledge about the process of Biocomposting.
2. Students will be able to demonstrate Biocomposting techniques for various end applications like solid waste management, industrial waste recycling using sugarcane bagasse, etc.
3. To gain knowledge about the economic cost of establishing small Biocompost units as a cottage industry.

Unit – I
Biocomposting – Definition, types and ecological importance.

Unit – II
Types of Biocomposting technology – Field pits - ground heaps – tank – large – scale - batch and continuous methods.

Unit – III
Preparation of Biocompost pit and bed using different amendments.

Unit – IV
Applications of Biocompost in soil fertility maintenance - promotion of plant growth - value added products - waste reduction.

Unit – V
Economics of establishment of a small biocompost unit – project report proposal for Self Help Group (Income and employment generation).

References

1. Bikas R. Pati& Santi M. Mandal (2016). Recent trends in composting technology.
2. Van der Wurff, A.W.G., Fuchs, J.G., Raviv, M., Termorshuizen, A.J. (Editors) 2016.
3. Handbook for Composting and Compost Use in Organic Horticulture. BioGreenhouse Cost Action FA 1105, www.biogreenhouse.org.

SEMESTER -IV

Course Code CC1	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Developmental Biology	Core	Y	-	-	-	5	5	25	75	100
Learning Objectives											
CO1	To create an awareness to the students about the theories, concepts and basics of Developmental Biology.										
CO2	To provide students about the idea of sex cells, fertilization, cleavage, differentiation and development of organs.										
CO3	To make an awareness of the induction, organizers and development of extra embryonic structures.										
CO4	To provide adequate explanation to students about the late embryonic developments and post embryonic development and ageing										
CO5	To give an idea about teratogenesis, invitro fertilization, stem cells and amniocentesis to the students										

UNIT	Details	No. of Hours	Course Objectives
I	**Fertilization:** Basic concepts of developmental biology. Structure & types of Spermatozoa, Mammalian egg - Egg membranes. Types of egg - Spermatogenesis – Oogenesis. Fertilization – mechanism, theories and significance – Parthenogenesis.	12	CO1
II	**Cleavage, Blastulation & Gastrulation:** Cleavage - Planes and Patterns, Factors controlling cleavage - Fate map and its construction. Blastulation –types of blastula. Morphogenetic movements - Gastrulation of frog & chick.	12	CO2
III	**Organogenesis:** Development of Brain, Eye and Heart in frog. Development of Nervous system in chick. Foetal membranes in chick. Development of Pro, Meso and Metanephric kidneys. Placentation in Mammals – Sheep and Pig.	12	CO3
IV	**Applied Embryology:** Organizer concept – structure – mechanism of induction and competence. Nuclear transplantation - teratogenesis Regeneration: Types - events and factors. Embryonic stem cells & significance.	12	CO4

V	**Human embryology:** Reproductive organs, Menstrual cycle and menopause - Pregnancy – trimesters – development. Erythroblastosis foetalis - Twins – types. Infertility – causes - Test tube baby and Assisted Reproductive Technology – Embryo transfer – Amniocentesis.	12	CO5
		60	
Course Outcomes			
CO1	To describe and illustrate the significance of cellular processes in embryonic development.	PO1	
CO2	To relate the factors that contribute to the developmental process, construct fate maps and illustrate the steps in morphogenesis and organogenesis.	PO1, PO2	
CO3	To correlate the involvement of specific cell types in the formation of specific organs and explain the importance of morphogenesis.	PO4, PO6	
CO4	To distinguish between the different types of developmental mechanisms in various organisms and appraise the species-based differences in development.	PO4, PO5, PO6	
CO5	To justify and validate the role of environment and genetics in influencing embryonic development	PO3, PO8	
Text Books (Latest Editions)			
1.	Lewis Wolpert 2007. Principles of development, 3rd edition, Oxford University Press, New Delhi, India		
2.	Subramoniam, T. 2003. Developmental Biology, Narosa Publishing House, New Delhi, India.		
3.	Verma, P.S., Agarwal, V. K.2010.Chordate Embryology: Developmental Biology, S. Chand & Company, New Delhi., India.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Gilbert S.F. 2010. Developmental Biology, Sinauer Associates, Massachusetts, USA.		
2.	Balinsky, B.I. 1970. Introduction to Embryology, Philadelphia & London, UK.		
3.	Berril, N.J.1971. Developmental Biology, McGraw Hill, New York, USA.		
4.	Russ Hodge 2010. Developmental Biology, Facts on File, Inc., New York, USA.		
5.	Carlson, Bruce, M. 2009. Human embryology and Developmental Biology, Elsevier, Philadelphia, USA		
Web Resources			
1.	https://www.ncbi.nlm.nih.gov/books/NBK10052/		
2.	https://www.cdc.gov/ncbddd/developmentaldisabilities/facts.html		
3.	https://anatomypubs.onlinelibrary.wiley.com/doi/full/10.1002/dvdy.20468		
4.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5293490/		

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) M-Medium (2) L-Low (1) B N

SKILL ENHANCEMENT COURSE
FOOD, NUTRITION AND HEALTH

Learning Objectives:

The course covers the basic concepts of balanced diet for people of different ages besides focusing on the consequences of malnutrition and the deficiency diseases and the diseases caused due to poor hygiene.

Unit I : Nutrition and dietary nutrients:

Basic concepts of Food: Components and nutrients. Concept of balanced diet, nutrient requirements and dietary pattern for different groups viz., adults, pregnant and nursing mothers, infants, school children, adolescents and elderly people.

Unit II: **Macro nutrients and micronutrients:**

Macronutrients. Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role. Micronutrients. Vitamins - Water-soluble and Fat-soluble vitamins - their sources and importance. Important minerals viz., Iron, Calcium, Phosphorus, Iodine, Selenium and Zinc: their biological functions.

Unit III: **Malnutrition and nutrient deficiency diseases**:

Definition and concept of health: Common nutritional deficiency diseases- Protein Malnutrition (e.g., Kwashiorkor and Marasmus), Vitamin A deficiency, Iron deficiency and Iodine deficiency disorders- their symptoms, treatment, prevention and government initiatives.

Unit IV: Life style dependent diseases:

Hypertension, diabetes mellitus, and obesity their causes and prevention. Social health problems - smoking, alcoholism, narcotics. Acquired Immuno Deficiency Syndrome (AIDS): causes, treatment and prevention.

Unit V: **Diseases caused by microorganisms:**

Food hygiene: Potable water- sources and methods of purification at domestic level. Food and Water-borne infections: Bacterial diseases: cholera, typhoid fever - viral diseases: Hepatitis, Poliomyelitis - Protozoan diseases: amoebiasis, giardiasis - Parasitic diseases: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention.

References

1. Mudambi, S.R. and Rajagopal, M.V. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed;; New Age International Publishers.
2. Srilakshmi, B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.
3. Swaminathan, M. (1986). Handbook of Foods and Nutrition; Fifth Ed; BAPPCO.
4. Bamji, M.S.; Rao, N.P. and Reddy, V. (2009). Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd.
5. Lakra, P. and Singh M.D. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.
6. Gibney, M.J. et al. (2004). Public Health Nutrition; Blackwell Publishing.

Course outcomes:

1. Understand the role of food and nutrients in health and disease.
2. Gain knowledge about hygiene, food safety, disease transmission.
3. Perform food system management and leadership functions that consider sustainability in business, healthcare, community and institutional areas.

SKILL ENHANCEMENT COURSE
ORNAMENTAL FISH FARMING& MANAGEMENT

Learning Objectives:

- To highlight the importance of ornamental fish culture in relation to entrepreneurship development.
- To enable the identification, culture and maintenance of commercially important ornamental fishes.
- To provide the knowledge on the techniques of ornamental fish breeding, rearing, disease control and economics of ornamental fish farming.

Unit I:

Introduction to ornamental fish keeping. Scope and importance of ornamental fish culture. Domestic and global scenario of ornamental fish trade and export potential. Commercially important ornamental fishes - Indigenous and exotic varieties.

Unit II:

Biology of egg layers and live bearers. Food and feeding in ornamental fishes. Formulated feed and Live feed; Live feed culture. Breeding, hatchery and nursery management of egg layers (Goldfish) and live bearers (Guppy).

Unit III:

Aquarium design and construction; Accessories - aerators, filters and lighting. Aquarium plants and their propagation. Maintenance of aquarium and water quality management. Ornamental fish diseases, their prevention, control and treatment methods.

Unit IV:

Conditioning, packing, transport and quarantine methods. Economics, trade regulations, domestic and export marketing strategies.

Unit V:

Fresh water ornamental fishes - taxonomy and biology. Fresh water aquarium plants. Marine ornamental fishes - habits and collection from nature. Methods of collection.

References:

1. Swain SK., Sarangi N. and Ayyappan S. 2010. Ornamental fish farming. ICAR, New Delhi.
2. Living Jewels – A handbook on freshwater ornamental fish, MPEDA, Kochi.
3. Dey V.K.A. 1997. A handbook on aquafarming ornamental fishes. MPEDA, Kochi.
4. Ahilan, B., Felix N. and Santhanam R. 2008. Text book of aquariculture. Daya Publishing House, New Delhi.

Web links:

- **http://ecoursesonline.iasri.res.in/course/view.php?id=297**
- **https://www.ofish.org/**
- **https://krishijagran.com/agripedia/income-generation-by-ornamental-fish-culture/**
- https://99businessideas.com/ornamental-fish-farming/

Course Outcome:

- The students will be able to identify culture, maintain and market the commercially important ornamental fishes.
- The knowledge and skills gained on the different aspects of ornamental fish keeping will enable the students to develop entrepreneurship potential and help in self employment.

SEMESTER- V

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
CC6	**EVOLUTIONARY BIOLOGY**	Core	Y	-	-	-	4	5	25	75	100
Learning Objectives											
CO1	Evolutionary biology is a branch of the biological sciences concerned with the origin of life and the diversification and adaptation of life forms over time.										
CO2	This course helps to understand the important processes, principles, and concepts on evolution.										
CO3	To provide adequate information on the Lamarckism - Neo Lamarckism – Darwinism, Neutral Theory of Molecular Evolution, and Human Genome Project.										
CO4	To explain the importance of the fossil records in evolutionary studies, and the role of phylogenetic studies in the wider context of biodiversity and conservation.										
CO5	In this course, we will apply the knowledge of human evolutionary history to simulate how genetic variation within and among human populations affects risk, diagnosis, and treatment of modern diseases.										
UNIT	**Details**							**No. of Hours**	**Course Objectives**		
I	Inorganic and organic evolution - History of evolutionary thought, Primordial earth and atmosphere, Chemical origin of life: Synthesis of organic molecules, Urey-Miller experiment, Origin of prokaryotes and eukaryotes.							12	CO1		
II	Lamarckism - Neo Lamarckism - Darwinism - Neo Darwinism and modern synthetic theory – De Vrie's Mutation theory - modern concepts of mutation - Mutation and their role in evolution - Animal colouration and Mimicry.							12	CO2		
III	Isolating mechanisms - Modes of speciation- Law of Adaptive Radiation - Adaptive radiation in reptiles and mammals - Convergence and parallelism - Evolutionary constancy.							12	CO3		
IV	Evidences of Evolution - Homologous organs, Analogous organs, Vestigial organs, Mass extinction – causes, major extinctions. Types of rocks -							12	CO4		

	Geological time scale – Nature of fossils- Dating of fossils - Fossil records of man and horse. Culture Evolution, Future Evolution.		
V	Natural selection in action in man - level of selection - Eugenics, Euphenics and Euthenics- Adaptation - Human Genome Project – Evolution and ethics.	12	CO5
	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	To understand the Primordial earth and theories on origin of life	PO1	
CO2	To integrate and assess Lamarckism - Neo Lamarckism – Darwinism	PO1, PO2	
CO3	To analyse various fossil records of man and fossil records of horse, various types of rocks - Geological time scale.	PO4, PO6	
CO4	To explain the Nature of fossils- Dating of fossils, evidences of evolution, Adaptive radiation in reptiles and mammals,	PO4, PO5, PO6	
CO5	To construct and compile the role of Human Genome Project, Evolution in the diagnosis, and treatment of diseases.	PO3, PO8	
Text Books (Latest Editions)			
1.	Ridley, M., 2004. Evolution. III Edition. Blackwell Publishing.		
2.	Lull, R.S. 2010. Organic evolution, The Macmillan, New York.		
3.	Minkoff, E. C. (1983). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company		
4.	Sober, E. (1994). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.		
5.	Dr. Kishore R. Pawar, Dr. Ashok E. Desai, 2019. A text book of Organic Evolution, Nirali Prakashan,		
6.	Rastogi VB. 1991. Organic Evolution. Kedar Nath Ram Nath Publications, Meerut,Uttar Pradesh, India.		
7.	Stricberger, M.W., 1996. Evolution. Jones& Bartlett, USA		
8.	Colbert, E.H. Morales, M. and Minkoff, E.C. 2011. Colbert's Evolution of The Vertebrates: A History of the Backboned Animals Through Time, Wiley, India.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Burns GW. 1972. The Science of Genetics. An Introduction to Heredity. Mac Millan Publ. Co.Inc.		
2.	Gardner EF. 1975. Principles of Genetics. John Wiley & Sons, Inc. New York.		
3.	Harth and Jones EW. 1998. Genetics – Principles and Analysis. Jones and BarHett Publ. Boston.		

4.	Levine L. 1969. Biology of the Gene. Toppan.
5.	Pedder IJ. 1972. Genetics as a Basic Guide. W. Norton & Company, Inc.
6.	Rastogi VB. 1991. A Text Book of Genetics. Kedar Nath Ram Nath Publications, Meerut, Uttar Pradesh, India.
7.	White MJD. 1973. Animal Cytology and Evolution. Cambridge Univ.Press.
Web Resources	
1.	https://bit.ly/3nPD09m
2.	https://bit.ly/3CHOdgL
3.	https://bit.ly/2XvcCXl
4.	https://bit.ly/2XAL1Vh
5.	https://bit.ly/3zoU9Jl

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course Code CC9	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ANIMAL PHYSIOLOGY	Core	Y	-	-	-	4	5	25	75	100

Learning Objectives	
CO1	To familiarize students with the principles and basic facts of Animal Physiology
CO2	To give students an insight about the molecular and cellular basis of physiological functions in animals.
CO3	To give an idea about the regulation of organ system functions in a whole animal using a conceptual model of feedback to explain homeostasis.
CO4	To make the student's aware about how the structure-function relationships and its synchronization with the molecular signals.

UNIT	Details	No. of Hours	Course Objectives
I	**Nutrition:** Digestion and absorption of carbohydrates proteins and lipids. Minerals & Vitamins – their deficiency. Hormonal control of digestion. **Respiration:** Types of Respiration, Respiratory pigments - structure of Haemoglobin, Transportation of gases – Bohr effect – Regulation of respiration - bronchitis, asthma. – Physiological effects of smoking	12	CO1
II	**Circulation:** Blood - composition and functions, Mechanism of clotting. Types of Hearts – Heart beat and its regulation - pace maker – Cardiac cycle – ECG - Pulse and blood pressure. **Excretion** Nephron structure & mechanism of urine formation, Regulation of acid base balance, excretory products, Osmoregulation in fishes.	12	CO2
III	**Muscle:** Types of muscles – Ultra structure of striated muscle, Muscle contraction & properties, **Nerve Physiology:** Neurons – structure & types Impulse propagation, synaptic transmission, neurotransmitters - Reflex action, Nerve disorders – epilepsy, Alzheimer's disease, Parkinson's disease.	12	CO3
IV	**Sense Organs:** Structure of eye, physiology of vision, visual elements and pigments, photo chemistry of vision - Eye defects – myopia, hyperopia, presbyopia, astigmatism, cataract - Structure of ear and mechanism of hearing - Hearing impairments – deafness, labyrinthine disease -Olfactory, gustatory and tactile sense organs.	12	CO4

V	**Reproductive Physiology:** Endocrine glands in man - Hormones, action and disorders - Feed-back mechanism, Outlines of mechanism of hormonal activity. Puberty, adolescence, pregnancy, parturition, lactation and birth control.	12	CO5
	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Be able to explain how the various organ systems are coordinated and controlled.	PO1	
CO2	Be able to list the functions of various organs in relation to physiological process.	PO1, PO2	
CO3	Be able to develop the idea of multi level controlling and feedback mechanism in relation to various physiological functions.	PO4, PO6	
CO4	Be able to understand the basic physiological process related to adaptation, metabolism and major requirements.	PO4, PO5, PO6	
CO5	Be able to correlate and understand human physiology.	PO3, PO8	
Text Books (Latest Editions)			
1.	Agarwal R A., Anil K Srivastava., Kaushal Kumar.,1978. Animal Physiology and Biochemistry, S. Chand & Co. Ltd., New Delhi Publishing., 377 pp.		
2.	Ambika Shanmugam, 2001. Fundamentals of Biochemistry for Medical students, Karthik Offset Printers, Chennai, 590pp		
3.	Berry A.K.1998. A text book of Animal Physiology and Biochemistry. Emkay Publications, New Delhi, 320 pp.		
4.	Parameswaran, Ananta krishnan and Ananta Subramanian, 1975. Outlines of Animal Physiology, S. Viswanathan (Printers & Publishers) Pvt. Ltd., 329 p p.		
5.	Verma P.S., Tyagi B.S & Agarwal V.K., 2010. Animal Physiology, S. Chand & Co. Ltd., New Delhi Publishing., 417 pp.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Guyton, A.C. and Hall, J.B., 2011. Text Book of Medical Physiology, 9th Edition, W.B. Sanders Company, Prism Books (Pvt.) Ltd., Bangalore., 1064 pp.		
	Ganong, W.F., 2019. Review of Medical Physiology, McGraw Hill, New Delhi., 340 pp.		
	Hill, W.R., Wyse, G.A and Anderson, M. 2016. Animal Physiology (4thedn). Sinauer Associates is an imprint of Oxford University Press; USA, 828 pp.		
2.	Hoar, W.S. 1983. General and Comparative Physiology. Prentice Hall of India, New Delhi, 928 pp.		
3.	Prosser C.L., 1985. Comparative Animal Physiology, Satish Book Enterprise, Agra - 282 003, 966 pp.		
4.	Sarada Subrahmanyam, Madhavan Kutty, K., & Singh H.D., 2018. Text Book of Human Physiology, S. Chand & Co, New Delhi.		

5.	Singh, H.R and Kumar, N. 2017. Animal physiology and biochemistry, Vishal publishing company, Jalandhar, 864 pp.
6.	Sreekumar, S. 2010. Basic physiology, PHI learning private ltd., New Delhi.210 pp
7.	Tortora G.J. & Derrickson B., 2016. Principles of Anatomy and Physiology, John Sons, Inc. 1232 pp.
	Wood, D.W., 1968. Principles of Animal Physiology, Edward Arnold Ltd, London., 342 pp.
Web Resources	
1.	https://microbenotes.com/category/biochemistry/
2.	https://www.stem.org.uk/resources/collection/3931/animal-physiology
3.	https://animalphys4e.sinauer.com
4.	https://nptel.ac.in/courses/102/104/102104042/
5.	https://biochem.oregonstate.edu

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course Code CC10	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ENVIRONMENTAL BIOLOGY	Core	Y	-	-	-	4	5	25	75	100

Learning Objectives	
CO1	To understand the structure and functions of the ecosystem.
CO2	To explain the relationship between biotic and abiotic factors in an ecosystem.
CO3	To know the causes and effects of climate change and habitat loss.
CO4	To bring awareness about the impact of socio-economic development on the environment and the solutions put forward by the government to reduce environmental damage.

UNIT	Details	No. of Hours	Course Objectives
I	**Ecosystem**: Concept of an ecosystem - Structure and function of an ecosystem - Producers, consumers and decomposers - Energy flow - Ecological succession - Food chains, food webs and ecological pyramids - Forest ecosystem - Grassland ecosystem - Desert ecosystem - Aquatic ecosystems (ponds, estuaries).	12	CO1
II	**Population and Biological Cycles:** Structure and distribution – Growth curves - Population Groups, natality, mortality - Density indices, Life tables - factors affecting population growth. Complete and incomplete biogeochemical cycles – Carbon, Nitrogen, Phosphorus.	12	CO2
III	**Environmental Pollution**: Definition- cause, effects and control measures - Air pollution - Water pollution - Soil pollution - Marine pollution - Noise pollution - Thermal pollution - Nuclear hazards.	12	CO3
IV	**Environmental Stress and Management**: Global warming, atmospheric ozone, acid and nitrogen deposition. Bioaccumulation, Biomagnifications, Biodegradation and Bioremediation. Pesticides and other chemical in agriculture, industry and their disposal. Bio indicator and biomarkers of environmental health.	12	CO4

V	**Biodiversity Conservation**: Biodiversity crisis – habitat degradation, poaching of wild life. - Socio economic and political causes of loss of biodiversity. - In situ and ex situ conservation of biodiversity - Hot spots of Biodiversity. Green peace movement - Chipko Movement - Role of government agencies: Central and State Pollution Control Boards - Ministry of Environment and Forests- National Biodiversity Authority. Awareness, Programme, NGOs, Bio villages – sustainable utilization and development, Environmental ethics.	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand the fundamental structure and functions of the ecosystem.	PO1
CO2	Assess the inter-relationship between organisms and between biotic and abiotic factors in an ecosystem.	PO1, PO2
CO3	Analyze the factors that cause pollution, climate change, loss of biodiversity and depletion of resources.	PO4, PO6
CO4	Evaluate the impact of human population growth and socio-economic development on the structure and function of the ecosystem.	PO4, PO5, PO6
CO5	Design plans to scientifically solve environmental problems using biological tools, technologies and government policies.	PO3, PO8

Text Books (Latest Editions)	
1.	Matthew R. Fisher, 2018. Environmental Biology.Open Oregon Educational Resources. James Madison University.
2.	Asthana, D.K. and Meera, A. 2009. A text book of environmental studies, S. Chand, New Delhi.
3.	Sanyal, K. Kundu, M. and Rana, s. 2009. Ecology and environment, Books and allied, Kolkata.
4.	Grant, W.E. and Swannack, T.M., 2008, Ecological Modelling, Blackwell.

References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Odum E.P.1983. Basic Ecology, Saunders, New York
2.	Wilkinson, D.M., 2007, Fundamental Processes in Ecology: An Earth system Approach, Oxford University Press, UK.

3.	Saha, T.K. 2010. Ecology and Environmental biology, Books and Allied, Kolkata.	
Web Resources		
1.	https://bit.ly/2VYWOM5	
2.	https://bit.ly/2VZQFiT	
3.	https://bit.ly/3kqdXYA	
4.	https://bit.ly/39rvvgt	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) M-Medium (2) L-Low (1)

GENERIC ELECTIVE COURSE
AGRICULTURAL ENTOMOLOGY

Learning Objectives

1. Explain the basic concepts of entomology and observe the pest status of agriculture.
2. Illustrate and examine the systemic and functional morphology of various group of agricultural insect pests.
3. Differentiate and classify the various groups of insect animals and estimate biodiversity.
4. To compare and distinguish the general and specific characteristics integrated pest management.
5. Infer and integrate the economic importance of insect species.

Unit I: Outline classification of insects - Causes for insect assuming pest status - Methods of collection, mounting and preservation of insect pests.

Unit II: Insect vectors of plant diseases, Insect pests of stored grains their preventive and curative methods, Common insect pests of the plants and their control measures: Paddy, Sugarcane, Groundnut, Coconut and Cotton. Locust and its control. Insect pollinators and scavenger.

Unit III: Apiculture - Introduction, types of honey bees, hive, apiary, selection of bees for apiary, Newton's bee hive, enemies and diseases of honey bees. Sericulture: Introduction, types of silk worms, silk worm races, life history of mulberry silk worm, features of sericulture industry, pests and diseases of silk worm.

Unit IV: IPM, physical, mechanical, chemical and biological control methods, Pesticide application equipment.

Unit V: Introduction and steps towards IPM, Pheromones, antifeedents, repellents and biopesticide.

Text Books

1. David,BandAnanthakrishnan,T.N.2006.Generaland AppliedEntomology, Second edition, Tata McGraw hill publishing company Ltd.,New Delhi, India.
2. Vasanthraj David, B. and Ramamurthy, VV. 2012. Elements ofEconomic Entomology, Seventh edition, Namruthapublications, Chennai.
3. Pruthi,H.S.1969.TextbookonAgriculturalEntomology,I.C.A.R.Publication,New Delhi.
4. Awasthi, V.B. 2012. Introduction toGeneral and Applied Entomology, third edition, Scientific publishers.

Suggested Readings

1. AbishekShukla, D. 2009.A Hand Bookof EconomicEntomology, VedamseBooks,NewDelhi.
2. MinistryofAgriculture,GovernmentofIndia,1995.ManualonIntegratedPest Management in Rice andCotton.
3. John WilliamS. 1995. Management ofNatural Wealth, Loyola College Publications, Chennai.

Web resources

1. http://www.fao.org
2. http://flybase.bio.indiana.edu/
3. http://www.ipm.ucdavis.edu
4. http://www.ent.iastate.edu/list/
5. www.entsoc.org

Course Outcomes (COs)

1. Examine and identify the systemic and functional morphology of various group of agricultural insect pests.
2. Differentiate and classify the various groups of insects and estimate the biodiversity.
3. Explain the pest status in agriculture and control measures.
4. To compare the methods and outcomes of integrated pest management.
5. List the economic importance of agricultural insect species.

ELECTIVE COURSE
MEDICAL LABORATORY TECHNIQUES

Learning Objectives

1. To understand the different protocols and procedures to collect clinical samples.
2. To explain the characteristics of clinical samples.
3. To demonstrate skill in handling clinical equipment.
4. To evaluate the safety precautions while handling clinical samples.
5. To summarize the control measures to avoid contamination of clinical samples.

Unit I: Laboratory Safety, Human Health and Hygiene: Laboratory safety – toxic chemicals and biohazards waste - biosafety level- good laboratory practice –health and hygiene issue – physiological effect of alcohol, tobacco, smoking and junk food and its treatment.

Unit II: Hematology: Composition of blood and their function - collection of blood – haemopoiesis - types of anaemia - mechanism of blood coagulation - bleeding time- clotting time - determination of hemoglobin - erythrocyte sedimentations rate - packed cell volume - Total count of RBC and WBC - Differential count WBC - Platelet count - blood grouping and typing – haemostasis - bleeding disorder of man.

Unit III: Microbiology and Instrumentation Techniques: Definition and scope of microbiology - parasites – Entamoeba – Plasmodium - Leishmania and Trypanosoma - Computer Tomography (CT scan) – Magnetic Resonance Imaging (MRI) – Treadmill test.

Unit IV: Medical Physiology: Cardiovascular system- Blood pressure - Pulse – regulation of heart rate, cardiac shock. Heart sounds, Electrocardiogram (ECG) – ultra sonography - Electroencephalography (EEG).

Unit V: Diagnostic Pathology: Handling and labelling of histology specimens - Tissue processing - histological tissues for paraffin embedding block preparation. Microtome – types of microtome-sectioning, staining methods - vital staining – mounting.

Text Books

1. Godker, P. B. and Darshan, P, Godker, 2011. Text book of medical Laboratory Technology, Mumbai.
2. Guyton and Hall, 2000. Text Book of medical Physiology, 10th edition, Elseiner, New Delhi.
3. Mukerjee, K.L, 1999. Medical Laboratory Technology- Vol, I, II, III. Tata MC GrawHill, New Delhi.
4. Sood, R, 2009. Medical Laboratory technology, Methods and interpretation.

Suggested Readings

1. Manoharan,A, and Sethuraman, 2003. Essential of Clinical Heamatology, Jeypee brothers, New Delhi.
2. Richard, A, McPherson, Mathew, R, Pincus, 2007. Clinical and management by laboratory methods, Elsevier, Philadelphia.Published by Tata McGraw-Hill Education Pvt. Ltd.,
3. Ochei. J., A. Kolhatkar (2000). Medical Laboratory science: Theory and practice, Published by Tata McGraw-Hill Education Pvt. Ltd, First edition.

Web Resources

1. https://bit.ly/3tUs8In
2. https://bit.ly/2XKu7mT
3. https://bit.ly/3hNS1EP
4. https://bit.ly/2ZgrLga
5. https://bit.ly/3hTBO1b

Course Outcomes (COs)

1. Understand protocols and procedures to collect clinical samples for blood analysis and to study human physiology.
2. Explain the characteristics of clinical samples.
3. Demonstrate skill in handling clinical equipment.
4. Evaluate the hematological and histological parameters of biological samples.
5. Elaborate the role of medical laboratory techniques in health care industry.

SEMESTER - VI

Course Code CC14	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ANIMAL BIOTECHNOLOGY	Core	Y	-	-	-	4	6	25	75	100

Learning Objectives	
CO1	To impart the skills required to explain the protocols for genetically manipulating cells and produce transgenic animals.
CO2	To encourage the use of the apt molecular techniques to evaluate and analyze animal traits and diseases at the genomic level and employ methods for easy taxonomical identification and classification for biodiversity and environmental studies.
CO3	To study methods of Transgenesis and to consider their use in improving animal husbandry and animal health.
CO4	To motivate students to review the ethics and speculate on the environmental implications of animal biotechnological methods

UNIT	Details	No. of Hours	Course Objectives
I	**Fundamentals of Biotechnology**: Basic requirements and techniques of cell culture, natural and synthetic culture media, primary culture and cell lines. Stem cells: types, culture and applications. r-DNA technology, Enzymes, Vectors – pBR322, Phage lambda, Cosmid, BAC, YAC; Host cells, Gene cloning.	12	CO1
II	**Techniques in Animal Biotechnology**: Isolation and purification: DNA and mRNA; Blotting techniques: Methods of different types of blotting; DNA sequencing: Sanger method, microarray; PCR: principle, types and application; Gene library: Site directed mutagenesis: principle and application; Gene transfer in animal cells: electroporation, biolistic.	12	CO2
III	**Transgenic Animal Technology**: Transgenesis: Concept, transgenes, transgenic animal models - knockout mice; Applications of Transgenesis: Molecular farming, Transgenic fishes and its significance.	12	CO3

IV	**Animal Biotech and Health Care**: Medical biotechnology: Monoclonal antibodies, recombinant vaccines – hepatitis B, hormones – insulin. DNA diagnostic systems: tuberculosis, AIDS, Gene therapy in cancer treatment; CRISPR gene editing. Molecular markers: RFLP, RAPD, DNA fingerprinting.	12	CO4
V	**Applications and Ethics:** Human genome project: Mapping of human genome, applications, ethics; Industrial biotechnology: Bioreactors - Basic concepts of fermentation, bioreactor design, production of ethanol and streptomycin; Ethics: Socio ethical problem, recent trends in animal biotechnology, ethical implications.	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	To describe the methodologies for handling animal cells based on their diverse characteristics and identify the correct biotechnological tools to obtain the desired products from the cells.	PO1
CO2	To develop and explain the protocols for genetically manipulating cells and produce transgenic animals	PO1, PO2
CO3	To select the apt molecular techniques to evaluate and analyze animal traits and diseases at the genomic level and devise methods for easy taxonomical identification and classification for biodiversity and environmental studies.	PO4, PO6
CO4	To choose the correct methods of transgenesis and to consider their use in improving animal husbandry nationally and globally	PO4, PO5, PO6
CO5	To speculate on the environmental implications of animal biotechnological methods and design responsible, ethical solutions to livestock production and health issues.	PO3, PO8

Text Books (Latest Editions)

1.	Singh B. D., 2015. Biotechnology: Expanding horizon, Kalyani publishers.
2.	Sasidhara, R., 2015. Animal biotechnology, MJP publishers.
3.	Dubey R. C., 2014. A text Book of Biotechnology, S. Chand & Co Ltd, Ram Nagar, New Delhi.
4.	Dubey S. K., Bandana Ghosh, 2012. Fish biotechnology, Wisdom Press.

<table>
<tr><td>5.</td><td colspan="2">Dubey R.C., 2014. Advanced Biotechnology, S. Chand Publication.</td></tr>
<tr><td>6.</td><td colspan="2">Ruby, R.C., 2012. A text book of biotechnology, S. Chand Company, New Delhi.</td></tr>
<tr><td>7.</td><td colspan="2">Sambamurthy K., Ashutosh Kar., 2009. Pharmaceutical Biotechnology, New Age International (P) Ltd.</td></tr>
<tr><td>8.</td><td colspan="2">Ramdoss P.,2009. AnimalBiotechnology- Recent concepts and developments, MJP publishers.</td></tr>
<tr><td>9.</td><td colspan="2">Sathyanarayran U., 2008. Biotechnology, Books and Allied, Kolkata.</td></tr>
<tr><td>10.</td><td colspan="2">Ignacimuthu, S., 2008. Basic Biotechnology, Tata McGraw hill, New Delhi.</td></tr>
<tr><td>11.</td><td colspan="2">Rastogi S. C., 2007. Biotechnology: Principles and applications, Alpha Science publishers. Ranga, M.M., 2003. Animal biotechnology, Agrobios, New Delhi.</td></tr>
<tr><td colspan="3">References Books
(Latest editions, and the style as given below must be strictly adhered to)</td></tr>
<tr><td>1.</td><td colspan="2">Veer Bala Rastogi, 2016. Principles of Molecular biology, Medtech, Maine, USA.</td></tr>
<tr><td>2.</td><td colspan="2">Michael Crichton, 2014. Essentials of Biotechnology, Medtech, Maine, USA.</td></tr>
<tr><td>3.</td><td colspan="2">Godbey W.T., 2014. An Introduction to Biotechnology, Academic press, New York, USA.</td></tr>
<tr><td>4.</td><td colspan="2">Peters, P., 2009. Biotechnology – A guide to genetic engineering, WMC brown publisher, UK.</td></tr>
<tr><td>5.</td><td colspan="2">Ramawat, K.G and Shailey Goyal, 2009. Comprehensive biotechnology, S.Chand company, New Delhi, India.</td></tr>
<tr><td>6.</td><td colspan="2">Primrose S.B., R. M. Twyman and R. W. Old, 2001. Principles of gene manipulation, Wiley- Blackwell, UK.</td></tr>
<tr><td>7.</td><td colspan="2">Primrose S. B., 2001. Molecular Biotechnology, Panima Publishing Corporation, New Delhi, India.</td></tr>
<tr><td>8.</td><td colspan="2">Hames B.D. and Higgins S.J. 1995. Gene Probes: A Practical Approach, Oxford University Press, UK.</td></tr>
<tr><td colspan="3">Methods of Evaluation</td></tr>
<tr><td rowspan="4">Internal Evaluation</td><td>Continuous Internal Assessment Test</td><td rowspan="4">25 Marks</td></tr>
<tr><td>Assignments</td></tr>
<tr><td>Seminars</td></tr>
<tr><td>Attendance and Class Participation</td></tr>
<tr><td>External Evaluation</td><td>End Semester Examination</td><td>75 Marks</td></tr>
<tr><td></td><td>Total</td><td>100 Marks</td></tr>
<tr><td colspan="3">Methods of Assessment</td></tr>
<tr><td>Recall (K1)</td><td colspan="2">Simple definitions, MCQ, Recall steps, Concept definitions</td></tr>
<tr><td>Understand/ Comprehend (K2)</td><td colspan="2">MCQ, True/False, Short essays, Concept explanations, Short summary or overview</td></tr>
<tr><td>Application</td><td colspan="2">Suggest idea/concept with examples, Suggest formulae, Solve problems,</td></tr>
</table>

(K3)	Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course Code CC15	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	MICROBIOLOGY	Core	Y	-	-	-	4	6	25	75	100

Learning Objectives	
CO1	To become familiar with the foundation concepts of history of Microbiology
CO2	To understand the structure and functions of a typical prokaryotic cell
CO3	To gain the knowledge of microscopy and staining concepts
CO4	To understand and implement disposal and safety measures

UNIT	Details	No. of Hours	Course Objectives
I	**Introduction to microbiology** History, scope, branches of microbiology. Contribution of Leeuwanhoek, Jenner, Pasteur, Koch. Evolution of Microbial diversity. Systematic position: 5 kingdom classification of Whittaker and 3 kingdom classification of Carl Woese. Comparison of Bacteria, Archaea, Eukarya.	12	CO1
II	**Microscopy** Principles of microscopy; Compound microscope - Monocular and Binocular microscopes, Principle and its uses. Dark field, Phase contrast and Fluorescence microscopes, Principle and its applications. Electron microscopy – TEM and SEM – principle and its uses.	12	CO2
III	**Introductory Mycology** General characteristics and outline classification of fungi, Morphology of some common fungi – Mucor, Aspergillus, Penicillium. Yeasts: General characteristics and outline classification. General characteristics of Lichens and Mycorrhiza.	12	CO3
IV	**Introductory Bacteriology** Classification of bacteria. Anoxygenic photosynthetic bacteria: general characteristics of purple bacteria and green bacteria. Oxygenic photosynthetic bacteria: General characteristics of Cyanobacteria – external and internal features, physiology and ecology. Food born bacterial disease. Gram staining.	12	CO4

V	**Introductory Virology** Virus Structure and Classification. Virus Entry and Viral Pathogenesis. Positive-strand RNA viruses: Picornaviruses, Coronaviruses. Negative-strand and double-strand RNA viruses: Rhabdoviruses, Reoviruses. DNA viruses: Papillomaviruses, Baculoviruses, Herpes viruses and Poxviruses.	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	To understand history, relevance of microbiology and classification of bacteria	PO1
CO2	To understand the working of various microscopes and their application	PO1, PO2
CO3	To gain knowledge of various (physical and chemical) methods of control of microorganisms and safety measures to be followed while handling microbes	PO4, PO6
CO4	To understand the structure of bacterial cells, its organelles, physiology and behaviour.	PO4, PO5, PO6
CO5	To learn different methods of staining bacteria and demonstrate proficiency in handling aseptic bacteriological specimen.	PO3, PO8

Text Books (Latest Editions)	
1.	Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom Cultivation , New Age International, New Delhi.
2.	Atlas R.M., Microbiology – fundamentals and applications, Macmillan Publishing Company, New York.
3.	Ravindra Nath, Fundamentals of Biology Courses for Biotechnology, - Vol.1, Special Bangalore University edition, Kalayani Publishers.
4.	Greenwood D, Richard CD, John S and Peuther F (1992). Medical Microbiology, 16th edition. ELBS, Churchill living stone.

References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Alexopoulos C.J. and Mims C.W., Introductory Mycology, New Age International, New Delhi.
2.	Thomas M. Bell, 1965. An Introduction to General Virology, William Heinemann Medical books, London.
3.	Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi.

<table>
<tr><td>4.</td><td colspan="2">Salle A.J., Fundamental Principles of Bacteriology, Tata McGraw – Hill Publishing Company Limited, New Delhi.</td></tr>
<tr><td>5.</td><td colspan="2">Pelczar .J. Chan E.C.S. and Krieg N.R., Microbiology, McGraw Hill Book Company, New York.</td></tr>
<tr><td>6.</td><td colspan="2">Benson Harold J, Microbiological Applications, WCB McGraw – Hill, New York.</td></tr>
<tr><td>7.</td><td colspan="2">Brock T.D. and Madigan M.T., Biology of Microorganisms, Prentice Hall of India Private Limited.</td></tr>
<tr><td>8.</td><td colspan="2">Collins CH, Patricia M, and Lyne JM (1995). Collins and Lynes Microbiological Methods 7th edition. Grange, Butter Worth, Oxford.</td></tr>
<tr><td>9.</td><td colspan="2">Cappucino JG and Sherman N (1996). Microbiology, A Laboratory Manual 4th edition. Benjamin Cumings Inc. California.</td></tr>
<tr><td>10.</td><td colspan="2">Pelczar MJ, Chan ECS and Krieg NR (1993). Microbiology 5th edition, Tata McGraw Hill.</td></tr>
<tr><td>11.</td><td colspan="2">Madigan MT, Martinko JM and Parker J (2012). Brock Biology of Microorganism, 11th edition Prentice Hall International Inc. London.</td></tr>
<tr><td colspan="3">Web Resources</td></tr>
<tr><td>1.</td><td colspan="2">https://vlab.amrita.edu/?sub=3&brch=73</td></tr>
<tr><td>2.</td><td colspan="2">https://learn.chm.msu.edu/vibl/</td></tr>
<tr><td>3.</td><td colspan="2">https://mvi-au.vlabs.ac.in/</td></tr>
<tr><td>4.</td><td colspan="2">https://virtuallab.tlc.ontariotechu.ca/intro.php</td></tr>
<tr><td>5.</td><td colspan="2">https://www.merlot.org/merlot/viewMaterial.htm?id=79694</td></tr>
<tr><td colspan="3">Methods of Evaluation</td></tr>
<tr><td rowspan="4">Internal Evaluation</td><td>Continuous Internal Assessment Test</td><td rowspan="4">25 Marks</td></tr>
<tr><td>Assignments</td></tr>
<tr><td>Seminars</td></tr>
<tr><td>Attendance and Class Participation</td></tr>
<tr><td>External Evaluation</td><td>End Semester Examination</td><td>75 Marks</td></tr>
<tr><td></td><td>Total</td><td>100 Marks</td></tr>
<tr><td colspan="3">Methods of Assessment</td></tr>
<tr><td>Recall (K1)</td><td colspan="2">Simple definitions, MCQ, Recall steps, Concept definitions</td></tr>
<tr><td>Understand/ Comprehend (K2)</td><td colspan="2">MCQ, True/False, Short essays, Concept explanations, Short summary or overview</td></tr>
<tr><td>Application (K3)</td><td colspan="2">Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain</td></tr>
<tr><td>Analyze (K4)</td><td colspan="2">Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge</td></tr>
<tr><td>Evaluate (K5)</td><td colspan="2">Longer essay/ Evaluation essay, Critique or justify with pros and cons</td></tr>
</table>

Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
CC16	**IMMUNOLOGY**	Core	Y	-	-	-	4	6	25	75	100

Learning Objectives	
CO1	To understand the fundamentals of immunology in protection against disease and also the key principles of antigen- antibody reaction in the immune system.
CO2	To list basic mechanisms that regulate immune responses, describe the main steps in the generation of cells and organs of the immune system.
CO3	To describe the basic mechanisms that provides innate immunity and antigen processing and presentation.
CO4	To differentiate B and T cell receptors, organs, and microenvironments of the Immune System.
CO5	To promote critical thinking and provide students with knowledge on how the immune system works building on their previous knowledge from biochemistry, genetics and cell biology.

UNIT	Details	No. of Hours	Course Objectives
I	**Immune Cells and Organs**: Overview of Immune System - General concepts and Haematopoeisis. Cells of the immune system - T and B-lymphocytes, NK cells; Monocytes and macrophages. Organs of the Immune system: Primary lymphoid organs - Thymus and bone marrow; Secondary Lymphoid organs - Lymph nodes and spleen; Lymphatic tissues - Peyer's patches and Kupffer cells, MALT, GALT and CALT.	12	CO1
II	**Innate and Adaptive Immunity:** Innate Immunity; Anatomical barriers, Inflammatory response, Cells and molecules involved in innate immunity, Adaptive immunity - Cell mediated and humoral immunity. Receptors and Signaling: Cytokines and Chemokines - General Properties of Cytokines and Chemokines. Major Histocompatibility Complex (MHC).	12	CO2
III	**Antigen and Antibodies**: Antigens- Antigenicity and immunogenicity: Properties - foreignness, molecular size, heterogeneity. B & T epitopes, T-dependent and T-independent B cell responses. Antibodies: Structure, function and properties of the Immunoglobulins.	12	CO3

	Classes, antigenic determinants on antibodies. Hybridoma technology.		
IV	**Hypersensitivity and Autoimmune Diseases**: Hypersensitivity: classification and brief description of various types of hypersensitivities. Autoimmunity: cause of autoimmune diseases. Transplantation immunology: Types of grafts, immunologic basis of graft rejection, immunosuppressive therapy and clinical transplantation.	12	CO4
V	**Clinical Immunology:** Immunity and tumors- tumor antigens (TSTA and TAA), immune response to tumors. Immunotherapy for tumors. Immunity against - viral, bacterial and parasitic infections. Vaccines: Types and uses - Immunization schedule for children.	12	CO5
	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Understand and recall the basic structural and functional components of the immune system compare and contrast cells with respect to origin and maturation.	PO1	
CO2	Classify and explain types of immunity state the significance of antigen and examine their relevance to immunizations.	PO1, PO2	
CO3	Describe and differentiate the biological characteristics of the antibodies, analyze and formulate the procedure for antibody production	PO4, PO6	
CO4	Compare and rate the mechanism of various types of hypersensitivity reactions, assess and identify the different types of autoimmune diseases.	PO4, PO5, PO6	
CO5	Summarize immune responses against pathogens	PO3, PO8	
Text Books (Latest Editions)			
1.	Kuby, J, Punt, J, Stranford, S, Jones,Pand Owen, J, 2018. Immunology, 8th Edition, W.H.Freeman Publishing, New York, 944 pp.		
2.	Roitt, M, Peter J. Delves, Seamus J. Martin and Dennis R. Burton, 2017. Essential Immunology, 13th Edition, Wiley-Blackwell Publishing,USA, 576 pp.		
3.	Coleman,R.M., 2014. Fundamental Immunology, 2nd Edition, Published by Mc Graw Hill Education India, 357 pp.		
4.	Raj Khanna, 2011. Immunology, Oxford University press, New Delhi. 428 pp.		
5.	Rao.C.V. 2011. Immunology, Narosa Publishing House, New Dehli, 426 pp.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Abul A. Andrew, Lichtman. H, Shiv. P, 2014. Cellular and Molecular		

	Immunology, 8th Edition, Published by W.B. Saunders, 544 PP.	
2.	Chapel. H, Haeney. M, Misbah. S, and Snowden. N, 2006. Essentials of Clinical Immunology, 5th Edition. Blackwell Publishing, 368 PP.	
3.	William R. Clark, 1985. The Experimental Foundations of Modern Immunology, Published by Johns Hopkins University Press, New York. 326 PP.	
4.	Kenneth Murphy & Casey Weaver, 2016. Janeway's Immunology, Garland Science publishers, 924 pp.	
Web Resources		
1.	https://www.aaaai.org/	
2.	https://www.bsaci.org/	
3.	https://www.immunology.org/	
4.	https://nptel.ac.in/courses/102/103/102103038/	
5.	https://microbenotes.com/category/immunology/	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

CORE LAB COURSE (PRACTICAL – I)
SEMESTER – II

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	LAB COURSE-I **Invertebrata And Chordata**	Core	Y	-	-	-	3	5	40	60	100

Learning Objectives	
CO1	To identify the different groups of invertebrate and chordate animals by observing their external characteristics.
CO2	To understand the organs, organ system and their functions in lower animals.
CO3	To get knowledge about the different modes of life and their adaptation based on the environment.
CO4	Able to dissect and display the internal organs and mount the mouthparts and scales of invertebrates and to know about the classification, adaptations and affinities of chordate animals.

Content	**Details**	**No. of Hours**	**Course Objectives**
Major (20 Marks)	**Cockroach**: Digestive system, Nervous system; **Prawn**: Nervous system, Appendages; **Fish**: Digestive system.	12 12	CO1 CO2
Minor (10 Marks)	**Mounting:** Earthworm-Body setae; **Mouth parts** - Honey Bee, House fly and Mosquito. **Fish**: Placoid and Ctenoid scales.	12	CO3
Spotters (20 Marks)	**Classify giving reasons:** **(i).Protozoa:** Paramoecium, Plasmodium vivax **(ii).Porifera:** Sycon, Spongilla. **(iii).Coelenterata:** Obelia, Aurelia. **(iv).Platyhelminthes:** Planaria, Fasciola hepatica. **(v).Nemathelminthes:**Ascaris (Male & Female), Wuchereria. **(vi).Annelida:**Hirudinaria. **(vii).Arthropoda:** Scorpion, Limulus. **(viii).Mollusca:**Pila, Unio. **(ix).Echinodermata:** Asterias, Echinus. **Specimens and Slides**: **(i) Hemichordata:** Balanoglossus **(ii). Protochordata:** Amphioxus **(iii). Cyclostomata:** Petromyzon	12 12	CO4 CO5

	(iv).Pisces: Hippocampus, Echieneis. **(v).Amphibia:**Bufo, Rana. **(vi).Reptilia:** Chemaeleon, Vipera russelli, Naja naja,. **(vii).Aves:** Archaeopteryx, Columba. **(viii).Mammalia:** Manis, Loris. **Draw labeled Sketch:** Obelia medusa, Taenia solium – scolex, Frog Skull and Lower Jaw, Pectoral girdle, Pelvic girdle, Pigeon – synsacrum. **Biological Significance**: Sponge-Gemmule, Peripatus, Bipinnaria Larva. **Related Structure and function**: Neris-parapodium, Pila-radula, Pigeon-Skull and Lower Jaw, Skull of Rabbit.		
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Identify and label the external features of different groups of invertebrateand chordate animals.	PO1
CO2	Illustrate and examine the circulatory system, nervous system and reproductive system of invertebrate and chordate animals.	PO1, PO2
CO3	Differentiate and compare the structure, function and mode of life of various groups of animals.	PO4, PO6
CO4	To compare and distinguish the dissected internal organs of lower animals.	PO4, PO5, PO6
CO5	Prepare and develop the mounting procedure of economically important invertebratesand chordates.	PO3, PO8

Text Books (Latest Editions)	
1.	Ekambaranatha Iyyar and T. N. Ananthakrishnan, 1995 A manual of Zoology Vol.I (Part 1, 2) S. Viswanathan, Chennai
2.	Ganguly, Sinha an d A dhikari , 2 0 11 . Biology of Animals: Volume I, New Central Book Agency; 3rd revised edition. 1008 pp.
3.	Sinha, Chatterjee and Chattopadhyay, 2 0 1 4. Advanced Practical Zoology, Books & Allied Ltd; 3rd Revised edition, 1 07 0 pp.
4.	Lal ,S. S, 2016 . Practical Zoology Invertebrate, Rastogi Publications.
5.	Verma, P. S. 2010. A Manual of Practical Zoology: Invertebates, S Chand, 4 97pp.
6.	Lal S S, 2009. Practical Zoology Vertebrate, Rajpal and Sons Publishing, 484pp.
7.	VermaP.S,2000.AManual ofPracticalZoology:Chordates,S.ChandLimited, 627pp.

References Books **(Latest editions, and the style as given below must be strictly adhered to)**	
1.	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.
2.	Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition. Holt Saunders International Edition.
3.	Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition,

	E.L.B.S. and Nelson
4.	Boradale, L.A. and Potts, E.A. (1961). *Invertebrates: A Manual for the use of Students*. Asia Publishing Home.
5.	Lal, S.S. 2005. A text Book of Practical Zoology: Invertebrate, Rastogi, Meerut
6.	Robert William Hegner, 2015. Practical Zoology, BiblioLife, 522pp.
7.	Young, J,Z., 1972. The life of vertebrates. OxfordUni. London.
Web Resources	
1.	https://nbb.gov.in/
2.	http://www.agshoney.com/training.htm
3.	https://icar.org.in/
4.	http://www.csrtimys.res.in/
5.	http://csb.gov.in/

Methods of Evaluation		
Internal Evaluation	Internal Assessment Test	40 Marks
	Observation Record	
	Attendance and Regulatory in Lab Participation	
External Evaluation	End Semester Practical Examination	60 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, Dissection and mountings.
Understand/ Comprehend (K2)	Explain the concept of animal adaptation and biological significance to respective model (specimen-Spotters) of life.
Application (K3)	Define the morphological observation of selected animals.
Analyze (K4)	Define the structure and functions of animal parts.
Evaluate (K5)	Analysis the microscopic organisms.
Create (K6)	Identify and draw selected parts of animal's origin.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

CORE LAB COURSE (PRACTICAL – II)
SEMESTER – IV

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	LAB COURSE-II Cytology, Genetics and Developmental Biology	Core	Y	-	-	-	3	5	40	60	100

Learning Objectives	
CO1	To encourage students to interpret the organization of genomic material and to research theories of genetic inheritance.
CO2	To impart the skills required to prepare samples of genetic molecules and to determine their purity, structure and characteristics and to analyze genomic preparations.
CO3	To study the changes in genetic material and to predict and consider the consequences of those changes.
CO4	To encourage students to report and justify the results of molecular, genetic and developmental experiments in an accurate and meaningful manner.

UNIT	Details	No. of Hours	Course Objectives
Major (20 Marks)	1.Preparation and Identification of slides of Mitotic divisions with onion root tips. 2.Preparation and Identification of different stages of Meiosis in Grasshopper Testes. 3.Staining and observation of polytene chromosomes in salivary glands of chironomous larva 4.Observation of sperm motility of bull.	12 12	CO1 CO2
Minor (10 Marks)	1.Measurement of cell using – Stage Micrometer and Ocular Micrometer. 2.Buccal epithelium (Barr body) preparation 3.Verification of the Mendelian laws of inheritance using coloured beads, Observation on genetic traits. 4.Karyotyping (with the help of photographs) – normal male and female karyotypes and study of karyotypes of different genetic syndromes. 5.Principle and methods of Haematoxylin and Eosin staining.	12	CO3

Spotters (20 Marks)	Mutant Drosophila: Body color mutant - Ebony body and Yellow body. Wing mutant - Curly wing and Vestigial wing. Eye color mutant- Bar eye, White eye, Sepia eye. Kleinfelter's Syndrome, Down Syndrome, Tumer's Syndrome. Slides - mammalian sperm, Ovum; Chick embryo - 24 Hours, 48 Hours, 72 hours and 96 Hours; Cleavage stages - Blastula, Gastrula and Morula of frog. Placenta – Sheep, Pig.	12 12	CO4 CO5
	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	To describe, examine and interpret the organization of genomic material and to research theories of genetic inheritance.	PO1	
CO2	To prepare samples of genetic molecules and to determine their purity, structure and characteristics.	PO1, PO2	
CO3	To experiment with genomic preparations and devise techniques to distinguish genetic material in different organisms to survey biodiversity.	PO4, PO6	
CO4	To assess the changes in genetic material and to predict and consider the consequences of those changes.	PO4, PO5, PO6	
CO5	To report and justify the results of molecular, genetic and animal developmental experiments in an accurate and meaningful manner.	PO3, PO8	
Text Books - (Latest Editions)			
1.	Surya Nandan Meena, Milind Naik, 2019. Advances in Biological Science Research: A Practical Approach, Academic Press, New York, USA.		
2.	Michael Perlin, William Beckerson, Adarsh Gopinath, 2017. Cell, Genetics, and Molecular Biology: A Lab Manual (First Edition), Cognella Inc., USA.		
3.	Saxena J., Baunthiyal M., Ravi I., 2015. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology, Scientific Publishers, India.		
4.	Bansal M.P., 2013. Molecular Biology and Biotechnology: basic experimental protocols, The Energy and Resources Institute (TERI), New Delhi, India.		
5.	Chaitanya K.V., 2013. Cell and molecular biology: A Lab Manual, Phi Learning Pvt. Ltd., New Delhi, India.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Andreas Hofmann, Samuel Clokie, 2018. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, UK.		
2.	Bancroft, J.D. and Gamble, M (2007) Theory and Practice of Histological Techniques, 6 th Edition, Churchill Livingstone.		
3.	Ian Freshney R., 2010. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, John Wiley & Sons, USA.		
4.	Leonard Davis, Mark Dibner, James Battey, 2012. Basic Methods in Molecular		

	Biology, Elsevier Science Pubilshing Co., NY, USA.
5.	Luiz Carlos (2005) Basic Histology: Text and Atlas (11th Ed). Mc Graw Hill Medical.
6.	Robert F. Schleif, Pieter C. Wensink, 2012. Practical Methods in Molecular Biology, Springer-Verlag, NY, USA.
7.	Ross, M.H,, Kaye, G.I. & Pawlina, W. (2002) Histology: A text and atlas (4th ed). Lippincoat Williams & Wilkins.
	Sarah Stauffer, Aaron Gardner, Wilko Duprez, Dewi Ayu Kencana Ungu, Philip Wismer, 2018. Labster Virtual Lab Experiments: Basic Genetics, Springer Publishers, NY, USA.
Web Resources	
1.	https://www.jove.com/
2.	https://vlab.amrita.edu/?sub=3&brch=77
3.	http://cbii-au.vlabs.ac.in/
4.	https://media.hhmi.org/biointeractive/vlabs/transgenic_fly/index.html
5.	https://www.ibiology.org/biology-techniques/

Methods of Evaluation		
Internal Evaluation	Internal Assessment Test	40 Marks
	Observation Record	
	Attendance and Regulatory in Lab Participation	
External Evaluation	End Semester Practical Examination	60 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Preparation and Identification of slides of Mitotic divisions.
Understand/ Comprehend (K2)	Staining and observation, Karyotyping and Verification of the Mundelein laws.
Application (K3)	Types of microtome, Principle and methods of stains.
Analyze (K4)	Study of different types of Mutant of Drosophila.
Evaluate (K5)	Analysis the microscopic organisms.
Create (K6)	Study of various breeds of layers and broilers, Different types of embrios.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

CORE LAB COURSE (PRACTICAL – III)
SEMESTER – IV

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	LAB COURSE-III Evolutionary Biology, Environmental Biology, Animal Physiology and MLT.	Core	Y	-	-	-	4	3	40	60	100

Learning Objectives	
CO1	To demonstrate an understanding of core environment toxicological principles, and define scientific principles and concepts as related to environmental studies and sustainability.
CO2	To understand the physiological process that regulates body functions.
CO3	To attain knowledge of important biomolecules such as carbohydrates, lipids, amino acids, proteins and enzymes.
CO4	Measure and interpret experimental data and demonstrate laboratory skills in animal physiology and ecology
CO5	To develop data that can ensure appropriate protection of public health from the adverse effects of exposures to environmental agents.

UNIT	Details	No. of Hours	Course Objectives
Major (20 Marks)	1. Estimation of dissolved Oxygen. 2. Estimation of Dissolved carbon-di-oxide. 3. Determination of salinity of water samples. 4. Total Erythrocyte count by hemocytometer. 5. Total and differential Leukocyte counts.	12 12	CO1 CO2
Minor (10 Marks)	1. Identification of freshwater/Marine plankton. 2. Use of pH meter for estimation of pH in water and soil samples 3. Ptyalin activity in relation to temperature in human saliva. 4. Estimation of Haemoglobin 5. Blood grouping.	12 12	CO3 CO4
Spotters (10 Marks) **&**	Reflux condenser, BOD incubator, Spectrophotometer, Colorimeter, pH meter, hemocytometer, Heamoglobinometer, Atomic absorption spectroscopy, Ultracentrifuge, Incubator and HPLC. Connecting Link of fossils: Euglena, Balanoglossus, Chimaera, and Archaeopteryx.	12	CO5

Field work and submission of report (10 Marks)	Living fossils: Limulus, Peripatus, Latimeria and Sphaenodon. 1. Visit to a local area to document environmental assets river/forest/grassland/hill/ mountain. 2. Visit to a local polluted site - Urban/Rural/Industrial/Agricultural field/area. 3. Visit to Vermicompost production field/Bio gas production plant. 4. Visit to Natural History Museum.		
	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	List and recall the basic equipment used in physiology and environmental toxicology lab and develops skill about quantitative determination of bio molecules and quantitative analysis of blood.	PO1	
CO2	Demonstrate the instruments, discuss the clinical importance and its applications, and explain the principle of bio instruments.	PO1, PO2	
CO3	Understand and identify the toxic, chemical composition of major and minor nutrients and analyse Physio - chemical parameters that regulate metabolism.	PO4, PO6	
CO4	Evaluate and Examine the various parameters of haematology and biochemistry and Identify the nitrogenous waste products of animals.	PO4, PO5, PO6	
CO5	Summarise the effect of various physical and chemical factors on enzyme activity/. Compile the changes in various physiological parameters in man and other animals using various tools and techniques.	PO3, PO8	
Text Books (Latest Editions)			
1.	Widmaier, E.P., Raff, H. and Strang, K.T. 2008. Vander's Human Physiology, XI Edition., McGraw Hill., 770 PP.		
2.	Bishop, ML.,Fody, E.P., Schoeff, LE. 2010. Clinical Chemistry: Principles, Procedure, correlations. Wolters Kluwer, Inida, 298 PP.		
3.	Burtis, C.A. and Ashwood, E.R. 2008. Tietztext book of Fundamentals of clinical chemistry and molecular diagnostics, Elsevier, Philadelphia.		
4.	Ramesh, R and M, Anbu 1996. Chemical methods for environmental Analysis of water and sediment. Macmillan India Limited, Chennai.		
5.	Micheal, P, 1984. Ecological Methods for field visit and laboratory investigation.		

	Tata McGraw Hill, New Delhi.	
6.	Agarwal, A. State of India's Environment: A Citizens Report, Centre for Science and Environment, New Delhi.	
7.	Michael, P, 1984. Ecological Methods for field visit and laboratory investigation. Tata McGraw Hill, New Delhi.	
8.	APHA, 1992. Standard Methods for the examination of water and waste water, American Public Health association, Washington D.C.	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Hoar, W.S. 1983. General and Comparative Physiology. Prentice Hall of India, New Delhi., 928 PP.	
2.	Prosser C.L., 1985. Comparative Animal Physiology, Satish Book Enterprise, Agra - 282 003, 966 PP.	
3.	Wood, D.W., 1968. Principles of Animal Physiology, Edward Arnold Ltd, London.,342 PP.	
4.	Maier, R. M., Pepper I.L. and C. P. Gerba, 2009. Environmental Microbiology. 2 nd ed. AcademicPress. USA	
5.	Rastogi, S.C., 2005. Experimental physiology, New age International Pvt. Ltd. New Delhi.	
6.	Rump, H.H., 1999. Laboratory Manual for the Examination of Water, Wastewater and Soil,3rd Ed., Wiley-VCH, New York.	
Web Resources		
1.	https://bit.ly/3hNyeFN	
2.	https://www.medicinenet.com/alp_test/article.htm	
3.	https://vlab.amrita.edu/?sub=3&brch=63	
4.	https://bit.ly/3u6o0Fb	
5.	https://bit.ly/3hX8Ux0	
Methods of Evaluation		
Internal Evaluation	Internal Assessment Test	40 Marks
	Observation Record	
	Attendance and Regulatory in Lab Participation	
External Evaluation	End Semester Practical Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Estimation of dissolved Oxygen, Dissolved carbon-di-oxide, and salinity.	
Understand/ Comprehend (K2)	Estimation of pH in water and soil samples	

Application (K3)	Simple lab Tests for detection of proteins, carbohydrates and fats.
Analyze (K4)	Methodology of toxicity testing in different samples.
Evaluate (K5)	Examination of human blood groups.
Create (K6)	Identify and draw selected spotters and submission of Field Report.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

CORE LAB COURSE (PRACTICAL – IV)
SEMESTER – VI

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	LAB COURSE-IV **Animal Biotechnology** **Microbiology and Immunology**	**Core**	**Y**	**-**	**-**	**-**	**4**	**3**	**40**	**60**	**100**

Learning Objectives	
CO1	To encourage students to interpret the organization of genomic material and to research theories of genetic inheritance.
CO2	To impart the skills required to prepare samples of genetic molecules and to determine their purity, structure and characteristics and to analyze genomic preparations.
CO3	To study the changes in genetic material and to predict and consider the consequences of those changes.
CO4	To encourage students to report and justify the results of molecular and genetic experiments in an accurate and meaningful manner.

UNIT	Details	No. of Hours	Course Objectives
Major	1. Isolation of genetic molecules: Isolation of DNA from plant/animal cells (Crude method). 2. Identification of bacteria from water samples. 3. Estimation of Protein by calorimeter Culture medium preparation & Pure culture Techniques (Demonstration only).	12 12	CO1 CO2
Minor	1. Sterilization of culture media, techniques and equipments – Demonstration. 2. Staining techniques: Bacterial smear preparation from pure culture, simple staining, Gram's staining. 3. Methylene blue reduction test (Milk). 4. Preparation of temporary mount of Fungi by Lacto phenol cotton blue staining method 5. Preparation of Serum components. 6. Erythrocyte Sedimentation Rate	12 12	CO3 CO4
Spotters	Thymus, Spleen, Bone marrow, Lymph node, Laminar	12	CO5

	air flow, autoclave, petri dish, inoculation loop,pH meter, PBR322-Plasmid, Instrument: PCR ,Gel Electrophoresis, pH meter, ELISA,Western Blot, Haemoglobinometer.		
	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	To describe, examine and interpret the organization of genomic material and to research theories of genetic inheritance.	PO1	
CO2	To prepare samples of genetic molecules and to determine their purity, structure and characteristics.	PO1, PO2	
CO3	To experiment with genomic preparations and devise techniques to distinguish genetic material in different organisms to survey biodiversity.	PO4, PO6	
CO4	To assess the changes in genetic material and to predict and consider the consequences of those changes.	PO4, PO5, PO6	
CO5	To report and justify the results and in an accurate and meaningful manner.	PO3, PO8	
Text Books (Latest Editions)			
1.	Surya Nandan Meena, Milind Naik, 2019. Advances in Biological Science Research: A Practical Approach, Academic Press, New York, USA.		
2.	Michael Perlin, William Beckerson, Adarsh Gopinath, 2017. Cell, Genetics, and Molecular Biology: A Lab Manual (First Edition), Cognella Inc., USA.		
3.	Saxena J., Baunthiyal M., Ravi I., 2015. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology, Scientific Publishers, India.		
4.	Bansal M.P., 2013. Molecular Biology and Biotechnology: basic experimental protocols, The Energy and Resources Institute (TERI), New Delhi, India.		
5.	Chaitanya K.V., 2013. Cell and molecular biology: A Lab Manual, Phi Learning Pvt. Ltd., New Delhi, India.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Andreas Hofmann, Samuel Clokie, 2018. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, UK.		
2.	Sarah Stauffer, Aaron Gardner, Wilko Duprez, Dewi Ayu Kencana Ungu, Philip Wismer, 2018. Labster Virtual Lab Experiments: Basic Genetics, Springer Publishers, NY, USA.		
3.	Leonard Davis, Mark Dibner, James Battey, 2012. Basic Methods in Molecular Biology, Elsevier Science Pubilshing Co., NY, USA.		
4.	Robert F. Schleif, Pieter C. Wensink, 2012. Practical Methods in Molecular Biology, Springer-Verlag, NY, USA.		
5.	Ian Freshney R., 2010. Culture of Animal Cells: A Manual of Basic Technique		

	and Specialized Applications, John Wiley & Sons, USA.	
Web Resources		
1.	https://www.jove.com/	
2.	https://vlab.amrita.edu/?sub=3&brch=77	
3.	http://cbii-au.vlabs.ac.in/	
4.	https://media.hhmi.org/biointeractive/vlabs/transgenic_fly/index.html	
5.	https://www.ibiology.org/biology-techniques/	
Methods of Evaluation		
Internal Evaluation	Internal Assessment Test	40 Marks
	Observation Record	
	Attendance and Regulatory in Lab Participation	
External Evaluation	End Semester Practical Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, analysis and Isolation of genetic molecules.	
Understand/ Comprehend (K2)	Determination of the purity of isolated DNA and RNA samples.	
Application (K3)	Define the morphological observation and study of Eliza, Western Blot tests.	
Analyze (K4)	Estimation of Hematological Analysis.	
Evaluate (K5)	Analysis the microscopic organisms.	
Create (K6)	Determination of the viability of different cells..	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

ALLIED ZOOLOGY
SEMESTER – I

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ALLIED ZOOLOGY-I	Core	Y	-	-	-	3	4	25	75	100

Learning Objectives	
CO1	To acquire a basic knowledge of diversity and organization of Protozoa, Coelenterata, Helminthes and Annelida
CO2	To acquire a basic knowledge of diversity and organization of Arthropoda, Mollusca and Echinodermata
CO3	To comprehend the taxonomic position and diversity among Protochordata, Pisces and Amphibia
CO4	To comprehend the taxonomic position and diversity among Reptilia, Aves and Mammalia
CO5	To acquire detailed knowledge of select invertebrate and chordate forms

UNIT	Details	No. of Hours	Course Objectives
I	Invertebrata - Principles of taxonomy. Criteria for classification – Symmetry and Coelom – Binomial nomenclature. General characters and Structure of Protozoa - Paramecium, Porifera - Leucosolenia, Coelenterata - Aurelia	12	CO1
II	General characters and Structure of Helminthes - Fasciola hepatica and Annelid - Leech, Arthropoda – Cockroach, Mollusca - Fresh water mussel and Echinodermata - Starfish.	12	CO2
III	Classification and External characters of Prochordata – Cephalochordata - Amphioxus, Pisces- Shark and Amphibia - Frog.	12	CO3
IV	Classification and External characters of Reptilia - Calotes, Aves - Pigeon and Mammalia - Rabbit.	12	CO4
V	Animal organization - Structure and organization of Earthworm, Fish & Rat	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Recall the characteristic features invertebrates and chordates.	PO1
CO2	Classify invertebrates up to class level and chordates up to order level	PO1, PO2
CO3	Explain and discuss the structural and functional organisation of some invertebrates and chordates	PO4, PO6
CO4	Relate the adaptations and habits of animals to their habitat	PO4, PO5, PO6
CO5	Analyse the taxonomic position of animals.	PO3, PO8
Text Books (Latest Editions)		
1.	Ekambaranatha Iyer,-OutlinesofZoologyViswanathanPublication	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Ekambaranatha Iyar and T.N.Ananthakrishnian - A ManualofZoologyInvertebrata–VolI:ViswanathanPublishers.	
2.	EkambaranathaIyarandT.N.Ananthakrishnan,-AManualofZoology-Invertebrata–VolII:ViswanathanPublishors.	
3.	EkambaranathaIyarandT.N.Ananthakrishnan,-AManualofZoology:ChordataViswanathanPublishers.	
4.	JordanE.L.andP.S. Verma-Invertebrate Zoology,S.Chand&Co.	
Web Resources		
1.	www.sanctuaryasia.com	
2.	www.iaszoology.com	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	

Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

ALLIED ZOOLOGY
SEMESTER - II

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ALLIED ZOOLOGY-II	Core	Y	-	-	-	3	4	25	75	100

Learning Objectives	
CO1	To enable students to learn basic concepts relating to aspects of respiratory, circulatory, excretory nervous and sensory physiology.
CO2	To enable students to comprehend the processes involved during development
CO3	To enable students to learn basic concepts of immunity and the working of immune organs and familiarize them with the recommended vaccination schedule
CO4	To enable students to comprehend the basic concepts of human genetics and patterns of inheritance
CO5	To enable students to learn about aspects of animal behaviour such as foraging, courtship, nest construction, parental care and learning

UNIT	Details	No. of Hours	Course Objectives
I	Respiratory pigments and transport of gases. Mechanism of blood clotting. Structure of neuron – Conduction of nerve impulse, Mechanism of vision and hearing. Types of excretory products – Ornithine cycle.	12	CO1
II	Fertilization - Cleavage, Blastulation, Gastrulation and Organogenesis of Frog; Placenta in mammals (Sheep and Pig).	12	CO2
III	Immunity - Innate and Acquired Immunity - Active and Passive Immunity; Antigens and Antibodies; Immunological organs – responses in humans; Vaccination schedule.	12	CO3
IV	Human Genetics - Human Chromosomes – Sex Determination; Patterns of Inheritance: Autosomal Dominant and Recessive, X-linked Inheritance, Y-linked Inheritance, Mitochondrial Inheritance, Multiple Allelic and Polygenic Inheritance, Genetic Counseling.	12	CO4
V	Animal Behaviors - Habitat Selection (Shelter and Nest Construction), Food Selection, Anti-predator defense, Parental Care, Migration.	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Recall the parts and working of body organs and developmental stages, name the patterns of inheritance and list different types of animal behaviour	PO1
CO2	Analyse the different developmental stages	PO1, PO2
CO3	Analyse the working of body and immune systems	PO4, PO6
CO4	Analyse the different patterns of inheritance	PO4, PO5, PO6
CO5	Relate the behaviour of animals to physiology. Analyse the different types of behaviour	PO3, PO8
Text Books (Latest Editions)		
1.	Verma P.S. & Agarwal - Developmental Biology, Chordata embryology S. Chand & Co.	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Owen, J. A., Punt, J. & Stranford, S. A. - Kuby Immunology. New York: W.H. Freeman & Company	
2.	Klug, W. S., Cummings, M. R. & Spencer, C - Concepts of Genetics. (12th ed.). New Jersey: Pearson Education	
3.	Mathur, R.- Animal Behaviour. Meerut: Rastogi.	
4.	VermaP.S.&Agarwal-DevelopmentalBiology,ChordataembryologyS.Chand&Co.	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Simple definitions, MCQ, Recall steps, Concept definitions	
	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
External Evaluation	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	75 Marks
	Longer essay/ Evaluation essay, Critique or justify with pros and cons	100 Marks

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

ALLIED ZOOLOGY
LAB COURSE (PRACTICAL)
SEMESTER - II

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	LAB COURSE - ALLIED ZOOLOGY	Core	Y	-	-	-	2	2	40	60	100
Learning Objectives											
CO1	1. Learn and be familiar with the Laboratory techniques. **2.** To understand the taxonomic position, body organization and evolutionary relationship of animals. **3.** To inculcate the significance of various non chordates and chordates.										
Expected Course Outcomes - On the successful completion of the course, student will be able to:											
1	Familiar with practical skills in the use of tools, technologies and methods common to microbiology and physiology.										
2	Apply knowledge and come to know how to handle different organisms.										
3	Analyze and to observe various specimens by using Microscope.										
UNIT	**Details**							**No. of Hours**	**Course Objectives**		
MAJOR (20 Marks)	1.Cockroach/Fish –Digestive System. 2.Qualitative detection of excretory products (Ammonia, Urea, Uric acid).							12 12	CO1		
MINOR (10 Marks)	1.Mouth parts of Honey Bee, Mosquito. 3.Fish – Earthworm Body Setae. 4.ABO blood group							12 12	CO2		
SPOTTERS (20 Marks)	Invertebrata: Amoeba, Paramecium, Trypanosoma, Euglena, Plasmodium, Leucosolenia, Sycon sponge, Aurelia, Obelia, Liver fluke, Tapeworm, Earthworm, Nereis, Leech, Cockroach, Prawn, Scorpion, Grasshopper, Fresh water mussel, Pila, Starfish. Protochordata and Vertebrata: Amphioxus, Shark, Fish, Frog, Salamander, Calotes, Chamaeleon, Turtle, Cobra, Viper, Pigeon, Rat, Bat, Rabbit. Larval forms: Zoea larva, Mysis larva, Bipinneria larva, Tadpole larva.							12	CO3		
								60			
Text Book(s)											

1	Arumugam N. (2013). *Developmental Zoology*, Saras Publication, Nagercoil, Tamilnadu,India.
2	Das S. (2020).*Microbiology Practical Manual,* CBS Publication, Delhi.
3	Jayasurya, Arumugam N, Dulsy Fatima. (2013). *Practical Zoology Vol 3,* Saras Publication,Nagercoil, Tamilnadu, India.
4	Singh HR and Neerajkumar. (2014). *Animal Physiology and Biochemistry*, Vishal PublishingCo. Jalandhar, Delhi.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S		M	S	L	M	S	L
CO2		S		M	M			
CO3	S	S	L			L	L	L

***S-Strong; M-Medium; L-Low**

B.Sc., ZOOLOGY

(CBCS PATTERN)

THEORY QUESTION PAPER PATTERN

Time: 3 Hours **Max. Marks: 75**

Part-A: Objective Type Questions 15x1=15 Marks
(Answer ALL the Questions - One question in each unit)

Part-B: Short notes 2x5=10 Marks
Answer any TWO Questions - One question in each unit)

Part-C: Detailed Answer 5x10=50 Marks
(Either or Choice - (Two questions from each unit)

PRACTICAL QUESTION PAPER PATTERN

Time 3 Hours **Max. Marks: 60**

Major Practical	- 20 Marks
Minor Practical	- 10 Marks
Spotters/Field Trip	- 20 Marks
Record	- 10 Marks
Internal Marks	- 40 Marks

Total	**- 100 Marks**

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